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WELCOME TO ICSD 2019

On behalf of the organizing committee, we are pleased to announce that the 4th International Conference on Sustainable Development (ICSD-2019) is held from April 17 to 21, 2019 in BELGRADE. ICSD 2019 provides an ideal academic platform for researchers to present the latest research findings and describe emerging technologies, and directions in Sustainable Development issues. The conference seeks to contribute to presenting novel research results in all aspects of Sustainable Development. The conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Sustainable Development. It also provides the premier interdisciplinary forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments, and applications in all areas of Engineering and Natural Sciences. The conference will bring together leading academic scientists, researchers and scholars in the domain of interest from around the world. ICSD 2019 is the oncoming event of the successful conference series focusing on Sustainable Development. The scientific program focuses on current advances in the research, production and use of Engineering and Natural Sciences with particular focus on their role in maintaining academic level in Engineering and Applied Sciences and elevating the science level. The conference's goals are to provide a scientific forum for all international prestige scholars around the world and enable the interactive exchange of state-of-the-art knowledge. The conference will focus on evidence-based benefits proven in clinical trials and scientific experiments.

Best regards,

Prof. Dr.Özer ÇINAR

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Simulation of Almond Shell Gasification in Circulating Fluidized-bed Gasifier by Using Cycle-Tempo

Tulgaochir Tumurbat[1], Ugur Ozveren[2], Fatma Karaca[3], Halime Yakisik[3], Yagmur Dalbudak[3], Furkan Kartal[3], Beyzanur Ozturk[3]

Abstract

Almond shell is regarded as one of promising renewable sources for energy in Turkey for biomass gasification. Steam gasification for almond shell supplies remarkably higher gas qualities than air-blown gasification. The aim of this study is to simulate a circulating fluidized-bed gasifier for almond shell gasification in situ steam atmosphere using Cycle-Tempo software (TU Delft, the Netherlands). Effect of gasifier temperature and ratio of steam to biomass were discussed. The outcomes of the circulating fluidized-bed gasifier model demonstrated the high steam amount in almond shell gasification enhances production of H_2 and exergy of producer gas. The model was capable of providing detailed data of performance of the almond shell steam gasification in terms of composition of producer gas and exergy as well as lower heating value, and model results are in a good agreement with the experimental results from the literature.

Keywords: Biomass, Circulating Fluidized-bed Gasifier, Almond Shell, Cycle-Tempo

1. INTRODUCTION

Biomass is promising renewable source and alternative to fossil fuels (coal, oil, etc.). Unlike nonrenewable energy sources (oil, natural gas, coal, etc.), it is carbon-neutral. Carbon dioxide which is released during conversion process is later consumed in photosynthesis process [1].

Gasification is the relatively efficient technique to obtain energy carrier or chemical medium using biomass over other methods such as pyrolysis and direct combustion. Biomass gasification technology deals with the conversion of carbon-rich biomass into energy carriers or mediums in a gasifier.

Based on gasifier design and way of introduction of gasifying media and feedstock, three gasifier types are considered: fluidized-bed, fixed bed and entrained bed gasifier [2]. Particularly, circulating fluidized-bed gasifier provides higher mass and heat transfer rate, higher conversion rate and large-scale application for biomass gasification. Modeling can be used as an important tool to optimize and design gasification system [3].

Main goal of present paper is to investigate performance of almond shell gasification in a circulating fluidized-bed gasifier by simulating system with Cycle-Tempo and to assess influence of operation parameters on product gas through exergy, lower heating value and composition. The model is validated through comparison with experimental results in literature. Moreover, with a view to defining the optimal operating configurations and

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obtaining product gas with expected composition, parametric study is conducted and conclusion is made based on the results.

2. MATERIALS AND METHODS

2.1. Characterization of Feed Stock

Almond shell is one of potential renewable sources of energy in Turkey for biomass gasification. Therefore, the feed stock used in developed circulating fluidized-bed gasification model is chosen as almond shell. Ultimate and proximate analysis of almond shell are provided by ECN (Netherlands) [4] and presented below (Table 1).

Table 1. Physical and chemical characteristics of almond shell [4]

Characteristic	Value
Proximate analysis (wt%)	
Volatile matter	70.13
Moisture	7.85
Fixed carbon	19.22
Ash	2.80
Ultimate analysis (wt% db)	
Hydrogen	5.95
Carbon	50.14
Nitrogen	0.74
Oxygen	40.10
Sulphur	0.03
Calorific value (MJ/kg db)	
Lower heating value	17.75

2.2. Modeling

A few software packages are available to optimize the energy conversion systems for gasification using thermodynamic equilibrium equations. Cycle-Tempo is one of them, which is developed at the Delft University of Technology. In this study, Cycle-Tempo simulation program was utilized to model and simulate circulating fluidized-bed gasifier for almond shell gasification. The developed model has been given in Figure 1 for almond shell.

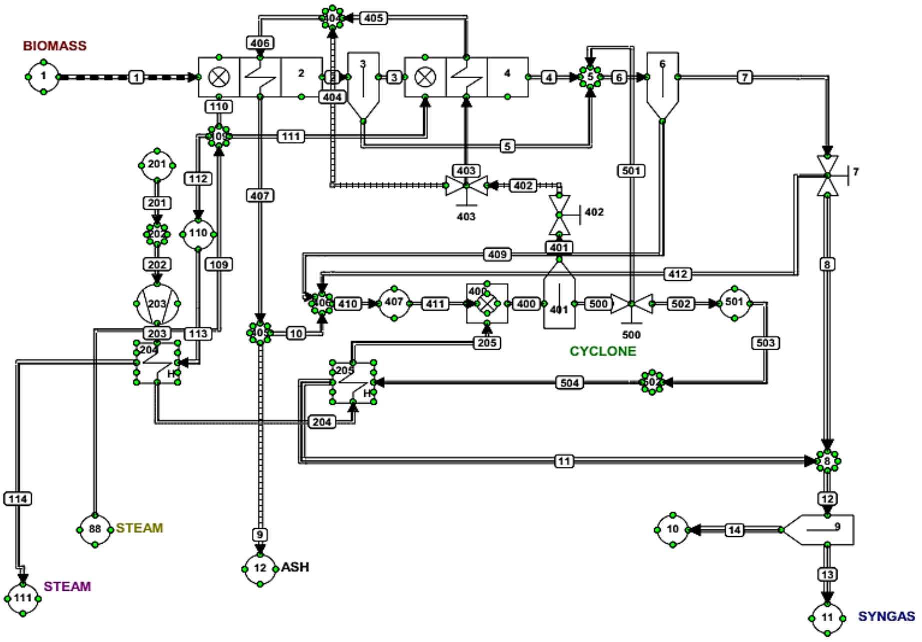

Figure1. Flow sheet of circulating fluidized-bed gasifier in Cycle-Tempo

3. RESULTS AND DISCUSSION

3.1. Validation of the Model

Validation of the developed model has been done through published data from literature [5], [6]. Operating parameters of the gasification system and physical and chemical properties of the used biomasses were set in the model using the data provided by Myohänen et al. [5] and Pfeifer et al [6]. Validation of the model and comparison are presented in Table 2.

Table 2. Validation of the model

1	Sample	Composition (dry %vol.)	[5]	Model
	Woody biomass	H_2	49	50.7
		CO	20	18.8
		CO_2	23	20.2
		CH_4	6	6.3
2	**Sample**	**Composition (dry %vol.)**	**[6]**	**Model**
	Wood pellets	H_2	39.1	40.8
		CO	29.1	29.08
		CO_2	17.5	14.04
		CH_4	11.4	11.38

As it is observed from the Table 2, composition of syngas produced in the developed model is in good agreement with published study. As for CO_2, some under-predictions by the model are observed. The reason for such under-prediction can be related to equilibrium difference which always exist between experimental work and modeling [7]. Other gas contents in the model are close enough to that of gases produced in the experiment work by the researchers.

3.2. Parametric Study

After validation of the developed model comparing with published data from the literature, parametric study has been conducted to investigate performance of the gasification system utilizing the developed model. In the parametric study, temperature of the gasifier and ratio of steam to biomass were varied while other parameters kept constant to estimate sensitivity of composition of product gas, lower heating value and exergy.

3.2.1. Effect of Gasification Temperature on Syngas Composition

The temperature of gasifier was changed from 650°C to 950°C, while steam to biomass ratio and other parameters of circulating fluidized-bed gasifier from Table 3 were kept constant.

Table 3. Operating parameters of the model

Parameters	Unit	Value
Feedstock: almond shell	Kg/h	25
Steam/fuel	Kg/Kg	0.63
Gasification pressure	Bar	1.47

The temperature effect on product gas composition is depicted in Figure 2. As presented in the figure, it is noticed that as gasification temperature increases H_2 and CO amount in the exit gas increase owing to chemical reactions taking place in the gasifier, e.g. Bouduoard and water gas reactions.

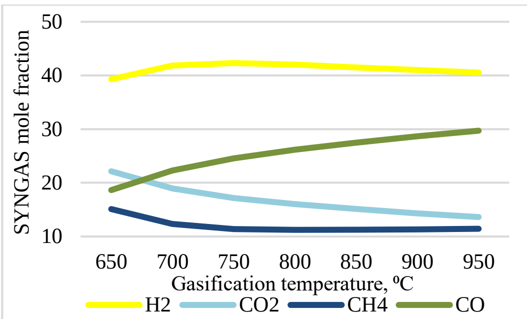

Figure 2. Effect of temperature of gasifier on product gas

The endothermic reactions in the process are endorsed by high temperature shifting to right side producing more CO and H_2 and thus concentration of combustible increases.

3.2.2. Effect of Steam to Biomass Ratio on Syngas Composition

Impact of ratio of steam to biomass over composition producer gas presented in Figure 3. Ratio of steam to biomass was changed from 2.0 to 5.0 while gasification temperature (840°C) and biomass feed rate (25 kg/h) kept constant.

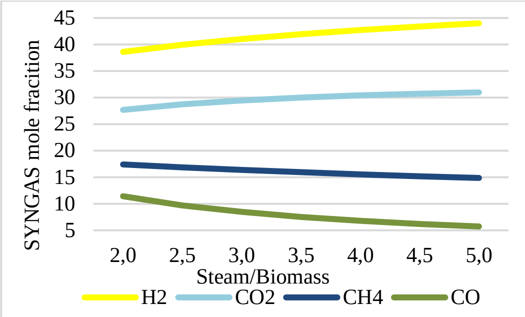

Figure 3. Effect of steam/biomass on syngas

H_2 and CO_2 amount in producer gas increase along with ratio of steam to biomass. However, CH_4 and CO contents in exit gas are reduced owing to water gas shift and methane steam reforming reactions.

3.2.3. Effect of Temperature of Gasifier on Lower Heating Value of Syngas

Effect of temperature of the gasifier is plotted in Figure 4. Temperature of gasifier was changed between 650°C and 950°C while steam to biomass ratio (0.63 Kg/Kg) and biomass feed rate (25 kg/h) kept constant.

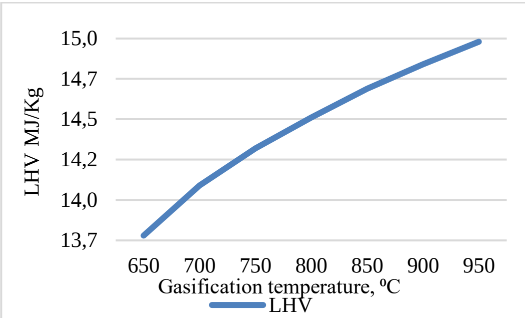

Figure 4. Effect of gasifier temperature on lower heating value of product gas

As seen in Figure 4, the lower heating value of producer gas increases with the gasifier temperature. It provides higher H_2 and CO evolution, which are main contributors to the calorific value of exit gas.

3.2.4. Effect of Steam to Biomass Ratio on Lower Heating Value of Syngas

Effect of ratio of steam to biomass on syngas composition is presented in Figure 5. Ratio of steam to biomass was changed from 2.0 to 5.0 whereas temperature of the gasifier (840°C) and biomass feed rate (25 kg/h) kept constant.

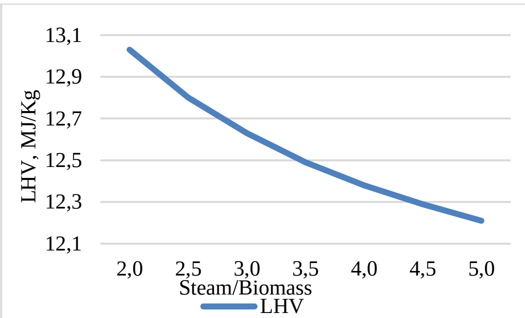

Figure 5. Effect of steam to biomass ratio on lower heating value of syngas

As it can be seen, increase of ratio of steam to biomass reduces lower heating value of syngas. Because, although higher steam to biomass ratio produces more H_2 in producer gas, it causes decrease of other syngas contents such as CH_4 and CO. Moreover, CO_2 concentration in product gas increases.

3.2.5. Effect of Gasifier Temperature on Exergy of Syngas

Effect of temperature of gasifier on syngas exergy was depicted in Figure 6. Temperature of that gasifier was changed between 650°C and 950°C and other parameters (biomass ratio (0.63 Kg/Kg) and biomass feed rate (25 kg/h) kept constant.

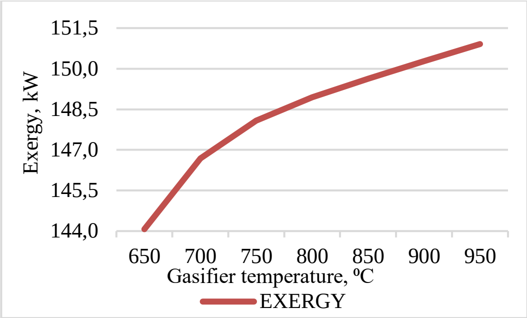

Figure 6. Effect of temperature of gasifier on exergy of syngas

It is observed in the figure that an increase in temperature of gasifier leads to chemical and physical exergy of product gas.

3.2.6. Effect of Steam to Biomass Ratio on Exergy of Syngas

Figure 7 depicts effect of ratio of steam to biomass over exergy of syngas. Steam to biomass ratio was varied in the range of 2.0 and 5.0 while other parameters kept constant.

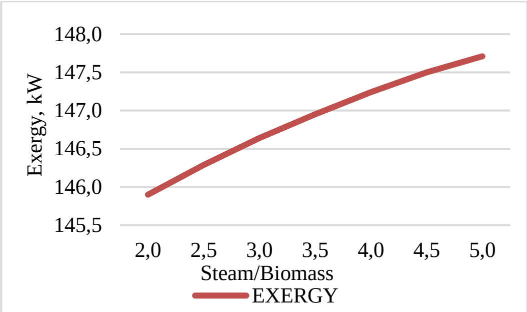

Figure 7. Effect of steam to biomass ratio on exergy of syngas

As plotted in the figure, an increase in ratio of steam to biomass causes rise of syngas exergy. Higher steam amount in the gasification system produces more H_2 in producer gas. As a result, promoted production of hydrogen in product gas increase exergy of syngas.

4. CONCLUSION

In the present study, steam gasification for almond shell in circulating fluidized-bed gasifier was modeled using Cycle-Tempo simulation program. The model validation was made by comparing its results with experimental published data. Finally, parametric study was conducted in the developed model to estimate behavior of the gasifier and predict syngas composition. In the parametric study, effect of temperature of gasifier and ratio of steam to biomass on performance of the gasifier were investigated.

Results of the study are outlined as followings:

1. The model has been successfully compared and validated with data from the literatures.

2. Result are in agreement with literature data, which means our model is capable of assessing performance of the gasification system under different operating conditions using various biomass.

3. For parametric study, it is noticed that rise of gasification temperature promotes generation of H_2 and CO.

4. With an increase of steam to biomass ratio, CO and CH_4 contents in syngas gas are reduced due to excess supply of steam. But, on the other hand, H_2 production is promoted.

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Energy and Exergy Analysis of Air Gasification for Pine Cone in Downdraft Gasifier by Using Cycle Tempo

Tulgaochir Tumurbat[1], Ugur Ozveren[2], Fatma Karaca[3]

Abstract

Biomass gasification is considered as a potential pathway for energy production compared to gasification of fossil fuels such as coal, crude etc. from perspective of its environmental, and economical aspects. However, the exergy and energy analysis must be deemed for efficient conversion of biomass. The aim of this paper is to conduct a thermodynamic study with respect to exergy and energy analysis of a fixed-bed downdraft gasifier for pine cone using Cycle-Tempo software (TU Delft, the Netherlands). The gasification process is predicted to take place at environmental pressure using air as gasifying medium. The gasifier produced a combustible gas with a H_2, CO, CO_2 and CH_4 concentrations of 21.6, 22.8, 14.5 and 2.52 mol.% respectively, at a total flow of air of 8.93 kg/h. The pine cone in the feedstock was effectively gasified to produce syngas with a lower heating value of 4.98 MJ/Nm^3 and chemical exergy value of 38.40 kW. Results reveal that the developed model is able to predict composition of syngas, exergy and the heating value.

Keywords: Biomass Gasification, Pine Cone, Cycle-Tempo, Downdraft Gasifier, Exergy Analysis, Energy Analysis.

1. INTRODUCTION

Rising energy demand and environmental issues worldwide cause depletion of fossil fuels and urge countries to find more environmentally friendly, sustainable and cleaner energy sources.

Biomass is regarded as potential alternative source of energy to fossil fuels use of which has negative impact on environment such as carbon dioxide emission. Specifically, carbon dioxide released during conversion of biomass into gaseous energy carrier is fixed from the atmosphere through photosynthesis process later on [1].

There are conventional and developed routes for energy production from biomass such as gasification, pyrolysis and direct combustion. Among above-mentioned methods, it is noted that gasification of biomass is the most efficient route for converting biomass into producer gas as source of energy [2-7], while conventional direct combustion is the least efficient thermolysis method [8].

Biomass gasification is a complex procedure which is affected by various parameters such as gasifier types, configuration of a reactor, choice of gasifying medium, composition and moisture content of biomass, etc. [9]. Generally, three types of gasifier apparatus are considered which are fluidized-bed, entrained bed and fixed-bed gasifier [8]. The fixed-bed gasifiers are categorized based on the way gasifying medium is introduced into the reactor as downdraft, updraft and cross draft reactors. [10]. The main advantage of downdraft gasifier is the less tar formation in the producer gas, which is very essential to any type of gasifier for its long-term-stable operation.

Although, experimental works are essential for understanding operating behavior of a gasifier, but, at the same time, it is time-consuming and expensive compared to modeling method. Therefore, from this perspective, simulation model analysis is more economically viable and faster than the experimental analysis for investigating gasification.

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The purpose of this study is to assess efficiency of air gasification of pine cone in a downdraft gasifier. The simulation of downdraft gasifier was conducted by using Cycle-Tempo simulation program to estimate influence of operating parameters on composition of producer gas through parametric study.

2. MATERIALS AND METHODS

2.1. Characteristic of Material

Proximate analysis of pine cone used in experimental gasification were determined according to ASTM standard testing methods [11], [12], [13]. Ultimate analysis was performed with LECO Truspec CHN-S analysis. The calorific value of pine cone were measured with Parr Instrument bomb calorimeter. Physical and chemical characteristics of pine cone is given in Table 1.

Table 1.Physical and chemical characteristics of the solid fuel

Characteristics	**Value**
Length (mm)	12
Width (mm)	8
Proximate analysis (wt%)	
Fixed carbon	11.7
Moisture	9.6
Ash	0.9
Volatile matter	77.8
Ultimate analysis (wt% db)	
Hydrogen	5.56
Sulphur	0.05
Nitrogen	0.76
Oxygen	51.01
Carbon	42.62
Calorimetric analysis (MJ/kg db)	
Lower heating value	16.25

2.2. Experimental Setup

Overall system consists of three main steps: (i) biomass gasification, (i) data acquisition and (iii) syngas gas composition analyze. In this study, a downdraft gasifier designed by All Power Labs Inc. was modified and further utilized. Inner diameter and height of the gasifier is 28 cm and 50 cm, respectively. Temperature of the gasifier, biomass feed rate and equivalence ratio were set to 840°C, 7 kg/h and 0.25, respectively. Gasification process took place in atmospheric pressure. Arduino-based system was used for monitoring the system and acquire real-time data during the gasification processes. Wuhan Cubic Syngas Analyzer Gas Board 3100P was utilized to measure syngas composition (CO, H_2, CO_2 and CH_4). Air was supplied as a gasifying agent in the gasification.

2.3. Modeling

Cycle-Tempo simulation program has been used for modelling the gasification system. Cycle-Tempo is simulation software which is used for thermodynamic modeling and optimizing energy conversion system. This program is based on approach of Gibbs free energy minimization. In Figure 1, our modeled downdraft gasifier is presented. Temperature of gasifier, equivalence ratio (ER) and biomass feed rate were set to 840 °C, 0.25 and 7 kg/h, respectively.

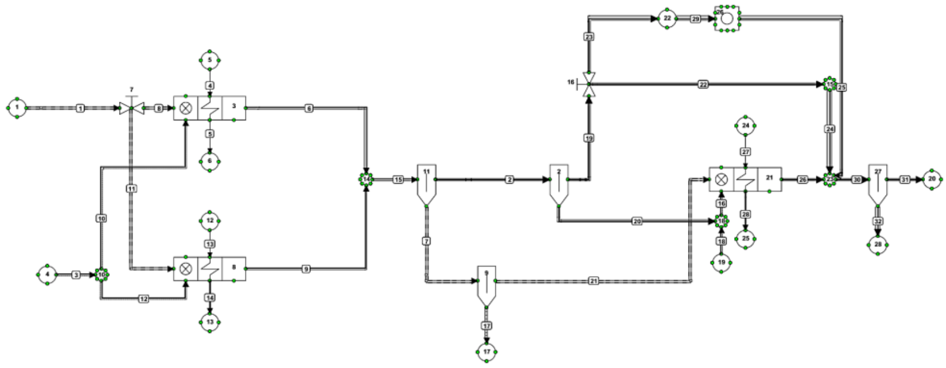

Figure 1. Flowsheet of downdraft gasification in Cycle-Tempo

The gasifier has been divided into four separate zones in the simulation. They are drying, pyrolysis, combustion and reduction zones. Depending on gasifying media and operating condition of the gasifier, different chemical reactions take place in each zone.

$$C + CO_2 \leftrightarrow 2CO \quad [1]$$

$$C + H_2O \leftrightarrow CO + H_2 \quad [2]$$

$$C + 2H_2 \leftrightarrow CH_4 \quad [3]$$

$$CH_4 + H_2O \leftrightarrow CO + 3H_2 \quad [4]$$

3. RESULTS AND DISCUSSION

3.1. Validation of the Model

The model was validated with results from experimental wor, gasifying medium and operating configuration were used as in model. In Table 2, comparison of results from model and experiment is presented. It can be noticed that our model results are in fair agreement with data from experimental work.

Table 2. Gas composition of the model and experimental work - Pine cone.

Compound	Experiment	Model
Temperature, ºC	840	840
Fuel feed rate, kg/h	7	7
ER	0.25	0.25
Gaseous products, (dry %vol)		
H_2	23.6%	21.6%
CO	22.5%	22.8%
CO_2	14.7%	14.5%
CH_4	2.50%	2.52%

After validation of the developed model with results from experimental work, the model has been validated with published experimental data by researchers [14], [15]. Predictions of the model were in fair agreement with experimental results in the literature (Table 3). Comparison and validation results reveal that our model is capable of predicting composition of syngas and performance of the gasification system under different operating configurations using different types of biomass. Some over- and under-predictions for H_2 and CH_4 were observed. It was commonly incurred by other researchers [16], [17] especially for CH_4 because of equilibrium state difference which exists between model and experimental work. In the model, it is assumed residence time for reactants in the gasifier during the process is long enough and therefore equilibrium is reached. But in the experimental work, in the reality, equilibrium never takes place [18].

Table 3. Comparison of syngas compositions from literature and model

1	Sample	Composition (dry %vol.)	[14]	Model
	Rubber Wood	H_2	15.5	20.2
		CO	19.1	20.1
		CO_2	11.4	11.4
		CH_4	1.1	1.2
2	**Sample**	**Composition (dry %vol.)**	**[15]**	**Model**
	Redwood waste	H_2	13	13.8
		CO	19	20.9
		CO_2	10	11.8
		CH_4	2	1.10

3.2. Parametric Study

In order to assess performance of gasification system, parametric study has been conducted on the developed modeling using same configuration and biomass as used in experimental work. Parametric study was conducted by varying equivalence ratio and gasification temperature while keeping other parameters constant to study effect on syngas composition and performance of the gasifier.

3.2.1. Effect of Temperature of Gasifier on Producer Gas

In the figure 2, effect of gasifier temperature on syngas composition is presented. Temperature of the gasifier was changed between 600°C and 900°C as ER and fuel feed rate was kept constant at 0.25 and 7 kg/h, respectively.

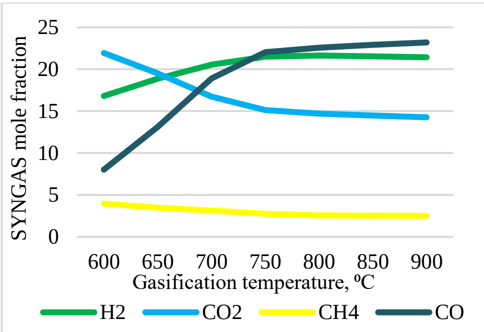

Figure 2. Effect of gasifier temperature on composition of product gas

It can be pointed out from the graph that with increase of gasification temperature production of CO and H_2 increase whereas CO_2 and CH_4 content decreases in the exit gas. This can be explained related to endo- and exothermic chemical reactions occurring in the gasifier such as methane steam reforming, Boudouard and water-gas reactions. In the high temperature, generation of products in these endothermic reactions is promoted, which is reason for an increase of production of combustible gases (CO and H_2).

3.2.2. Effect of Equivalence Ratio on Producer Gas

Equivalence ratio effect (ER) is shown in Figure 3. ER of the gasifier was varied from 0.1 to 0.5 while gasification temperature and fuel feed rate were set constant at 840°C and 7 kg/h.

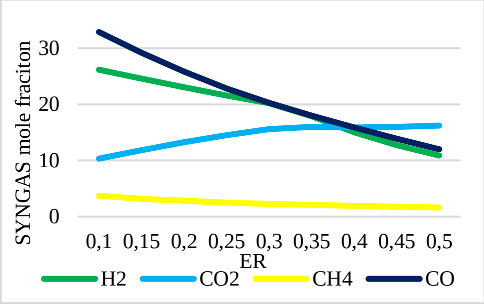

Figure 3. Effect of equivalence ratio on composition of product gas

When ER of the gasification process increases CO_2 production increases and content of combustible gas (CH_4, CO and H_2) in products gas decreases sharply. Increasing equivalence ratio means more oxidant supply to the gasifier. Therefore, the reason for a decrease of syngas concentration and increase of CO_2 production is that more oxidant supplied to the gasifier causes complete combustion of feedstocks and gas products increasing CO_2 as a result.

3.2.3. Effect of Gasification Temperature on Lower Heating Value of Producer Gas

In Figure 4, effect of temperature of gasification on lower heating value is presented. Gasification temperature was changed from 600°C to 900°C while ER and biomass feed rate was kept constant at 0.25 and 7 kg/h, respectively.

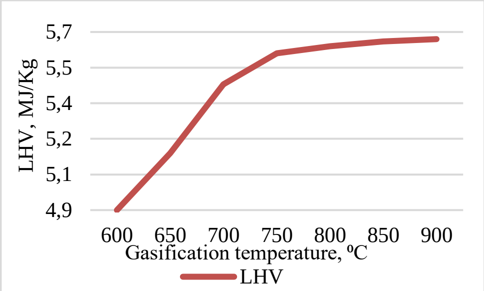

Figure 4. Effect of temperature of gasifier on lower heating value of syngas

Lower heating value of producer gas increase in accordance with an increase in temperature of gasifier. Because in higher temperature, endothermic chemical reactions such as Bouduoard, water-gas and methane steam reforming reactions are favored to produce more CO and H_2 which largely contribute to lower heating value of producer gas. Same observations were made in experimental works by other researchers [19].

3.2.4. Effect of Equivalence Ratio on Lower Heating Value of Producer Gas

Effect of equivalence ratio on lower heating value is presented in Figure 5. ER of the gasifier was varied between 0.1 and 0.5 as temperature of the gasifier and biomass feed rate were kept constant at 840°C and 0.25 respectively.

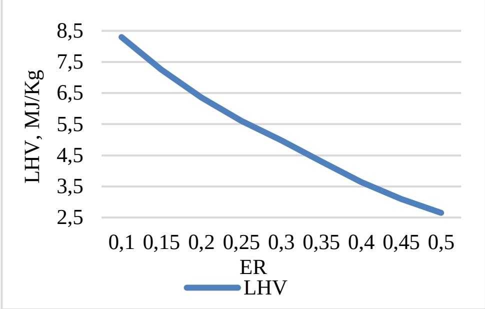

Figure 5. Effect of equivalence ratio on lower heating value of syngas

From the figure it can be said that as ER of gasifier increases lower heating value of exit gas reduces. Decrease of lower heating value of syngas is attributed to an increase in noncombustible gas such as N_2 and CO_2 caused by excessive supply of gasifying agent air. Moreover, as ER of the gasification process increases syngas production reduces due to complete combustion. Chen et al. [20] observed same tendency in their experimental work in which CO_2 production increased and H_2, CO and CH_4 concentration in exit gas decreased as ER is varied between 0.2 and 0.8.

3.2.5. Effect of Equivalence Ratio on Exergy of Product Gas

In the figure 6, impact of equivalence ratio on product gas exergy is depicted. Equivalence ratio in the gasifier was changed from 0.1 to 0.5 while gasification temperature and biomass feed rate were kept constant at 840°C and 7 kg/h.

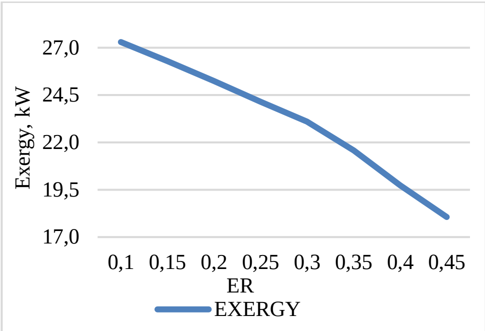

Figure 6. Effect of equivalence ratio on exergy of product syngas

As it is seen in the figure, with an increase in ER exergy of exit gas decreases. Because when ER rises more gasifying medium air is introduced to the gasifier and, therefore, complete combustion of feed stock and gas products takes place increasing concentration of noncombustible gases (CO_2 and N_2) in exit gas. As a result, chemical exergy of product gas is decreased.

3.2.6. Effect of Gasification Temperature on Exergy of Product Gas

Effect of temperature of gasifier on exergy of producer gas is given in the Figure 7. Temperature of the gasifier was varied between 600°C and 900°C while ER and biomass feed rate were constant at 0.25 and 7 kg/h.

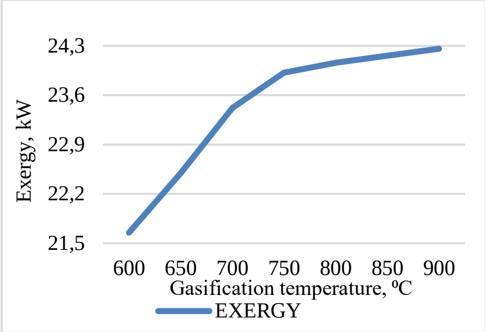

Figure 7. Effect of temperature of gasifier on exergy of syngas

From the figure, it is noticed that when gasification temperature increases exergy of syngas increases. This is ascribed to promoted generation of combustible (e.g. CO, H_2) in higher temperature, which increases chemical exergy of syngas or product gas. Moreover, higher temperature raises physical exergy of producer gas and thus total exergy of syngas is increased with higher temperature as a result.

4. CONCLUSION

In the present study, direct gasification of pine cone in downdraft gasifier has been conducted and product gas has been obtained. The gasification system has been modeled using same data as used in the experiment work in Cycle-Tempo simulation program. The developed model has been validated by comparing its data to experimental and literature data. Moreover, parametric study has been made on the developed model to assess performance of the gasifier and predict product gas. In the parametric study, impact of equivalence ratio and temperature gasifier on behavior of the system and producer gas was studied.

Overall, outcomes of this study are summarized as followings:

1. The model has been successfully validated and compared with data from the experiment and literatures.
2. The model result is in fair agreement with results from experimental work and literature, which reveal that the developed model is capable of predicting performance of the gasifier under different operating configurations using various types of biomass.
3. From the parametric study, it is observed that increasing gasification temperature leads to increasing production of CO and H_2 and, therefore, rise of LHV and exergy of product gas.
4. With an increase in equivalence ratio, combustible gas contents in exit gas decrease due to complete combustion caused by excessive supply of oxidant.

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Computer Simulation of User Behaviour in Built Environments – Improvements of Numerical Agent Models

Dujmo Žižić[1], Hrvoje Bartulović[2], Bruno Bartulović[3]

Abstract

The article elaborates several areas that can be improved in the field of computer simulations of user behaviour within the virtual 3D space, improving the efficiency, safety and overall sustainability of built environments. In state-of-the-art research there is no systematic implementation of random elements: differences in perception, encounters, changes in priorities, heterogeneity of the population, different age groups and physical possibilities, individual reaction to danger, the formation of user groups etc., that is, the whole set of complex protocols we are witnessing in the real world. The objective of the article is to suggest the concept based on the modelling of a complex agent that would autonomously "make decisions". Such a model would have several groups of variables whose combinations would generate a vast population structure. Agents behaviour would not be pre-programmed but would be calculated in real time according to the algorithm depending on the simulated spatial, temporal, social and other conditions.

By establishing a numerical model operational within 3D simulation, following processes could be optimised: determining the necessary space and equipment, ensuring an effective system of signalisation and user flow, detecting evacuation choke points and eliminating them, defining commercially interesting surfaces, etc. Implementation of the concept suggested in the article could provide the tools to designers and managers of buildings, transport and traffic systems, security services in the preparation of evacuation and rescue plans, insurance companies in risk assessment empowering all of them to analyse the efficiency, safety and sustainability of built environments.

Keywords: computer simulation, numerical agent model, sustainability of built environment, user behaviour

1. INTRODUCTION

The article elaborates several areas that can be improved in the field of computer simulations of user behaviour within the virtual 3D space, with the goal of improving the efficiency, safety and overall sustainability of built environments. Initially, current state-of-the-art of this field of research is established, together with the overlapping with architectural design methods used in practice. The scope of the article is to find compatibility and conflicts between these two processes, and then to suggest improvements of numerical agent models used in computer simulation of user behaviour. Improved models would simulate crowd behaviour in built environments more similar to real life, mimicking scenarios that architects conceive during design process. By establishing a model operational within 3D simulation, following processes could be optimised: determining the necessary space and equipment, ensuring an effective system of signalisation and user flow, detecting evacuation choke points and eliminating them, defining commercially interesting surfaces, etc. Implementation of the concept suggested in the article could provide the tools to designers and managers of buildings, transport and traffic systems, security services in the preparation of evacuation and rescue plans, insurance companies in risk assessment empowering all of them to analyse the efficiency, safety and sustainability of built environments.

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2. STATE-OF-THE-ART OF SIMULATING A PEDESTRIAN FLOW

Currently, there is considerable amount of research focused on the different aspects of simulating human behaviour in built environments: crowd simulation, collision avoidance, reaction distance, following behaviour, reorientation strategy, self-organized patterns, efficiency of traffic, etc. Simulation of the pedestrian flow is done by one of the two approaches: macroscopic and microscopic. *"The macroscopic models convert the scenario into a node-link presentation and focus on determining movement time. These models are rapid tools that provide an overview of the movement but are unable to describe the movement patterns in different areas at different time steps. (...) The microscopic models provide more detail by imposing the rules of movement onto each agent and letting them interact to simulate pedestrian movement."* [1] For this research, microscopic model is the relevant one, with a goal to make it more elaborate and therefore more realistic, so the current state-of-the-art will be briefly presented.

Microscopic models currently in use are divided into two categories: force-based models and agent-based models. One of the popular force-based models is the so-called social force model, in which Newton's Law of Motion represents the interaction between pedestrians and obstacles. Model was established by Helbing and Moln´ar and together with further development steps was presented in reference [2]. Simulation of pedestrian dynamics included the preservation of distances between agents. In this way elementary prevention of collisions between the agents was introduced. Further development was done by van den Berg et al. who presented a reciprocal velocity obstacle method to determine feasible movement directions of the simulated agents. Nevertheless, these models were still simplistic, resulting in calculation of automated movement patterns, far from resembling human-like behaviour. Further improvements followed: "*Karamouzas et al. introduced the idea of predicting future collisions to adjust the movement direction of each agent to add realism. Using the principle of least effort, the method presented by Guy et al. computes a biomechanically energy-efficient and collision-free trajectory for a crowd. Collision handling potentially results in deadlock. Agents that collide with each other are likely to collide again in the next time step. To prevent this problem, Curtis et al. set different priorities to agents and arranged that agents with lower priorities would give way to those with higher priorities. Johansson et al. applied evolutionary optimization to compute the parameters used in a social force model, using real videos. The method can be used to calibrate crowd models and group models. Durupinar et al. used psychological parameters to form different crowd models. Such models can be employed to enhance the realism of crowd simulation. Boatright et al. defined steering contexts (e.g., groups crossing, chaos) and adopted machine learning techniques to capture the main characteristics of crowds in each steering context. Li and Wong employed local views of agents and crowd movement to determine the movements of pedestrians. Kapadia et al. presented a variety of techniques to enhance the realism of crowd simulation, including sound perception, multisense attention, and understanding of environment semantics."*

Despite huge improvements, force-based models lack the authenticity and validity compared to agent-based models, as reference [1] explains: *"Pedestrian movement in continuous space is determined by the resultant force experienced by the pedestrian. In the respect of affected entity, social force can be presented as combination of: desired velocity, actual velocity and interaction force. However, in this case, the simulation of the motion is given only by formulas, and as a result, the movement of each object becomes too mechanical and does not resemble a real pedestrian. In contrast to the social force model, in the agent-based models, each pedestrian is usually represented as an independent and autonomous entity capable of adaptation."*

3. SCOPE OF OVERLAPPING BETWEEN SIMULATION OF HUMAN BEHAVIOUR AND ARCHITECTURAL DESIGN PROCESS

Agent-based models have developed greatly, and crowd simulations are becoming more and more realistic. As presented, many of the researchers focus on tackling one of the sub-themes of human behaviour. However, there is no overall systematic implementation of random elements: differences in perception, encounters, changes in priorities, heterogeneity of the population, different age groups and physical possibilities, individual reaction to danger, the formation of user groups etc., that is, the whole set of complex protocols we are witnessing in the real world. While designing a built environment, architects are constantly testing the expected usage of the space, but also events occurring less frequently, including accidents, incidents and random programmatic elements.

Overlapping between simulation of human behaviour and architectural design process is evident, but not easy to define because of allusive nature of architectural methodology. Even the term "methodology", used for all technical fields is replaced by "design process" when talking about architecture. As reference [3] explains: *"Strangely, though the design process is embedded in every project and is at the heart of the education and business practices of architects, the exact nature of that process is often obscure. It is under-documented, often invisible, and explained to students in anecdotes and one-off conversations. (...) Design methods were obviously present – as noted, each time a suggestion of how to proceed on a project is offered, that is a method. Every studio and practice has developed an approach to design which includes an overall framing position that biases what is important to that office as well as a set of steps on how to develop the design. How did this occur in the absence of any clear documentation? Mostly, it seemed to be constructed over years by the transfer of tacit knowledge from a master to an apprentice – be it the studio critic or office principal. Many times, the results are considered intuitive and part of the genius of the individual designer, an opinion which negates the learning environments in which many of these designers have been nurtured. In those learning environments, designers have been exposed to various aspects of knowledge as part of the design process. These include site analysis, case studies and precedents, theoretical writing, philosophical texts, historical dialogues, environmental studies, and cultural readings. Knowledge areas are joined by the technical skills of drawing, engineering systems, and structural systems. However, more often than not, these elements are not integrated into larger patterns of cognitive activity which can relate their use to specific predictive outcomes."*

Figure 2. Real life scenario inside built environment

Methods inherent to architectural design rely greatly on predictions of scenarios and user behaviour, which is later confirmed or invalidated in real life. Functionality, efficiency and safety are crucial aspects of built environments that are profoundly interlocked with computational tools because they depend on dimensions, distances, density and speed. However, none of the presented simulation models does not guarantee playing out of matrix of different scenarios that are integral part of design process.

The obstacles caused by complexity of modelling of certain problems involving real-world interacting agents are addressed by reference [4]: *"Modelling as optimal decision making processes enables elegant formulations but requires the use of problem models that can be intractable to actually solve. This has serious practical implications that tend to be overlooked in academic literature. Daskalakis and Papadimitriou (2005) raised this issue in a study of complexity in large, multi-agent systems by posing the question: "How can one have faith in a model predicting that a group of agents will solve an intractable problem?" In the realm of multi-agent systems, this work suggests that such questions may be avoided by employing models that allow agents to independently modulate the problem complexity."*

Figure 2. Pedestrian choke-point in historical city center of Split (Croatia), representing problems that require negotiation and cooperation to be solved

4. PROPOSED CONCEPT OF THE AGENT MODEL

The objective of the article is to suggest the concept based on the modelling of a complex agent that would autonomously “make decisions”. Such a model would have several groups of variables (physical, motivational, perceptual, psychological, etc.) whose combinations would generate a vast population structure. Agents behaviour would not be pre-programmed but would be calculated in real time according to the algorithm depending on the simulated spatial, temporal, social and other conditions. The life-like quality of the simulation is the goal that would be generated out of complexity of an individual agent, but also out of complex interactions between agents.

The reference [5] reveals the decision cycle of a single agent, confirming that numerous attributes can be quantified and put into an algorithm: *“Observing the working memory from the bottom up reveals the decision cycle of a single agent. Physiological data across a range of measures (including arousal, fatigue, hunger, thirst, injury, etc) are combined to set the levels of a series of stress reservoirs. The stress reservoirs then determine the agent’s coping style (a measure of the agent’s current awareness and capacity for rational thought) for the current decision cycle.”*

To demonstrate the importance of interactions between individual agents we will briefly present social aspects of movement simulation – wayfinding as researched by [6]: *“Crowd-level pedestrian dynamics research (...) as well as development of commercially available simulation models has been focused on lower-level perceptual and motoric phenomena. Currently such systems are very successful at predicting navigation at the level of locomotion rather than wayfinding. This includes avoiding collisions, bypassing other slower people, forming lanes and crowd level congestion dynamics. Simulating wayfinding qualities of buildings, neighbourhoods, or signage/map systems would require taking into account cognitive factors such as the goals of the navigators, group membership, social relations, and spatial mental representations underlying wayfinding decision-making.”* Asocial wayfinding is dominant in artificially controlled situations, such as in psychology experiments or computational models, while social dimension of wayfinding critical for any real-world situation. The complexity of interactions between individual agents is crucial for simulating social interactions. Proposed concept of complex agent model relies on establishing singular functional entity that will make interactions autonomously, rather than to hard-coding those interactions within the algorithm.

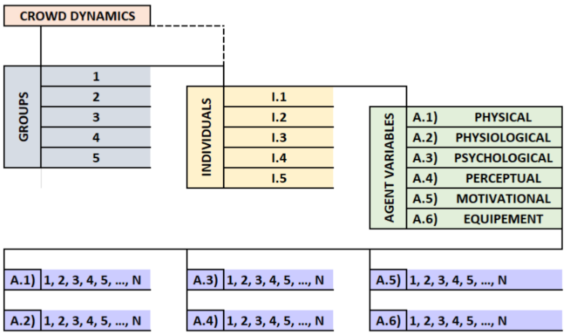

Figure 3. Constant recalculation of numerous variables determines the behaviour of individual agents, some of them grouped, and all of them forming a crowd whose dynamics are simultaneously creating the environment and reacting to it

Implementation of the concept suggested could provide the tools for designers and managers of buildings, transport and traffic systems, security services in the preparation of evacuation and rescue plans, insurance companies in risk assessment empowering all of them to analyse the efficiency, safety and sustainability of built environments. Methodology used to calibrate complex matrix of variables includes a combination of architectural design tools and three main technologies for collecting crowd data (vision-based systems, radio frequency and web/social media) that are beyond the scope of this article.

5. CONCLUSION AND FURTHER RESEARCH

The article suggest the concept of improvement in the field of computer simulations of user behaviour within the virtual 3D space, improving the efficiency, safety and overall sustainability of built environments. Novel concept is based on the modelling of a complex agent that would autonomously "make decisions" about its behaviour and movement. Such a model would have several groups of variables whose combinations would generate a vast population structure. User behaviour would not be pre-programmed but would be calculated in real time according to the algorithm depending on the simulated spatial, temporal, social and other conditions.

At this stage, concept needs to be experimentally tested, which is our future research plan within Laboratory for the Implementation of Modern Technologies in Architecture (LISTA). The laboratory was founded at University of Split (Croatia), Faculty of Civil Engineering, Architecture and Geodesy in 2018 and is conceived as a platform for the development of digital processes from design to performance based on parametric design, optimization and digital production of elements in architecture and urbanism. The purpose of the laboratory is to integrate specialized knowledge from a variety of scientific and economic areas so that architects, urban designers, designers, artists, engineers and contractors overcome barriers between ideas and achievements and explore the potential of existing equipment in the economic sector and increase its usability and efficiency. Integration of experimental phase of the concept with three main technologies for collecting crowd data is one of the areas for further research.

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Analysis of the Global Resilience Assessment Frameworks for the Urban Realm

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Abstract

Climate change has increased the frequency and severity of disaster events and this trend is expected to grow in the future. Extensive structural damages and fatalities are particularly located in urban areas where people, activities and resources are largely concentrated. In this context, the concept of community resilience has gained high prominence, as well as the need of developing methods and instruments for its assessment. During the last decade, diverse frameworks and tools have been developed in order to reduce disaster risk and prepare communities to withstand and adapt to a wide range of disasters. After selecting the most relevant urban resilience assessment frameworks, this research aims to determine the adequacy of the City Resilience Index (CRI), the City Resilience Profiling Tool (CRPT), the Disaster Resilience Index (DRI), the ICLEI Asian Cities Climate Change Resilient Network (ACCCRN) Process and the Disaster Resilience Scorecard for Cities to be globally implemented. Timeframe, stakeholders involvement, comprehensiveness and outcomes of the selected tools were examined in addition to the coverage of all abilities of resilience, namely Preparedness & Plan, Absorption, Recovery and Adaptation. Findings revealed significant gaps in several tools when analyzing the benchmarks adopted. The paper concludes by suggesting the City Resilience Index as the most suitable instrument to assess the resilience of urban communities worldwide.

Keywords: Resilience Assessment Tools, Disaster Risk Reduction, Urbanization, Urban Resilience.

1. INTRODUCTION

In the last decades, the amount of natural disasters has experienced a significant growth in terms of frequency and severity of loss events due to the effects of climate change [1]. This trend is expected to continue in the future [2], primarily affecting urban areas where the highest concentration of population, resources and activities is located. When combined with the impact of extreme climate events and increased poverty, the crowding of cities also creates new stresses. A large amount of people is settling in potential danger zones, inter alia, unstable hills, floodplains or coastal areas because they cannot afford safer land. The proliferation of informal settlements also implies the lack of infrastructure and basic services such as power, water or sanitation and inappropriate housing construction, escalating the vulnerability of communities.

Under these circumstances, the adoption of the Hyogo Framework for Action, aiming at "*building the resilience of nations and communities to disasters*", drew the attention of community leaders, policy makers and researchers to disaster management [3]. Upon the expiration of the Hyogo plan, the existing Sendai Framework took its place to focus on disaster risk management as opposed to disaster management. Seven global targets were defined such as the reduction of disaster risk, the prevention of new risk, the diminution of existing risk, the strengthening of resilience, as well as a set of guiding principles to prevent and lower disaster risk and the engagement of all institutions. Moreover, human-induced hazards and related environmental, technological and biological hazards and risks widened the primary focus on natural hazards [4]. The Sendai Framework promotes the understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics. Risk and resilience are two different concepts often used interchangeably in this field, which can lead to errors [5]. Risk can be defined as the likelihood of a loss impacting sustainable dimensions as result of hazards [6], being a compound function that involves hazard (probability) and vulnerability (value of likely losses) [7]. Unlike risk, resilience is a property of the system and includes a temporal component that risk management does not [5]. Thus, resilience can be referred as the ability to prepare and plan for, absorb, recover from and

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adapt to adverse events [8]. The condition of communities as social-ecological systems helps to recognize the dynamic correlation between resilience capabilities [9].

A wide range of Community Resilience Assessments (CRA) emerged in the last years to contribute to the reduction of risk disasters through hazard mitigation, strengthening resilience [10], risk understanding and awareness, and the promotion of the adaptive capacity [11]. Given that the purpose of this research is the analysis of diverse urban resilience frameworks used worldwide, it is crucial the understanding of the term "community" in spite of the lack of consensus on accepting a single description [12]. In this sense, it was embraced the approach set by some academics who identify "community" as a group of diverse individuals with common interests that engages in a determined geographical area under a changing socio-economic environment [13]. The definition of size range and community boundaries are another points of controversy due to the shifting condition of urban areas over time and the interrelation between them. Neighborhood and county are the lowest and highest thresholds that demarcate community spatial-scales.

Different approaches have been developed to appraise urban resilience such as indices, scorecards and toolkits, being the latter the least numerous. Indicators are measurable variables used as representation of a resilience feature whose combination can construct an index. The complexity of some matters suggests the statistical aggregation of multiple indicators into a single numeric value to reflect the nature of the construct [14]. Scorecards serve to evaluate the achievement or progress towards a particular goal through the rating of a set of questions concerning the presence or absence of resilience-related items and actions. In contrast to indicators more oriented to quantitative issues, scorecards can transform qualitative aspects into grades. In the search of understanding relationships and interactions affecting urban resilience, some toolkits were created by using a compilation of indices and scorecards as instruments for assessing resilience through the provision of data, models and procedures [15].

Although the overview and the structure of diverse CRA tools, as well as their similarities and differences were studied by some researchers [10], [16]-[19], a broad analysis was not undertaken yet. This article aims at bridging the gap by evaluating a selection of the most important CRA to determine which of them is the most suitable to be implemented globally in order to address all resilience dimensions. The manuscript comprises four sections. A description of materials and methods is provided in the next section. The results of the analysis of the selected tools are presented and discussed in the third section. Conclusions of the research are summarized in the last section.

2. MATERIALS AND METHODS

2.1. Selection of Tools for Analysis

Since more than two decades has been found as a long a period of time to extract relevant conclusions [20], a broad search was conducted in the last 20 years to identify all kind of schemes developed to assess the resilience of communities as a whole system, applicable worldwide and focused on multiple risks. As shown in Table 1, 7 frameworks met the requirements of the quest. However, the Framework for Community Resilience (FRC) created by the International Federation of Red Cross and Red Crescent Societies (IFRC), and the initiative launched by Grosvenor were both set aside owing to the serious limitations and constraints manifested in their application. Whilst the former was exclusively designed to evaluate the contribution of all IFRC programmes, projects, interventions and actions to the creation, development and sustainment of resilient communities, the scope of the latter is only confined to the ranking of 50 of the most important cities worldwide in terms of resilience. Thus, the general applicability of both tools is not feasible.

Table 1. The selected CRA tools applicable worldwide

Tool	Year	Risk	Developer	Ref.
City Resilience Index (CRI)	2014	Multiple	The Rockefeller Foundation and Arup	[21]
City Resilience Profiling Tool (CRPT)	2012	Multiple	UN-Habitat	[22]
Disaster Resilience Index (DRI)	2015	Multiple	Earthquakes and Megacities Initiative (EMI)	[23]
Disaster Resilience Scorecard for Cities (DRSC)	2017	Multiple	UNISDR	[24]
Framework for Community Resilience (FRC)	2014	Multiple	International Federation of Red Cross (IFRC)	[25]
ICLEI ACCCRN Process (IAP)	2014	Natural	ACCCRN, ICLEI, Rockefeller Foundation	[26]
Ranking of Resilient Cities	2014	Multiple	Grosvenor	[27]

2.2. Methodology of analysis

On the assumption of the abilities of resilience provided by the National Academies [8]: preparedness & plan, absorption, recovery and adaptation, four additional aspects were deemed to analyze the selected CRA tools: timeframe, stakeholders participation, comprehensiveness and outcomes. As multiple dimensions and characteristics of community resilience should be addressed in the resilience assessment process to be comprehensive [28], an extensive literature review was undertaken to obtain main topics concerning resilience in urban areas [29] to develop a list of criteria [30] which was compared with the criteria of the selected tools. Furthermore, the CRA were also studied to determine whether they cover all four resilience capabilities. Since resilience should be considered within the context of a temporal continuum [31] where past records of hazard events serve to implement actions in the present whose efficiency should be measured in the event of future disasters, the analysis was focused on ascertaining the attention of the past, present and future scenarios in the conception of the CRA tools. Involving a diversity of stakeholders in the management of social-ecological systems can help build community resilience [32] by improving legitimacy, expanding the depth and diversity of its knowledge and understanding, and helping detect and interpret perturbations. Participatory approaches should be also adopted for evaluating community resilience using appraisal tools, identifying priorities and developing action plans according to assessment results. The involvement of stakeholders groups in the development and application of the selected CRA tools was therefore examined too. The results of the assessment instruments are crucial for a better decision-making process. Thus, the evolution of community status over time can be defined through the study of changes in baseline conditions. The achievement of resilience program objectives can be determined by establishing threshold values in the assessment. In addition to them, the comparison between the performance of different communities in terms of resilience, the speed of recovery or the principles of good resilience can be also presented as findings [33].

3. RESULTS AND DISCUSSION

3.1. Overview of the selected CRA tools

The City Resilience Index (CRI) is the result of the collaboration between the Rockefeller Foundation and Arup in order to evaluate diverse factors that affect the resilience of cities. The tool is applied to the 100 Resilient Cities program to help cities around the world to strengthen their resilience to physical, social and economic challenges [34]. As reflected in Table 2, the index encompasses 4 dimensions, 5 goals and 7 qualities inherent to resilient systems. The rating of the 52 indicators forming the metric determines 5 levels of achievement: Excellent, Good, Moderate, Poor and Very Poor [21].

Table 2. Main Features of the City Resilience Index [21]

Dimensions	Goals	Qualities
Leadership and strategy	Effective leadership and management	Flexible
Health and wellbeing	Empowered stakeholders	Redundant
Economy and society	Integrated development planning	Robust
Infrastructure and ecosystems	Minimal human vulnerability	Resourceful
	Diverse livelihoods and employment	Reflective
		Inclusive

UN-Habitat launched the City Resilience Profiling Programme (CRPP) in 2012 to transform any human settlement into a flexible urban framework. Diverse metrics, software tools and global standards were produced to support this initiative. Among them, a self-assessment tool named the City Resilience Profiling Tool (CRPT) was developed to be fully updated in 2017 to incorporate key mandates and resolutions adopted by the international community, such as the Sustainable Development Goals (SDGs), the New Urban Agenda, the Paris Agreement for Climate Change and the Sendai Conference. City ID, Local Governments & Stakeholders, Shocks, Stresses & Challenges, and Urban Elements are the 4 SETs which comprise 19 key functions and 60 sub-functions [22].

The Disaster Resilience Index (DRI) aiming at benchmarking and measuring progress of risk reduction and resilience approaches in the development of resilience in urban settlements. This self-assessment tool establishes an initial benchmark to evaluate 10 indicators grouped into five main subject areas: Legal & Institutional Processes, Awareness & Capacity Building, Critical Services & Infrastructure Resiliency, Emergency Preparedness, Response & Recovery Planning, and Development Planning, Regulation & Risk Mitigation. The five pre-defined benchmarks and target levels of attainment are: little or no awareness, awareness of needs, engagement & commitment, policy engagement & solution development, and full integration. The transition from a negative to positive ranking entails the incorporation of risk reduction into planning and development processes. India, Jordan and the Philippines are the three countries where the DRI has been applied [23].

The progress in the implementation of the Sendai Framework for Disaster Risk Reduction: 2015-2030 is monitored by the Disaster Resilience Scorecard for Cities (DRSC) developed by UNISDR in 2017, as the evolution of the pioneering City Disaster Resilience Scorecard released in 2014. Main issues that cities need to address to become more disaster resilient are gathered in the "Ten Essentials for Making Cities Resilient" clustered into three principal themes: Governance & Financial Capacity, Dimensions of Planning & Disaster Preparation, and Disaster Response Itself & Post-event Recovery [24]. A multi-stakeholder group assesses a set of 117 indicator criteria, each with a score 0 to 5, to provide an overview to enable the development of resilience action plans to local governments.

The ICLEI Asian Cities Climate Change Resilient Network (ACCCRN) Process (IAP) is a toolkit developed by ICLEI-Local Governments for Sustainability´s South Asia & Oceania offices in 2014 with the support of the Rockefeller Foundation to assess climate risks in urban areas to propose strategies in the resilience field. The appraisal involves four phases: Engagement, Climate Research & Impacts Assessment, Vulnerabilities Assessment and City Resilience Strategy. The toolkit has been tested in three Indian cities so far [26].

3.2. Findings of the evaluation

As shown in Table 3, city is the spatial scale considered by all the five studied tools to assess the resilience in communities. Furthermore, toolkits is the preferred approach used by the CRI, the CRPT and the IAP for conducting resilience appraisal due to their broader scope that allows to identify assessment criteria, collect required data, perform assessment, suggest interventions and monitor the implementation of action plans. Conversely, the rating of CRA criteria was the method applied by the DRI (index) and the DRSC (scorecard) to measure the resilient condition of urban settlements. Excluding the DRI, focused uniquely on participatory processes to gather information, the rest of tools are based on both primary and secondary data sources for the development and the assessment of the criteria tools. Thus, the insights of community members in terms of, inter alia, needs, vulnerabilities and coping capacities are accurately reflected. Furthermore, the CRI, the DRI and the IAP are mostly constituted of qualitative criteria, as distinct from the CRPT and the DRSC that also involve quantitative parameters. Regarding the timeframe of evaluations conducted, the CRI, the CRPT and the IAP aim at enhancing adaptive capacity by involving ex-ante disaster occurrence appraisal and monitoring the conditions from the early stages of the planning process [35]. Instead, the DRI and the DRSC analyze the effectiveness of ex-post disaster measures adopted for making decisions about the need of modifying intervention strategies.

Table 3. General specifications of the selected CRA ([21]-[24], [26])

Tool	Spatial scale	Evaluation	Format	Data source	Quantitative/qualitative criteria
CRI	City	Ex-ante	Toolkit	Both	Qualitative
CRPT	City	Ex-ante	Toolkit	Both	Both
DRI	City	Ex-post	Index	Primary	Qualitative

DRSC	City	Ex-post	Scorecard	Both	Both
IAP	City	Ex-ante	Toolkit	Both	Qualitative

A wide range of thematic areas and goals were declared by the CRA tools (Table 4), however, those were developed using diverse methods. The CRI was formulated through an extensive literature review, the consultation of secondary data resources (censuses, organizational records or information collected by government departments) and the results of fieldwork (surveys, interviews, focus groups and workshops). UN-Habitat experts built the CRPT on the basis of main targets contained in the most prominent actions adopted by the international community such as the Sendai Framework, the Sustainable Development Goals, the New Urban Agenda, the Paris Agreement on Climate Change and the Agenda for Humanity. Similarly, experts working group harnessed feedback received from Mumbai (India), Aqaba (Jordan) and diverse municipalities in the Philippines to produce the DRSC. ICLEI-ACCCRN gathered practical experiences from ten Asian cities to develop the IAP toolkit.

Table 4. Fundamentals of the analyzed tools ([21]-[24], [26])

Tool	Themes	Goals	Method of Development
CRI	Health & wellbeing; economy & society; infrastructure & environment; leadership & engagement	Minimal human vulnerability; diverse livelihood & employment; effective safeguards to human health & life; collective identity & community support; comprehensive security & rule of law; sustainable economy; reduced exposure & fragility; effective provision of critical services; reliable mobility & communications; effective leadership & management; empowered stakeholders; integrated development planning	Literature review; data analysis; fieldwork
CRPT	General context of the city; data collection framework	Transformation of urban areas into safer and better places to live in; improvement of cities capacity to absorb and rebound from shocks or stresses	UN-Habitat experts by considering targets set in globally agreed inter-governmental frameworks
DRI	Legal & institutional processes; awareness & capacity building; critical services & infrastructure resiliency; emergency preparedness, response and recovery; response & recovery planning; development planning, regulation & risk mitigation	Development and strengthening of institutions and policies; systemic integration of risk reduction approaches into critical services and infrastructure, emergency preparedness, response and recovery	Stakeholders inputs
DRSC	Governance & financial capacity; dimensions of planning & disaster preparation; disaster response itself & post-event recovery	Understanding of city disaster risk; monitoring & reviewing progress in the implementation of the Sendai Framework; development of a local disaster risk reduction strategy	Experts working group and feedback from pilot cities
IAP	Urban climate change resilience; stakeholders engagement; city resilience strategies	Stimulating collective risk learning and action at the local level; catalyzing community building; development of a climate resilience strategy; integration of the resilience strategy into urban planning	Practical experience from ten Asian cities

As disclosed in Table 4, community resilience primarily involves social, economic, environmental, institutional and built environment dimensions that are complementary to resilience attributes. A depth analysis of the literature identified diverse resilience criteria that were conveniently clustered in accordance with the above dimensions. The interrelation between the CRA criteria and the selected resilience criterion (Table 5) revealed that the CRI shows the highest number of correlations (19), as opposed to the IAP with only 4 ones. The assignment of 18.33% (CRPT) and 3.03% (DRI) of resilience criterium to the tools could not be completed due to the lack of correspondence. Whilst institutional was the most aligned aspect with all the examined tools, the interlinkage with environmental facet remained close to zero for the CRI, the DRI, the DRSC and the IAP frameworks. Economic area reflected the lowest rate of coincidence for the CRPT. Regarding the resilience sub-dimensions, the IAP toolkit includes the highest correlated criteria associated with the preparation of contingency, emergency and recovery plans (68.75%).

Table 6 shows the allocation between the four resilience attributes and the CRA criteria. The DRSC was the only tool whose components cover preparedness & plan, absorption, recovery and adaption of communities to hazards events. Contrarily, the IAP tool solely focused its assessment on the preparation stage. Adaptation capability was not taken into account by the CRI and the CRPT criteria as long as the DRI only considered preparedness & plan and recovery abilities. The CRPT tool displayed the highest level of mismatch (31.67%).

Different outcomes are expected from the CRA tools to enable communities to highlight gaps, prioritize concerns and identify points for intervention and corrective action for enhancing resilience. The DRI was developed for benchmarking and measuring progress on the mainstreaming of risk reduction approaches in the cities. The CRI and the CRPT evaluate resilience to build sound strategies and plans through the development of profiles that covers the entire urban system. The DRSC scorecard aims at monitoring and reviewing progress in the implementation of the Sendai Framework for Disaster Risk Reduction. As a response of climate change impacts, the IAP toolkit provides actions to promote urban resilience.

Table 5. Proportion of correspondence among CRA criteria and resilience dimensions/sub-dimensions ([21]-[24], [26])

Dimension	Sub-dimension	CRI	CRPT	DRI	DRSC	IAP
Built environment	Efficiency	5.77	1.67	0.00	1.71	0.00
	Information & communication tec.	3.85	0.00	3.03	0.85	0.00
	Land use	9.62	5.00	3.03	4.27	0.00
	Transport networks	1.92	5.00	0.00	0.00	0.00
	Robustness & redundancy	7.68	6.67	18.19	7.69	12.50
Environmental	Natural resources	3.85	11.67	0.00	1.71	0.00
Economic	Financial cover	3.85	1.67	0.00	9.40	0.00
	Investment	9.62	0.00	0.00	0.00	0.00
	Statistics	1.92	5.00	0.00	0.00	0.00
Institutional	Efficient management	1.92	0.00	6.06	9.40	0.00
	Emergency plans	9.62	23.33	33.33	41.05	68.75
	Leadership	9.62	3.33	9.09	0.85	6.25
	Partnership	1.92	0.00	3.03	2.56	12.50
	Regulation	9.62	3.33	6.06	4.27	0.00
	Research & development	0.00	0.00	3.03	0.00	0.00
	Training	3.85	0.00	9.09	11.97	0.00
Social	Community frame	3.85	1.67	3.03	4.27	0.00
	Culture	1.92	3.33	0.00	0.00	0.00
	Equity and diversity	0.00	0.00	0.00	0.00	0.00
	Safety & health	7.68	1.67	0.00	0.00	0.00
	Social features	1.92	8.33	0.00	0.00	0.00
	Not allocated	0.00	18.33	3.03	0.00	0.00
	Total	100.00	100.00	100.00	100.00	100.00

Table 6. Distribution of the CRA criteria between the resilience abilities ([21]-[24], [26])

Resilience Feature	CRI	CRPT	DRI	DRSC	IAP
Preparedness & plan	76.81	53.33	75.76	72.66	100.00
Absorption	9.52	3.33	0.00	17.09	0.00
Recovery	5.67	11.67	21.21	9.40	0.00
Adaption	0.00	0.00	0.00	0.85	0.00
Not allocated	8.00	31.67	3.03	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

4. CONCLUSIONS

A wide range of community resilience assessment tools were developed in the few decades as a consequence of high-impact losses caused by natural hazards due to the effects of climate change. The rising concentration of population, resources and wealth-producing in cities determines the necessity of selecting the most suitable tool to assess urban resilience in order to be applicable worldwide. In this vein, an extensive literature review conducted to shortlist the City Resilience Index (CRI), the City Resilience Profiling Tool (CRPT), the Disaster

Resilience Index (DRI), the ICLEI Asian Cities Climate Change Resilient Network (ACCCRN) Process and the Disaster Resilience Scorecard for Cities as the tools to be examined. Timeframe, stakeholders involvement, comprehensiveness and assessment outcomes were the benchmarks set for performing the analysis, as well as the consideration of the four abilities of resilience: preparedness & plan, absorption, recovery and adaptation. The main conclusions drawn from this study are summarized as follows:

- Adaptation capacity to natural hazards is strengthen by the CRI, the CRPT and the IAP by evaluating early stages of the planning process (ex-ante assessment) in comparison to the DRI and DRSC mostly focused on examining the effectiveness of ex-post disaster strategies.
- All the five community resilience assessment tools evaluated in this research mainstreamed participatory processes involving community members.
- Whilst the CRI criteria revealed the highest number of correlations (19) with the selected resilience criterion from literature, as against 4 of the IAP toolkit, the CRPT showed a rate of 18.33% of mismatch. Thus, the CRI seems the most comprehensive tool.
- The DRSC covered the four resilience attributes in contrast to the CRI and the CRPT tools whose components only combined with preparedness & plan, absorption and recovery capabilities. However, 31.67% of the CRPT criteria were not allocated versus 8.00% of the CRI elements.
- The CRI, the CRPT and the IAP frameworks provide strategies and action plans to promote urban resilience. The DRI and DRSC aim at reducing disaster risks instead.

On the whole, all the five community resilience assessments disclosed several gaps. However, the City Resilience Index developed by the Rockefeller Foundation and Arup showed the highest performance in terms of adequacy to the benchmarks established in the research.

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Simulation of Imbat Coal Gasification in Fluidized Bed Using Aspen Plus

Furkan Kartal[1], Ugur Ozveren[2]

Abstract

Among the several types of gasification methods, fluidized bed gasification process has been applied as a key merit technology to ensure the product gas with high quality. Therefore, the aim of this study is to explore a novel steady state simulation approach of Imbat coal in a circulating fluidized bed gasifier by using Aspen Plus model which is based on the minimization of the Gibbs free energy of the system.

The syngas composition was obtained for different operating parameters such as temperature, pressure and feed stock & steam rate to evaluate performance of the developed ASPEN Plus model.

The simulation results show that the product gas produced during the steam gasification has much higher hydrogen contents than oxygen gasification models from the literature. Moreover, it is expected that the established model can be used for other type feedstocks to estimate the composition of product gas at optimized operating condition

Keywords: Imbat Coal, Gasification, Circulating fluidized bed gasifier, TGA, Uncertainty analysis

1. INTRODUCTION

Coal is one of the most popular energy sources in the world, which can be utilized by using coal gasification to generate energy production, methyl alcohol, ammonia, synthetic natural gas etc [1].

Gasification process has been considered to be a more beneficial operation to take the energy from low grade Turkish coals with better conversion yield for end products such as electricity, heat, transportation fuels etc. [2-5]. Furthermore, the gasification is eco-friendlier by the reason of low–oxidation conditions, less amount of greenhouse gases emitting [6].

Air as a gasification agent is most preferred at the moment due to its low cost. On the contrary, the syngas acquired through air gasification has low calorific value [7]. Therefore, steam gasification has been used to advance the heat quality of syngas, while increment of the hydrogen yield and diminishing the tar a char efficiency [8, 9].

For optimization a gasification process, the configuration of the gasifier is also a vital factor. Fluidized bed gasifiers offer to handle with high range of fuel types with a much better energy and mass transfer when compared to fixed bed gasifiers. Moreover, it has several advantages such as gas and solid phases come into contact excellently throughout great rate of turbulence which develops mass and heat transfer, improves the capability to manipulate temperature, and enhances volumetric capacity and heat storage [10].

Designing and developing a gasifier model on a simulation program is very important for obtaining information about the impact of operating conditions on the performance of gasification. However, there are a few thermodynamic equilibrium program giving good results for gasification simulation. Aspen Plus® is one of the most used thermodynamic equilibrium program for fluidized bed gasifiers. Emun et al. [11] developed an integrated gasification combined cycle (IGCC) plant and proved the advantages of working with Aspen Plus to get knowledge about performance of the system. Moreover, a FBR model on Aspen Plus was created by Nayak

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and Mewada [12]; their model was including various chemical phenomenon such as decomposition of volatiles, reactions of volatile matters and gasification - combustion reactions. The researchers modelled the decomposition of volatiles by using RYIELD unit operation block, the volatile reactions occurred in a RGIBBS unit block and the gasification - combustion reactions modelled in a RSTOIC unit block. Combining several types of reactors to simulate the reactions in a fluidized bed gasifier was also carried out by Doherty et al. [13]. However, there aren't enough studies for the modeling and/or simulation of steam gasification for Turkish coals using Aspen Plus.

The aim of this paper, for the first time, is to develop a CFBG simulation under steam atmosphere for Imbat coal using Aspen Plus simulation program that qualified to estimate the steady state and isothermal performance of a circulated fluidized bed gasifier taking gasification zones into consideration.

2. MATERIALS AND METHODS

2.1. Feedstock Material

Proximate analysis of Imbat coal was determined according to ASTM Standard D 5142-04 (Netzsch 409 PC). Ultimate analysis was performed using ASTM Standard D5373-2. Proximate and ultimate characteristics of Imbat coal are presented in Table 1.

Table 1. Proximate and ultimate analysis results of Imbat coal

Proximate analysis (wt%)	
Ash	14.81
Fixed carbon	46.68
Moisture	5.62
Volatile matter	32.89
Ultimate analysis (wt% db)	
Carbon	51.47
Oxygen	40.83
Hydrogen	4.31
Nitrogen	1.06
Sulphur	2.33

2.2. Aspen Plus Simulation

Because of complex reaction pathways in CFBG, only the main parts of coal gasification were taken into consideration, with some assumptions. When the particles of coal take part in a circulated fluidized bed gasifier, drying, decomposition of volatiles, char and volatile combustion & gasification reactions occur consequentially. The accepted assumptions in CFBG simulation is listed below:

- Gasification process is isothermal and steady state

- Volatile products of coal after the decomposition zone majorly include of H_2, CH_4, H_2O, CO_2, and CO [10, 14, 15]

- Whole reactions reach the chemical equilibrium in the gasification process

- Char includes only ash and carbon

- Ash is regarded as inert and does not affect the reactions

The flowsheet of developed CFBG simulation on Aspen Plus for the syngas production from Imbat coal under steam atmosphere has been given in Figure 1.

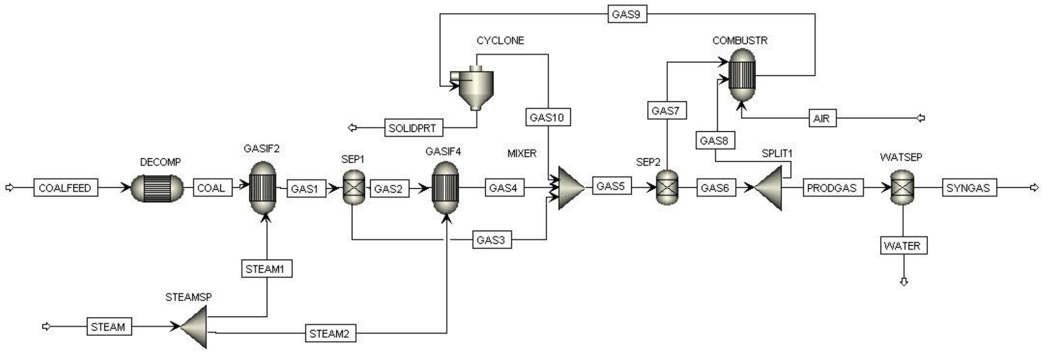

Figure 1. Flowsheet of circulated fluidized bed gasifier in Aspen Plus

In the simulation model, for the evaluation of density and enthalpy of the solid components DCOALGEN and HCOALGEN models were chosen, respectively. RYIELD reactor was selected to simulate the decomposition of Imbat coal. The coal is transformed into its related components such as oxygen, carbon, hydrogen, sulfur, ash and nitrogen. RYIELD reactor distributes the components by using the proximate and ultimate analysis that identified as an input parameter for the coal [16-19], also RGIBBS, the Gibbs reactor, was used for the minimizing Gibbs free energy to simulate gasification reactions for char and volatiles [12]. In this study, the operation blocks that chosen for simulation on Aspen Plus have been given in Table 2.

Table 2. Description of blocks in the model

Aspen Plus ID	Assigned ID	Description
RYield	DECOMP	Decomposes coal into conventional components
RGibbs	GASIF2 GASIF4	Minimizes the Gibbs free energy and simulates whole gasification reactions
RGibbs	COMBUSTR	Minimizes the Gibbs free energy and simulates combustion reactions
Cyclone	CYCLONE	Removes solid particles from gas
SSplit	STEAMSP	Dispenses steam into Gibbs reactors
Sep	WATSEP	Separates water from syngas

3. RESULTS AND DISCUSSION

3.1. Validation of the Model

Syngas composition obtained from experimental studies of [20] and [21] with the model results, which had been generated by using literature data for the model validation have been given Table 3.

Table 3. Comparison of syngas compositions from literature and model

	Sample	Comp(%vol.)	Literature [20]	Model
1	**Sample**	**Comp(%vol.)**	**Literature [20]**	**Model**
	Coal Coke	CH_4	1.0	1.8
		H_2	46.0	46.5
		CO	44.0	43.1
		CO_2	4.0	4.1
	Temperature (°C)		800	800
	Pressure (bar)		1.013	1.013
	Fuel Feed Rate (kg/h)		1	1
	Steam Feed Rate (kg/h)		1	1
	Steam Temperature (°C)		152	152
2	**Sample**	**Comp(dry%vol.)**	**Literature [21]**	**Model**
	Xuzhou Bituminous Coal	CH_4	2.3	2.4
		H_2	10.6	10.0
		CO	10.5	10.7
		CO_2	15.3	14.2
	Temperature (°C)		940	940
	Pressure (MPa)		0.5	0.5
	Steam Feed Rate (kg/h)		3.04	3.04
	Fuel Feed Rate (kg/h)		8	8
	Steam Temperature (°C)		300	300
	Air Feed Rate (kg/h)		25.67	25.67
	Air Temperature (°C)		300	300

Results show that predicted syngas composition is in fair agreement with reported experimental data from literature [20, 21].

3.2. Parametric Study

Impact of gasifier temperature, steam flow rate and pressure on composition and exergy of the syngas from gasification of Imbat coal was studied using the developed Aspen model in this study.

3.2.1. Effect of Gasifier Temperature on Syngas Composition

Temperature of a gasifier is the most influential factors that affects the syngas composition crucially. In the study, impact of temperature on syngas composition is investigated by varying temperature from 850 K to 1300 K. Effect of temperature of gasifier on produced gas composition have been presented in Figure 2.

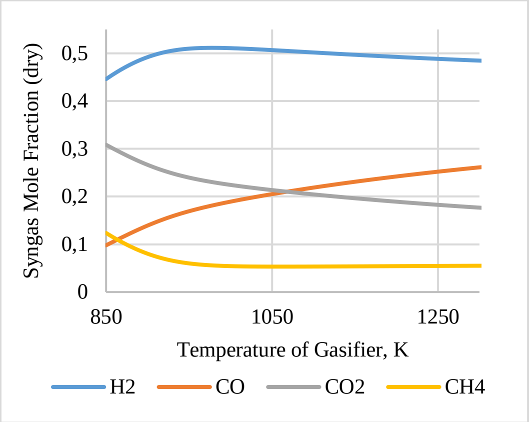

Figure 2. Effect of temperature on syngas gas composition

As observed in Figure 2, while the temperature increased from 850 K to 980 K, the H_2 evolution increased from 0.44 to 0.51. The H_2 molar fraction reached its maximum value at 980 K. Therefore, we can conclude that the molar fraction decreases with the temperature rising. On the contrary, the yield of CO increased with an increment in temperature. However, the evolution of CO_2 and CH_4 decreased. Gasification reactions include water gas, steam methane reforming and Bouduoard are endothermic reactions are favored by high temperature. Therefore, CO_2 and CH_4 are decreased, while the mole fraction of CO increased.

3.2.2. Effect of Steam Flow Rate on Syngas Composition

Steam is an important parameter for the hydrogen production during the coal gasification. Syngas composition at varying steam/coal ratios have been given in Figure 3.

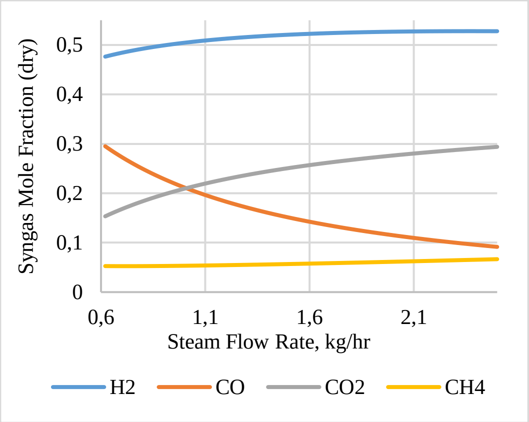

Figure 3. Effect of steam flow rate on producer composition

The results represented that when the S/C was increased, H_2 composition in syngas increased continuously as well. Higher amount of steam increased the moisture content in the gasifier that may provide better contact between moisture and other materials, obviously boosting water gas reaction [22, 23], water gas shift, steam gasification of volatiles, hydrocarbon cracking reactions and methane steam reforming reactions. While the S/C ratio increases the hydrogen concentration increases as well; this condition was observed by other authors [22, 24-26].

3.2.3. Effect of Gasifier Pressure on Syngas Composition

The gasifier pressure is an another important parameter for gasification processes. Effect of pressure of gasifier on produced gas composition was examined by increasing pressure from 1.01325 bar to 30.3975 bar, while steam/coal ratio is 1. The effect of pressure in gasifier on composition of syngas is presented in Figure 4.

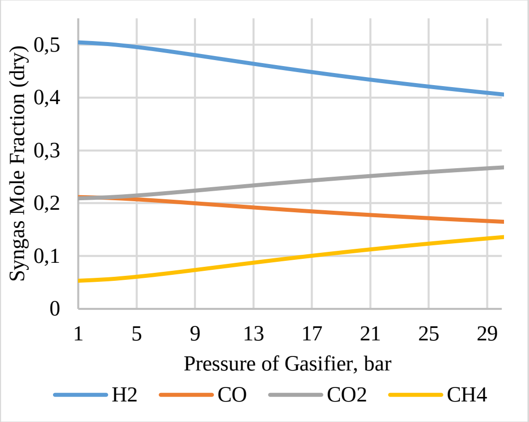

Figure 4. Effect of gasifier pressure on syngas composition

If a dynamic equilibrium condition is changed by a disturbing factor, the position of equilibrium acts to countermove the change according to Le Chatelier principle. It can be seen in Figure 4, while gasifier pressure increased among selected pressure range CO decreasing and CO_2 increasing due to Bouduoard reaction, while H_2 amount is decreasing as a result of water-gas reaction [27, 28].

3.2.4. Effect of Gasifier Temperature on Exergy of Syngas

Figure 5 shows the effect of temperature on syngas exergy. Exergy of syngas was examined by the temperature value from 850 K to 1350 K.

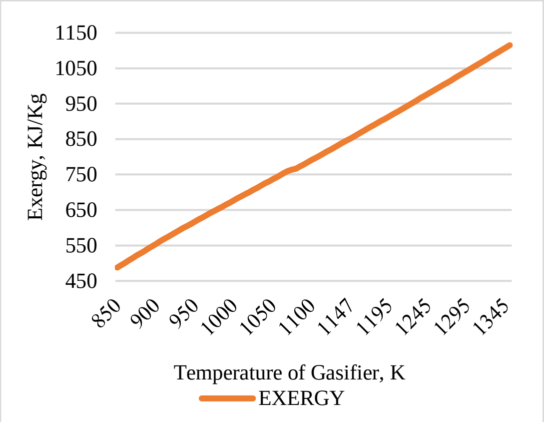

Figure 5. Effect of gasifier temperature on exergy of syngas

The syngas exergy increased with the rise of gasifier temperature. It attributes more favorable products like CO and H_2 obtained at high temperature, which increase the chemical exergy of syngas.

3.2.5. Effect of Steam Flow Rate on Exergy of Syngas

Steam is also an important factor to define the syngas exergy value. Steam flow rate has been changed from 1 to 3 kg/h, while coal flow rate (1 Kg/h) is constant. The effect of steam flow rate on the exergy value of syngas can be seen in Figure 6.

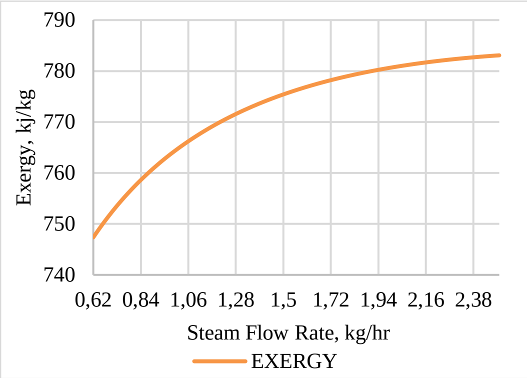

Figure 6. Effect of steam flow rate on exergy of syngas

In this situation, the production of hydrogen via steam reforming reactions enhances the chemical energy of syngas. However, excess amount of steam in CFB reduce the energy quality of syngas.

3.2.6. Effect of Gasifier Pressure on Exergy of Syngas

The effect of circulating fluidized bed gasifier pressure on syngas exergy has been given in Figure 7. The exergy value of syngas was investigated by changing pressure of circulating fluidized bed gasifier from 1.01325 bar to 30.3975 bar.

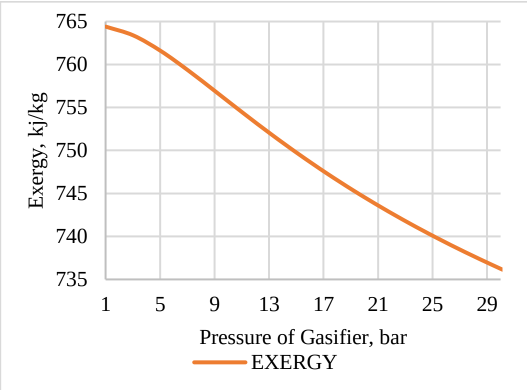

Figure 7. Effect of gasifier pressure on exergy of syngas

As seen in Figure 7, the exergy of syngas decreased with the rise of pressure. It can be explained with decreasing of production of combustible gas in terms of heating value at high pressure.

4. CONCLUSIONS

A new CFBG model for Imbat coal, for the first time, under steam gasification atmosphere has been built in Aspen Plus. Validation of simulation was successfully performed and model results are quite similar to literature data. Moreover, the parametric study in this work presents the steam gasification is a promising tool for low rank Turkish coals.

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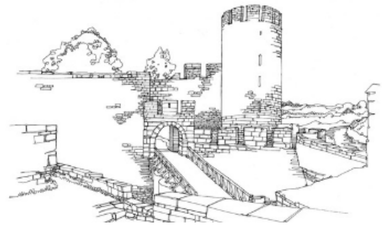

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The Experimental Determination of Effect Of Door Mirror To Drag Force On A Bus Model in Wind Tunnel

Cihan Bayindirli[1], Mehmet Celik[2]

Abstract

One major subject of study in the automotive industry is the determine of air flow around of a vehicle and its effect to drag and lift forces. High drag force reduces fuel efficiency and performance of vehicles. There are various ways to increase of vehicle performance and decrease fuel consumption such as improving the efficiency of engine and reducing drag force. In this study, the effect of mirror to drag force was investigated in a wind tunnel on a 1/33 scale bus model. The wind tunnel tests were made between the rate of 16.77 m / s-, 28.62 m / s in 5 different free flow velocities. To ensure geometric similarity 1/33 scaled licensed model bus is used. For the kinematic similarity blockage rate was %6.31. In studies Reynolds number independence is used to ensure dynamic similarity. It has been found that the mirror increase the aerodynamic drag coefficient by an average of 3.40%. It has been determined that the increase in aerodynamic resistance in this rate will increase fuel consumption by 2% at high speeds.

Keywords: *Drag force, wind tunnel, aerodynamic, bus model, door mirror*

1. INTRODUCTION

Improving of aerodynamic structures of vehicles is a steady innovation for automotive manufacturers. The door mirrors are obvious protrusions on the vehicle body. Drag is a force that opposes the movement of object through the air. Drag force is factors of velocity, area, air density and drag coefficient. The flow separation caused on the side mirror and creates a pressure based drag force. The high pressure of the flow creates a force towards the negative pressure region to the flat mirror behind the door mirror housing. As front area of the mirrors increase, drag force increase proportionately. In a study by Shah and Mahmood, 2014 the purpose was to determination of the impact of side mirrors drag to fuel consumption. By using analytical calculations basic shapes, the focus of the analysis was towards the mirror face. The author compared between a flat back and a hemispherical back mirror. The test was conducted at wind speeds of 60-120 km/h. The results reveal a reduction of fuel consumed for the hemispherical back mirror, which is 17 litres/year less than the flat back mirror at 120 km/h. This study was focused on the rear face of the side mirror where the drag was due to the turbulent flow of the side mirror after the front face. [1]. Ai Shen et al., 2016 were focused on the rear face of the side mirror where the pressure drag was due to the flow of the side mirror after the front face [2]. where $\dot{m}_{fuel}$ is the flow rate of fuel consumed, $H_{v,fuel}$ is the calorific value of fuel, P_{engine} is engine power required, F_D is drag force, v is velocity and η is engine efficiency. This formula will be used to quantify the fuel used to overcome the side mirror drag [2].

$$\dot{m}_{fuel} \cdot H_{v,fuel} = P_{engine} = F_D . v / \eta \quad (1)$$

The passive and active flow control methods are used to improve the aerodynamics of the car. Perzon, and Davidson, 2000 obtained the aerodynamic improvements with three different models. By rounding the back of the trailer he achieved 4 %, with nose cone 3% and with chassis skirt % 7 aerodynamic improvement is obtained [3]. The aerodynamic characteristics of 1/32 scale truck and trailer model were examined in a wind tunnel. In order to improve the aerodynamics structure of truck- trailer, one spoiler, one passive air channel and three

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different redirectors is used. The aerodynamic improvements are obtained respectively 14.78 %, 18.06 %, 23.15 % and 2.70 % [4]. According to Ogburn and Ramroth 2007, a decrease of 20 % in drag force is obtainable by adding some aerodynamic part on truck and trailer. The improvement in that ratio decrease fuel consumption about 10 % at or over 105 km/h speed [5]. Bayindirli et al (2017) determined by CFD method that the mirror increase the aerodynamic drag coefficient by an average of 4.78%. It has been determined that the increase in aerodynamic drag in this rate will increase fuel consumption by 2.5% at high speeds. Flow analysis performed in the Fluent program, simulation of static pressure distribution and on the mirror was obtained. CFD analyzes were carried out in the RNG turbulence model, and the pressure and friction-induced distribution of the total drag force was determined in their study [6]. The aim of this study is experimentally determine the effect of a standard door mirror of a bus model on aerodynamic drag and fuel consumption. The wind tunnel tests of base bus model were made by Bayindirli and Celik, 2018 in their study.

2. EXPERIMENTAL SETUP

The experiments were conducted in the test section of a low-speed, suction-type wind tunnel with a square test section of 400 mm × 400 mm × 1000mm. The 4 kW powered axial fan motor was used to achieve desired free stream velocity in the test region. The rpm of fan motor was controlled by frequency inverter. The frequency inverter operates in the range of 0-50 Hz and has 0.1 Hz step. The wind tunnel tests were carried out in the range of 3.8×10^5 – 7.9×10^5 Reynolds numbers, based on length of bus models. The minimum and maximum free stream velocity in the range of 0-30 m/s in wind tunnel. The view of the test devices and wind tunnel is given in Fig. 1.

Fig. 1. Experimental setup

In experimental studies, a Honeywell Model 41 load cell was used to measure the drag force with 0.1% accuracy which measures 0-5 lb force, with 0 - 5 Vdc output voltages. During the force measurement, total of 20000 data were acquired for 20 seconds at 1000 Hz frequency at each free stream velocity and the average of this 20000 value was taken as drag force. The free stream velocity of the wind tunnel was calculated with a pitot tube. The 24-bit OROS OR35 real-time multi-analyzer, external recorder with a 40 kHz sampling frequency and OROS Navigate data acquisition software were used to collect voltage outputs from the load cell. The experiments were performed on the test model which is shown in Figure 2-3. In this study, the bus model which is examined and improved aerodynamically is 1/33 scaled model of real vehicle. A 1/66 scaled toy bus was precisely scanned with three-dimensional scanning device and was created by computer-aided drawing method. It was double scaled and produced in 3D printer as 1/33 scaled due to measure of very little drag forces needs very sensitive test devices. The model bus positioned on floor plate in 5 cm hight. So uniform flow effected to model vehicle. The size of model bus 101 mm × 96.3 mm × 441 mm [7] . The experiments were performed on the test model which is shown in Fig. 2-4.

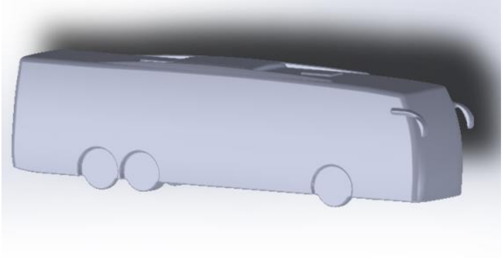

Fig. 2. Drawing data of bus model [7]

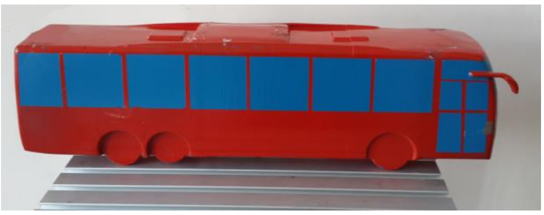

Fig. 3. The produced bus model with dood mirror in 3D printer [7]

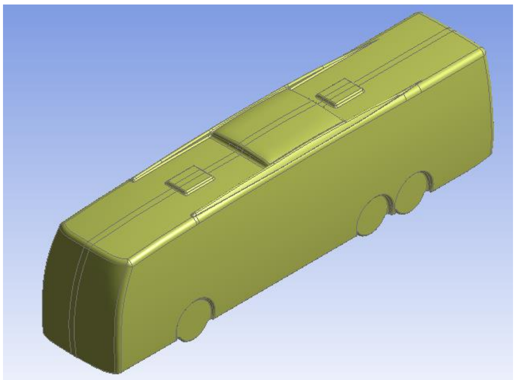

Fig. 4. Drawing data of door mirrorless bus model [6]

2.1. Calibration of wind tunnel

In Table 1, the voltage values corresponding to 9 different weights are obtained in the Origin Pro2017 program and the linear fitting graph and equation obtained in Fig.5. According to this equation, the force (N) corresponding to the voltage read is calculated.

Table 1. Calibration weights and equivalent voltage and force values

Weight (Gr)	Voltage (V)	Force (N)
368	3.048	3.456
324.5	2.854	3.172
284.5	2.677	2.911
223	2.206	2.217
172.5	1.857	1.703
122	1.549	1.250
71.5	1.209	0.749
21	0.834	0.197
0	0.679	0

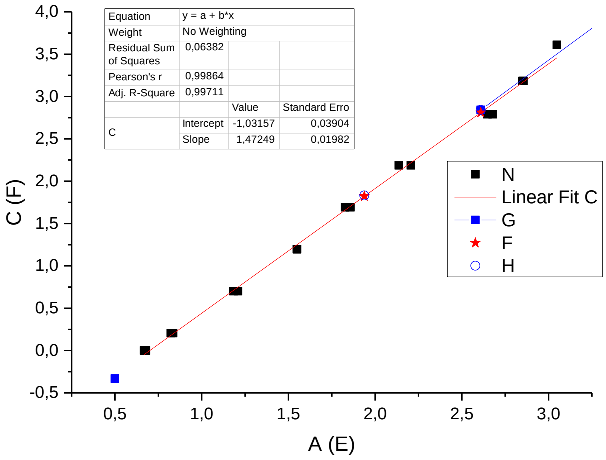

Fig. 5. Calibration graph

2.2. Uncertainty Analysis of Experimental Results

In this study, the results of the uncertainty analysis of the calculated parameters are given below.

2.2.1. Calculation of the uncertainty value of the Reynolds number

Uncertainty value for the Re number was obtained as 3,87 %.by writing ρ, U_{Pitot}, H and μ argument of uncertainty values instead of Eq. 2.

$$u_{Re} = \frac{w_{Re}}{Re} = \left[(u_{\rho})^2 + (u_{Pitot}\ )^2 + (u_H)^2 + (u_{\mu})^2\right]^{1/2} \tag{2}$$

2.2.2. Calculation of the uncertainty value of the drag force

The uncertainty values that are acting coefficient of drag forces was obtained as 4.5%. It was calculated for U = 10 m / s and Re = 312 000 value [7].

$$\frac{w_{F_D}}{F_D} = \left[\left(\frac{w_{X_1}}{X_1}\right)^2 + \left(\frac{w_{X_2}}{X_2}\right)^2 + \left(\frac{w_{X_3}}{X_3}\right)^2 + \left(\frac{w_{X_4}}{X_4}\right)\left(\frac{w_{X_4}}{X_4}\right) + \left(\frac{w_{X_5}}{X_5}\right)^2\right]^{1/2} \tag{3}$$

2.2.3.Calculation of the uncertainty value of the aerodynamic drag coefficient

The uncertainty value of the aerodynamic force coefficient was obtained as 4.7%.by writing F, ρ, A, the argument of uncertainty values instead of Eq. 4.

$$u_{C_D} = \frac{w_{C_D}}{C_D} = \left[(u_{F_D})^2 + (u_{\rho})^2 + 4(u_{pitot})^2 + (u_A\ )^2\right]^{1/2} \tag{4}$$

In this study, the results of the uncertainty analysis of the calculated. Uncertainty value for the Re number was obtained as 3,87% by writing ρ, U_{Pitot}, H and μ argument of uncertainty values. The uncertainty values of drag forces were obtained as 4.5%. It was calculated for 10 m / s free flow speed and Re = 312 000 value. The uncertainty value of the drag force coefficient was obtained as 4.7%.by writing F, ρ, A, the argument of uncertainty values [7].

3.EXPERIMENTAL RESULTS

3.1. The drag coefficient of base model bus

As seen in Table 1 and Fig. 6, as a result of experimental tests the C_D coefficient of the model bus was determined as 0.633 average. This result coherent with the literature [7].

Table 2. Aerodynamic drag coefficients of base model bus [7]

Reynolds Number	Base model C_D
382866	0.583
465426	0.630
544453	0.629
629112	0.654
712857	0.653
792900	0.651
Average	**0.633**

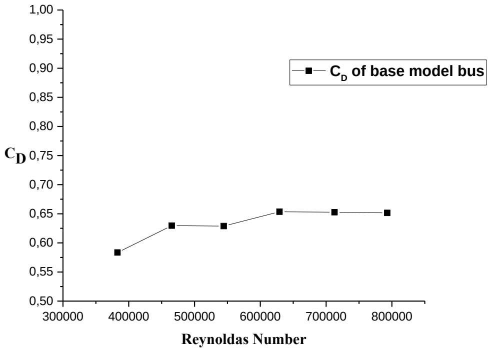

Fig. 6. The grapg of drag coefficient of base model [7].

3.2. The drag coefficient of door mirrorless bus model

As seen in Table 3 and Fig. 7, as a result of experimental tests were conducted same test conditions and free flow velocities. The C_D coefficient of the model bus which is without mirrors was determined as 0.612 average. There is 3.40% reduction in drag coefficient. It means door mirrors increase drag force average 3.40%.

Table 3. Aerodynamic drag coefficients of mirrorless model bus

Reynolds Number	Base model C_D	Door mirrorless bus C_D	Reduction
382866	0.583	0.569	2.46%
465426	0.63	0.597	5.53%
544453	0.629	0.608	3.45%
629112	0.654	0.638	2.51%
712857	0.653	0.629	3.82%
792900	0.651	0.632	3.01%
Average	**0.633**	**0.612**	**3.40%**

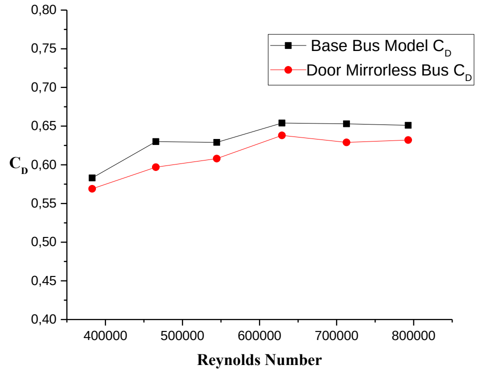

Fig. 7. The comparing grapg of drag coefficient of base model and mirrorles bus model

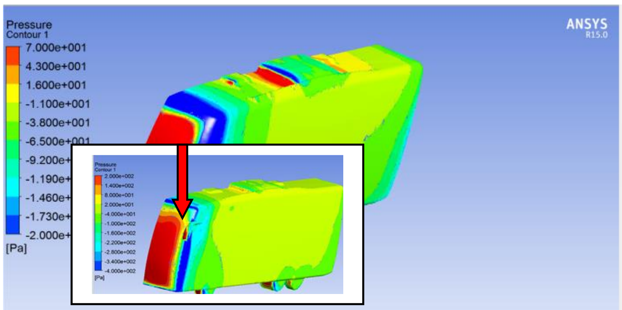

Fig. 8. Pressure distribution on bus at 15/m/s free flow velocity [6]

As seen in Fig. 8 the flow images, the pressure-based drag is high on the door mirror. When the mirrors were removed from the bus, the pressure induced drag decreased. This situation reduced the total drag coefficient by 3.4% on average.

4. CONCLUSIONS

Ai Shen et al. (2016) evaluated the effect of size and shape of side mirrors on the drag force of a personal vehicle. In running conditions of a vehicle, the side mirror contributes to the increase of drag, hence increasing the fuel consumption. However, the side mirror only contributes to the drag when velocity is greater than 60 km/h. The average drag coefficients of a car and its standard mirror were calculated as 0.354 and 0.175, respectively. The side mirror comprises of 3% of the total frontal area of model car. The removal of standard side mirrors reduces the total drag coefficient of the vehicle by 4.9%. They conducted this study using Computational Fluid Dynamic simulation. Bayindirli et al (2017) determined by CFD method that the mirror increase the aerodynamic drag coefficient by an average of 4.78%. In this study, the effect of a door mirror on drag force is examined experimentally for a bus model. Two door mirrors increased the total C_D coefficient by an average of 3.40%. This rate increases fuel consumption by 2% at high speeds. The more aerodynamic structure of the door mirrors to be used in buses is able to provide a significant reduction in annual fuel consumption considering the total route of the buses.

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Sustainability Dimensions for Inhabitants Living Near Sinkholes

***Seda H. Bostanci*[1]**

Abstract

In terms of its geological description, dissolution of the ceilings of the karst pits, and large and deep pits formed by karstic dissolution are defined as a sinkhole. Sinkholes, as they occur naturally and also occur as a result of human activities, especially in areas such as salt fields and mining. Naturally occurring sinkholes have cultural heritage characteristics. However, the fact that the sinkholes that suddenly occur in the places where people live causes this phenomenon to be brought to the agenda as a disaster that threatens the settlements. Processes such as disaster management, insurance systems, the approach of local governments to the issue, the government support, technical engineering solutions for the inhabitants which are effected from sinkholes vary from country to country. The aim of this study is to address the living conditions of the inhabitants whose houses are close to sinkholes in the context of sustainability. Among the sustainability and natural disasters, sustainability threats of the inhabitants can be examined with their ecological, economic and social dimensions. In the study, it is aimed to find an answer to the question of what can be done for the sustainability of the inhabitants that live in the sinkhole areas. The study which discusses sustainability and problems in areas close to the sinkholes from the urban-planning point of view has a conceptual nature. Therefore, a literature review was used as a method in the research. As a result of the study, starting from the current literature, there are suggestions on how to address the subject of mitigation planning, which is an important tool of disaster management in urban planning.

Keywords: Sustainability, disaster management, local governments, mitigation planning, sinkhole

1. INTRODUCTION

Sinkholes affect the sustainability of living conditions mostly negatively, but they also have some positive effects. The threats sinkholes create on agricultural areas, their impacts on the settlement pattern, and their eco-tourism potentials can be considered from an ecological point of view. The economic opportunities, property status, home sale, rent and insurance facilities of the families affected by the sinkholes can be discussed in terms of economics. Social solidarity, social assistance, local government support, and public opinion opportunities can be brought to the agenda on a social basis. Karstic structures are important for ecological environmental values, and these areas should be protected as natural areas. Besides, sinkholes that occur later in settlements is one of the problematic areas in which urban planning seeks solutions.

Sinkholes on the basement rocks are formed on the upper slopes of the paleo-cement planar surfaces facing the basin. These features show that sinkholes have been in a development process since at least Pliocene [1,2], which confirms that sinkholes formed before human settlements. The effects of human beings for formations of the sinkholes can be defined as: "The expanded sinkhole activity is caused by large-scale urban growth. The extreme low tide of groundwater, reforming or filling the surface with retention ponds, offices and houses, differences in drainage patterns, drilling vibrations, and increase in traffic are the factors of this phenomena." [3]."Karst environment ecology is modified considering the hydrologic constraints, and anthropogenic environmental change can cause a radical change in karst landscape ecology by threatening sustainability. [4]. In the formation of a sinkhole, building works, and mining comes first as human activities [5]. Van Beynen, et.al. (2012) grouped examples of human uses of karst environments and issues arising from human use as, mining agriculture, quarries, forestry, tourism, urban land use, water use [6]. When analyzed in these aspects, it is seen that in countries such as England that have engaged in intensive activities in the field of mining, the problems of sinkholes are due to the fact that these old mineral deposits are not fully located on the maps.

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Therefore, settlements established in the old mine areas face the problem of sinkholes. The main point of definition of sustainability is that they are based on the idea that today's decisions affect future generations. These mining areas couldn't be tailored to the settlement after the active process, which turns them into risky areas for current generations. Sinkholes that occur in natural areas create natural beauties while the settlements that occur in the settlement areas are considered in the scope of a disaster. When the issue is related to the disaster, mitigation planning, which is an important tool of urban planning on disasters, comes into question. "A coordinated series of structural and non-structural actions, processes which are designed to decrease the possibility of damages that can occur in the future as well as reducing the effects of natural hazards and disasters for health and safety can be definitions for the hazard mitigation planning." [7]. A balanced policy between mitigation and prevention is the preferred rational approach in the distribution of financial resources where it is more likely to achieve the right goal [8].

2. WHY PEOPLE LIVE NEAR SINKHOLES?

As stated in the previous section, sinkhole formations can be natural and human related. Generally, after the formation of a sinkhole in a certain area, the number of sinkholes in the same area begins to increase. Over time, those living in the immediate vicinity of these regions are abandoning or waiting for solutions depending on their economic opportunities, insurance systems in the country, government and local government policies. So: *Why do people live in areas close to them in these areas where life risk is intense?*

Perhaps one of the answers to this question is the spread of people to natural areas of the world and deformation of these areas sometimes by agricultural activities, sometimes with mining. In addition, sinkholes are parts of nature as valuable parts of the environment. People use urban areas more intensively with the urbanization process and reduce their opportunities for healthy living. As cities are producing crowded stress and their air and water become dirty, search for an alternative habitat for upper middle and high-income groups begins. From Ebenezer Howard to the present day, the search for linking urban and rural beauties is on the agenda of urban planning. According to Howard: “The garden city is a synthesize town and countryside-marry them-into a new urban form” [9]. When urbanization history is examined, it is seen that green areas and the desire to live in healthier environments with a high quality of life are important factors in urban sprawl. As this sprawl began to eradicate natural areas, there was an increasing interest in developing proposals on compact urban models. "The goal of the theory is to concentrate on development and decrease the need to travel by providing a concentration of socially sustainable mixed uses to an extent premised on urban containment and as a result a decrease in vehicle emissions" [10]. In addition to the alternatives in urban life, the desire to reach better living conditions during the time left in business life or retirement process brings up the phenomenon expressed as the second housing or summer residence. "In the twentieth century, the second home ownership expanded to other groups outside the upper classes along with changing ideas about contact with nature and wildlife." [11]. Its connection with sinkholes is that the landlords in Florida in the US face with the danger of sinkholes sometimes with permanent resettlement of natural areas, sometimes with the construction of second homes. In Florida, the issue of sinkhole is an important agenda. "Since the 1970s, the increase in the number and size of the sinkholes in Florida can be explained with a critical population growth which put a heavy demand on the aquifer system and stimulated by droughts in the 1970s and late 1990s" [12,3]. "The peninsula of Florida consists of porous carbonate rocks such as calcareous stones that store and help move groundwater. On top of the carbonate rock, dirt, sand and clay sit. Over time, these rocks may dissolve from an oxygen-created in acid water and create a void underneath the limestone roof. It can collapse and form a sinkhole when the dirt, clay or sand cannot be lifted by the calcareous roof. Although sinkholes can naturally causes, external events can trigger them" [13].

Sinkholes are geological features, one of the dominant landforms in Florida where it poses a threat to properties and environments. In West-Florida, there are problems with the formation of sinkholes due to accelerated development of underground and land resources. City planners, resource managers, and insurers were able to estimate the probability of occurrence of a sinkhole and associated risks. The Florida Insurance Office has designed the insurance premium for four submerged probability zones on the basis of insurance claims for sinkhole damage and hydrogeological conditions. Western central Florida was defined as an area with the highest frequency of sinkhole activity. The use of scientific information to assess risks and determine insurance rates illustrates the benefits of understanding the potential impacts of the hydrogeological framework and the development of water resources. This scientific understanding is essential to identify meaningful risks for both the property and the environment and to formulate effective land and water resource management strategies [14]. Figure 1 shows the effects of the Florida sinkholes on the cities and settlements.

Figure 1. (a) Sinkhole in Florida

Reference: https://www.foundationprosfl.com/what-is-floridas-sinkhole-alley-and-how-can-you-protect-your-home-if-you-live-there/

(b) Sinkhole effect of a house in Florida

Reference: https://www.nbc-2.com/story/36423410/irma-blamed-for-numerous-sinkholes-around-florida

With these facts, another answer to the same question is that the use of settlements in the past has not been written on the maps. So people learn that sinkholes can also form in a place after they move. In general, land imaging techniques, GIS and early warning systems are important stimulant and prevention methods for those who live near the sinkhole. In the Bayou Corne (US), sinkholes and environmental problems caused by salt extraction activities have undermined the lives of the inhabitants of this region. "As a result of the industry's efforts in order to extract brine which was used in chemical processing, a 25-acre sinkhole was opened up in Bayou Corne, it swallowed enormous trees, belched methane and sucked water from nearby wetlands" [15]. Many of the inhabitants of Bayou Corne, who have been evacuated from the area or left the area, still live in this area [16].

In addition to being a variety of disasters that affect life so far, sinkholes are a different type of disaster and a threat of sustainability in terms of being an example of how people use natural resources over time and without taking precautions for the future of settlements. How a potential disaster that people in residential homes on behalf of environmental justice are entitled to know that they can encounter. Today, the areas of cartography and geodesy offer new possibilities in the investigation of the land structure. "Unlike the other areas of monitoring of geological hazards, where have been developed over the years and are now commonly used, in the case of sinkholes, there is a lack of a specific tool developed for this purpose; therefore techniques usually adopted are derived from other areas like landslide monitoring" [17]. Besides, the multi-sensor approach studies for sinkholes have accelerated. The drone technique has become important geology tools in detecting sinkholes [18]. "It is still difficult to predict sinkholes occurring in deep areas despite the development of many sinkhole detection methods. For example, there are some new technological alternatives, such as singing a far-infrared thermal camera which is attached to a drone to detect potential sinkholes" [19]. The use of these technologies by urban planners before settlements will provide a significant development for mitigation planning.

3. DIFFERENT MEANING OF SUSTAINABILITY FOR THE INHABITANTS LIVING NEAR SINKHOLES

The concept of sustainability has three main dimensions such as: ecological, economic and social. Sustainability approaches have an impact on the shaping of urban and rural areas. As an interdisciplinary field of research, sustainability, resilient cities, and ecological justice are the most remarkable issues in urban and environmental studies.

Generally, the basis of sustainability discourses are the measures to be taken in the future. On the other hand, settlements near sinkholes are against ecological sustainability if the formation is natural. If people are settled in places where sinkhole occurs due to human-made reasons, and local governments are ineffective in this process, there is a phenomenon contrary to social sustainability. From a different perspective, it can be said that the decision has been made against economic sustainability if the place is selected wrong, which causes a loss in the value of construction and investment. In particular, it is significant negligence that drones capable of screening underground are developed and GIS allows comprehensive analysis and predictions. With such an approach, settlements near the sinkholes have features that are opposed to today's sustainability rather than the future. *Which strategies should be followed for the settlements near sinkholes in order to show a more sustainable approach?*

Perhaps at this point, the answer is in the correct interpretation of the balance between social, ecological and economic sustainability. This problem that arises in the field of sustainability should not be sought in people who live in this area and who have to face difficulties. The mine operators, entrepreneurs, and local administrators without solutions who have used these areas unconsciously are the actors who should be questioned more in this area.

In the field of engineering, solutions such as the consolidation of buildings against sinkholes have been seeking. Again, the most effective solutions to problems encountered in the formation of these areas are found by filling these areas. "Only with a thorough understanding of the epi-karst processes can proper planning for engineering works and remedial action to repair or alleviate damage" [20]. "Due to the importance of natural resources and the need to protect and properly exploit them, problems in karst management and the sustainability of karts environments are gaining increasing interest around the world. It can be said that the human impact on these fragile ecosystems in many karst areas is significant" [21].

Van Beynen at.al (2012) undertook an important study to determine the relationships between sustainability and karst areas and the standards in this field: "They have provided a framework in order to measure the sustainability of karst areas and they used an index setting goals for government entities by taking equity, environment and economic development issues into consideration. The Kars sustainability index has been developed taking into account the three basics of environmental sustainability for assessing karst areas: social equity, environmental values and economic development" [6]. As seen in this study, preservation of karstic zones where sinkholes are located as natural areas provides achievements on behalf of tourism and ecological sustainability.

4. CONCLUSION

Sustainability is of great interest in academic research. Sustainability can be interpreted as an opportunity for the human to question the negative forces of nature and to create a distinct common sense. Sustainability discourse has a very human-centred and one-sided content for deep ecology movement theorists who develop consciousness on the environment and who are interested in environmental justice. For this reason, many initiatives on sustainability continue to directly or indirectly affect the natural landscape in a negative way. For example, instead of fossil fuels, the production of renewable energy sources can be seen as more environmentally friendly. However hydroelectric power plants can change the flow of river beds. Similarly, considering the damage caused by wind turbines to birds, it is a fact that every human-made process harms the environment. Perhaps, as a contradictory comment on sustainability, a definition can be made such that people seek more peaceful aspects of exploiting nature in order to maintain the desired living conditions. People believe that technology will produce solutions to environmental problems. But the justice of nature does not remain silent to these processes. Global climate changes, natural disasters and sinkholes are important indicators of the fact that this unilateral development concept of man is not very sustainable. Sinkhole formations caused by the mining activities that began centuries ago are examples of how previous generations left living spaces full of problems to today's people.

There are a number of issues to be considered when looking for solutions to the problem of settlement in the sinkhole areas. For example, a very efficient technological solution for the settlement of these areas may result in the loss of more natural areas. A solution by covering the sinkholes with stones and gravel will just change the geological structure and harm the ecological sustainability. The contradictions of the discourse of sustainability come into play at this point. In the name of social sustainability, risks such as sacrificing ecological sustainability and even sacrificing ecological and social sustainability for economic sustainability should be considered comprehensively.

In the urban planning profession, mitigation planning, where disasters are considered, is one of the important issues. Urban planning studies should be developed on sinkholes. The issue of sinkholes should be given more attention in the planning of conservation. In future studies, the ways of handling sinkholes and implementation suggestions can be developed in urban planning.

In conclusion, in this study, it is discussed how to produce solutions for people whose houses are near sinkholes or threatened by sinkholes. In these processes, governments, local governments and non-governmental organizations capable of creating public opinion have important duties. When a neighbourhood encounters a danger of a sinkhole, the solution should be for all inhabitants living in that neighbourhood, not only for those whose houses are damaged. If a problem occurs in a very urbanized region, this problem should be considered in mitigation planning as a natural disaster and should be solved engineering-based. If this situation occurs in a natural area, then the area can be evacuated and more compact residential areas can be designed for those living in the neighbourhood. Respecting naturally formed sinkholes, entrusting these areas to nature, and less interfering with nature should be the actions to consider. From this point of view, it is now seen that people must find ways to make their sustainability compatible with environmental justice. Societies must be able to self-criticize and respect the wisdom of nature in order to develop.

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The Numerical Determination of Non-Smooth Surface to Drag Coefficient on a Minibus Model

Cihan Bayindirli[1], Mehmet Celik[2]

Abstract

The control of flow separation on vehicles is major interest area in fluid dynamics and as well as aerodynamic studies. In this study some techniques have been conducted to flow control around a minibus model. This study focused on decrease of drag coefficient of a 1/15 scale minibus model. Non-smooth surface plate was used to flow separation either by preventing it or by reducing its effects. The numerical flow analyses carried out between the free stream velocities 15-35 m/s and $2.8x10^5$-$6.6x10^5$ Reynolds number. In study Reynolds number independence was used to ensure dynamic similarity and blockage rate was 5.34 % for kinematic similarity. It was found that the use on non-smooth surface on the roof was decreased to drag coefficient by an average of 2.61%. This reduction rate decrease fuel consumption about 1.5% at high vehicle speeds. The pressure distributions on model vehicle and flow structure around the minibus model were determined numerically.

Keywords: *Drag coefficient, CFD, aerodynamic, minibus model, non-smooth surface*

1. INTRODUCTION

Automotive manufacturers are faced with the immediate task on more efficient aerodynamically designed vehicles due to increasing of fuel prices and greenhouse gas emissions. The drag force of a road vehicle is responsible for a large part of the vehicle's fuel consumption and contribute up to 50% of the total vehicle fuel consumption at high vehicle speeds. There are many scientific studies on reducing reducing aerodynamic drag of ground vehicles and increasing of their efficiency. This study mainly focuses on the methods employed to decrease of pressure based drag force and air flow separation around of vehicle. The active and passive flow controls method are used to improve of aerodynamic force on vehicles. Example of passive methods vortex generator, spoiler and splitter and example of active flow controls steady blowing, suction and air jet.

Belman et.al (2010) The fuel consumption by vehicles accounts for over 30% of CO2 and other greenhouse gas (GHG) emissions. Moreover, most of the usable energy from the engine goes into overcoming the aerodynamic drag (53%) and rolling resistance (32%); only 9% is required for auxiliary equipment and 6% is used by the drive-train. 15% aerodynamic reduction at highway speed of 55mph can result in about 5–7% in fuel saving [1]. Gopal and Senthilkumar (2012) examined on effects of vortex generator aplicationd for a passenger car. The variation of pressure coefficient, dynamic pressure, coefficient of lift and drag with and without vortex generators on the roof of a utility vehicle for varying yaw angles. The yaw angles used are 10°, 15° and 20°. To measure the effect of altering the vehicle body, wind tunnel tests have been performed with 1:15 scaled model of the utility vehicle with velocities of 2.42, 3.7, 5.42 and 7.14m/s. The experiments showed that minimum of 20% reduction in drag is obtained for VG with a yaw angle of 10˚ [2]. Song et al. (2012) aerodynamically optimized outer shape of a sedan car by using an Artificial Neural Network (ANN) method. They focused on modifying the rear body shapes of the sedan car. To determine the optimization variables, the unsteady flow field around the sedan driving at very fast speeds was analyzed by CFD simulation, and fluctuations of the drag coefficient (C_{D}) was calculated. When compared to the base model, aerodynamic

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performance was improved by about 5.64% in aerodynamically optimized shape for the rear end of the sedan [3]. Moussa et. al. (2015) investigated and optimized the effect of multiple bumps placed in the rear end of the cabin roof on the overall aerodynamic drag reduction for a generic model of a commercial truck. The numerical method combined automatic redesign of the add-ons, simulation, and optimization using a globalized form of the Taguchi method. The numerical optimization showed that drag reduction can be achieved at different values of the design parameters with an overall expected reduction between 6 and 10%. Overall, the bumps increased the cabin surface pressure coefficient and displaced the attachment of the bed flow over the tailgate toward the cabin, eventually reducing the size of the recirculating flow behind the tailgate and improving the pressure there [4]. Abinesh and Arunkumar (2014) aimed to modify the outer surface and structure of the bus aerodynamically in order to reduce the effect of drag force of the vehicle which in turn results in reduction of fuel consumption of the vehicle. The Two prototype bus body has been modeled by using CFD to reduce the drag force. As a result they increased performance and reduced the fuel consumption. The reduction in aerodynamic drag force was 10% [5].

The aim of this study is numerically determine the effect of a surface rougness to aerodynamic drag and fuel consumption. A minibus model was used in CFD flow anayses as model vehicle. The flow structure around of base minibus model investigated by Bayindirli and Celik, (2018) in their study [6].

2. MATERIAL AND METHOD

In this study, surface rougness is used as an aerodynamic passive flow control method on upper roof. The semi-circular surface rougness designed by using computer aid design program. The model minibuses and non-smooth plate are shown in Fig.1- 3.

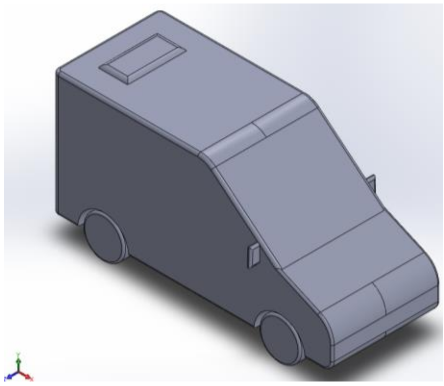

Fig. 1 Model Minibus (Izometric viev) [6]

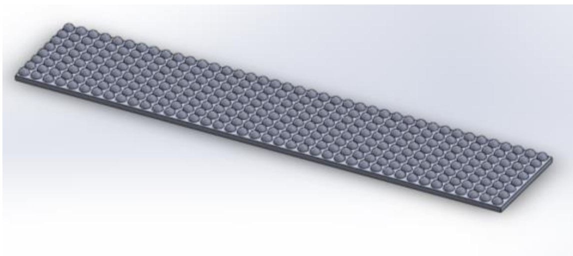

Fig. 2. Non-smooth surfaced plate

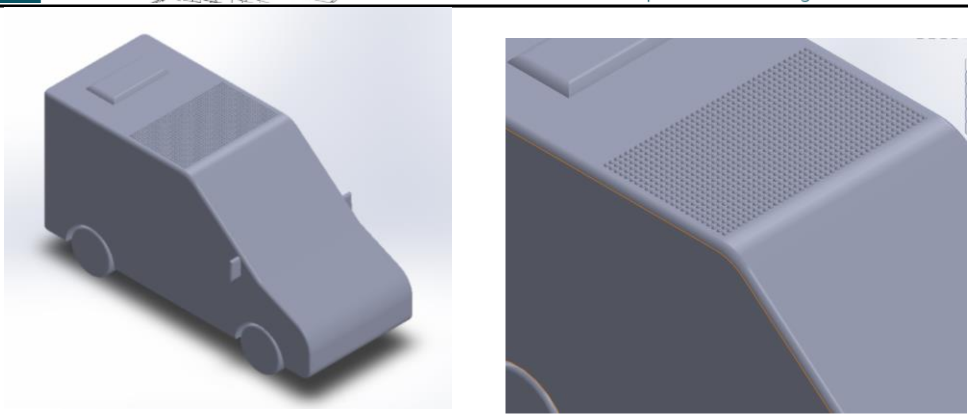

Fig. 3. Modified minibus model

2.1.Similarity conditions

In studies on vehicle aerodynamics, three different similarity conditions must be provided between prototype and model car. These are geometric, kinematic and dynamic similarity conditions. To provide geometric similarity, the licensed minibus model has been used. In kinematic similarity the rate of blockage is determinat factor. The front surface area of model bus is 0.01796 m^2; front surface area of test area is 0.3364 m^2 and blockage rate is 5.34%. The blocking rate should be lower than 7.5% [7]. Reynolds number independence was used to provide dynamic similarity in study.

2.2. Numerical Algorithm

The flow analysis were conducted in Fluent® program which solves general integral equations for continuity, momentum, energy, turbulence based on the finite volume method. In this study, convergence criteria is taken as 1.0×10^{-3} for continuity, x-velocity, y-velocity and z-velocity. The intensity of turbulence is also taken as 1%. The air density is taken 1 kg/m^3 and the dynamic viscosity is $1.56x10^{-5}$. The front surface area of the models calculated from the reports section in Fluent®. The analysis were made as standard initialization using standard wall functions and Simple Least Squared Cell Based k-ε RNG turbulence model. The numeric flow analysis were carrieded out in the Fluent® program using Workstation computer which has Intel® Xeon® CPU E3-1270 V5 3.60 GHz processor and 32 Gb Ram. The solution proceeds by the following steps:

- ✓ Generate the geometry (minibus and vortex generators model) and domain.
- ✓ Generate the mesh of geometry.
- ✓ Setup the pressure-based solver type, absolute velocity formulation and steady flow.
- ✓ Specify the properties of the fluid used such as air density and viscosity and boundary conditions.
- ✓ The solution method of problem is the pressure-velocity coupling simple scheme.
- ✓ Initialize solution and run calculations.
- ✓ Calculation of drag force, drag coefficient.
- ✓ Analyze the problem after specifying the convergence criteria and the iterations number.

2.3. Governing Equations

The following assumptions were used by the software package for the working fluid;

- ✓ Steady flow rate

- ✓ Incompressible fluid
- ✓ Newtonian fluid
  - ✓Fluid structure interaction is neglected
  - ✓Neglecting the heat transfer effects
  - ✓Neglecting the body forces
  - ✓K-ε model is most commonly used model in computational fluid dynamic to simulate average flow properties for the conditions of turbulent

The Fluent program solves the general integral equations for continuity, momentum, energy, turbulence using the finite volume method. Continuity and momentum equations are used in solving the finite volumes with computational flow dynamics (CFD). In practice, it is difficult to solve these equations analytically. Therefore, these equations are solved numerically using packet programs. The continuity equation is expressed as the mass balance in the control volume in a flow.

$$\frac{\partial\rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0 \tag{1}$$

According to Newton's second law, the rate of change of the momentum of a fluid fraction is equal to the total of the forces acting on that fluid fraction. The momentum increase rate in the x, y and z directions of the unit volume of a fluid fraction is respectively expressed in terms of $\rho\frac{Du}{Dt}$, $\rho\frac{Dv}{Dt}$ $\rho\frac{Dw}{Dt}$ [8].

Navier - Stokes and continuity equations are also referred to as differential motion equations. When these equations are solved, some assumptions are taken and pressure and three components of velocity (x, y, z) are calculated. The most useful way to develop the finite volume method of Navier - Stokes equations;

$$\rho\frac{Du}{Dt}=-\frac{\partial p}{\partial x}+div(\mu\, grad\, u)+S_{M_x} \tag{2}$$

$$\rho\frac{Dv}{Dt}=-\frac{\partial p}{\partial y}+div(\mu\, grad\, v)+S_{My} \tag{3}$$

$$\rho\frac{Dw}{Dt}=-\frac{\partial p}{\partial z}+div(\mu\, grad\, w)+S_{Mz} \tag{4}$$

As seen in Fig. 4 the mesh structure is formed more frequently in the regions which affects the aerodynamic structure of the model bus significantly. 3790343 triangular volumes cell structure (tedrahedrons) was formed on modified model minibus. The boundary conditions in the solution area are defined as inlet, outlet, wall and bus model.

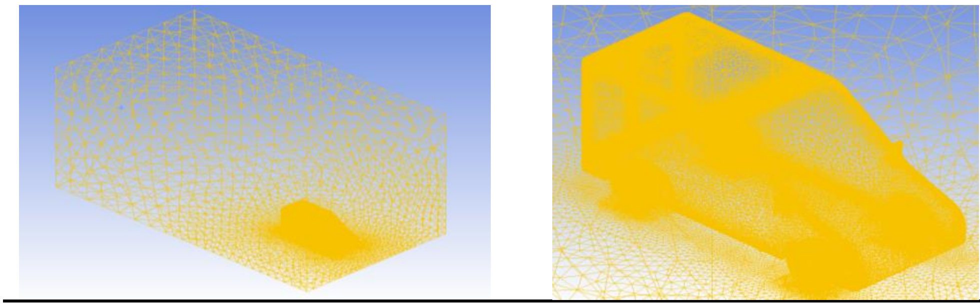

Fig. 4. Mesh distribution on the modified model minibus

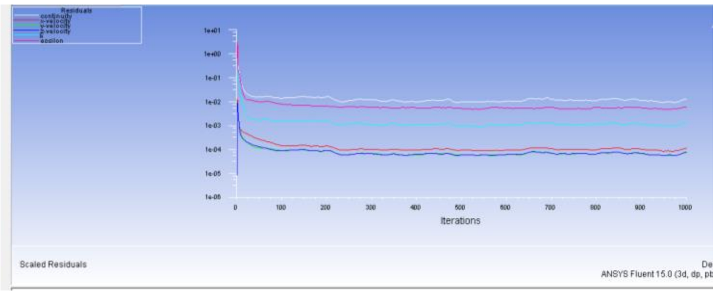

Fig. 5. Convergence graph in flow analysis

As a results of the flow analysis, the drag force which acted on the model bus was obtained and the C_D coefficient was determined. The aerodynamic drag coefficient C_D is the function of the drag force F_D, density ρ, free flow velocity V and front view area and it is given in Equation 8.

$$C_D = \frac{F_D}{\frac{1}{2}\rho V^2 A} \tag{5}$$

3. RESULTS

3.1. Drag coefficient of model minibus

As seen in Table 2 and Fig.6, C_D coefficient of the model minibus was determined as 0.415 at 5 different free flow velocity. It was determined that 91.20 % of the total drag force was caused by pressure induced and 8.8% by friction induced [6].

Table 1. Model minibus C_D Coefficients [6]

Velocity (m/s)	Reynolds Number	C_D
15	283653	0.435
20	378205	0.433
25	472756	0.391
30	567307	0.412
35	661859	0.405
	Average	**0.415**

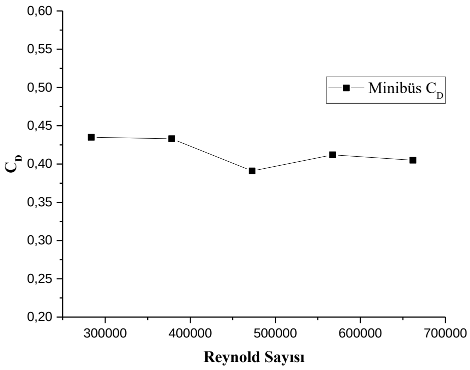

Fig. 6. Aerodynamic drag coefficient (C_D) graph of model minibus

3.2. Drag coefficient of modified minibus

As seen in Table 3 and Fig. 7, C_D coefficient of the modified minibus model which has non-smooth surface on roof area was determined as 0.405. When compared with base minibus model there was 2.62% drag reduction average.

Table 2. The C_D coefficient of modified model bus and reduction rates

Velocity (m/s)	Reynolds Number	Base Model C_D	Modified model C_D	Reduction
15	283653	0.435	0.426	2.24%
20	378205	0.433	0.420	2.86%
25	472756	0.391	0.380	3.04%
30	567307	0.412	0.403	2.08%
35	661859	0.405	0.394	2.88%
	Average	**0.415**	**0.405**	**2.62%**

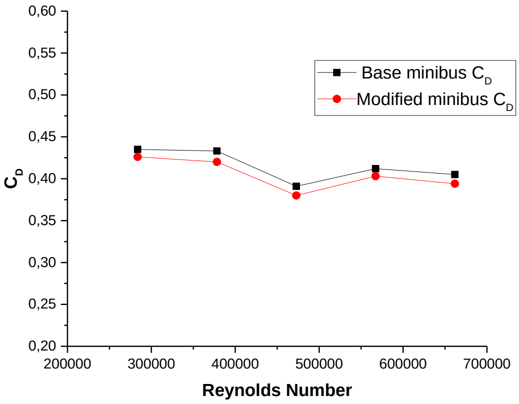

Fig. 7. Aerodynamic drag coefficient (C_D) reduction graph of modified minibus

In this study, numerical simulations were conducted to determine the effect of the nonsmooth surface, which was added on front area of roof. So flow seperation was delayed by this flow control method aplication and drag reduction obtained. The decrease in the negative zone, the turbulence kinetic energy and the vorticity in the wake area showed that non-smooth surface had a positive effect on the drag force. Flow visualiations around modefied minibus model are given in Fig. 8-10.

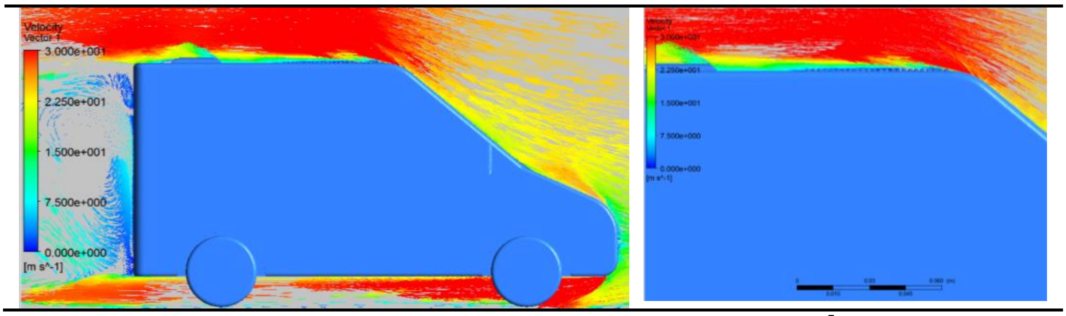

Fig. 8. The vector image of the effecting wind speed to model bus at $5.4x10^5$ Reynolds

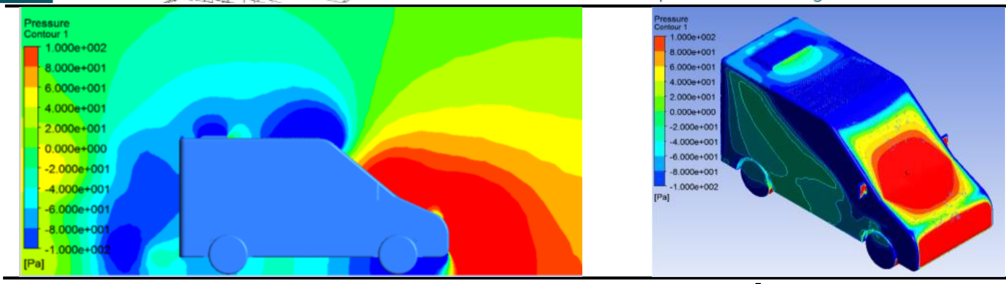

Fig. 9. The pressure distribution on the model bus at 5.4x10^5 Reynolds

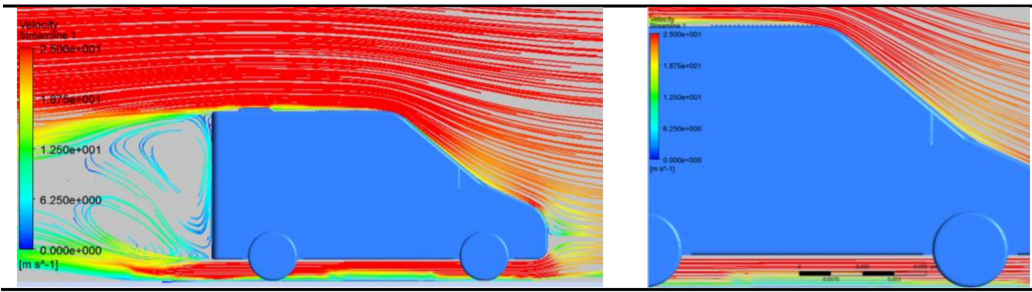

Fig. 10.The streamline image of the wind speed around the bus model at 5.4x105 Reynolds

4. CONCLUSIONS

Wang et.al. (2017) were carried out numerical simulations to investigate the influence of the dimpled nonsmooth surface on a Ahmed body model. In that numerical simulations were carried out to investigate the influence of the dimpled nonsmooth surface which was added on the rear slope of a general vehicle body on the reduction in the aerodynamic drag. The decrease in the negative zone the turbulence kinetic energy and the vorticity in the wake showed that the dimpled non-smooth surface had a positive effect on the reduction in the drag. The DOE analysis revealed that the D/S ratio is the key parameter for the dimples to reduce the aerodynamic drag and the results showed that the optimal combination of the design variables can reduce the aerodynamic drag coefficient by 5.20% [9]. In this study drag coefficient of a minibus model improved by using passive flow control. Non-smooth surface area was formed on half of roof area to decrease or delay flow seperation. As flow seperation decrease, negative pressure area decrease. Non-smooth surface creates drag force but its pozitive effect to flow seperation and negative pressure area compensated for this negativity. So drag coefficient was reduced 2.62%. Its effect to fuel consumption 1.5% about at high vehicle speeds.

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Sustainable Investing Exchange-traded Funds: Portfolios of the Global Leaders

Adam Marszk[1]

Abstract

This paper examines the portfolios of the world's largest sustainable investing exchange-traded funds (ETFs) in order to determine whether the assets they hold are consistent with the main principles of the principles-based investing. ETFs are one of the dynamically increasing types of investment funds. They can be defined as innovative investment funds that combine the features of the conventional, much more established mutual funds with the attributes of the securities traded through the stock exchanges. Sustainable investing ETFs are a quickly expanding category of the innovative funds - on the most mature markets, such as the United States, their number and assets have increased considerably in the last decade. The results of the analysis show that in most cases the managers of the largest sustainable investing ETFs follow the policies that are declared in the documents of the funds. Additionally, assets of the funds and their financial results were studied in order to establish the relationships between the consistency with the principles of ethical investing and performance of the funds. The results are mixed and no clear-cut conclusions can be formulated. Data on the 10 world's largest ETFs for the period 2010-2017 were used in order to reach the stated research aim. The applied research method was the analysis of the data on the assets of ETFs acquired from the financial databases and reports of the managing financial institutions.

Keywords: exchange-traded funds, investment funds, investment portfolio, sustainable investing

1. INTRODUCTION

Investment funds are a highly diversified group of investment products (or, in other perspective, group of financial companies). One category of investment funds has experienced a notable increase in terms of both the number of the available funds and their assets – exchange-traded funds (ETFs). In their most basic form ETFs can be defined as investment funds whose shares are listed and traded on stock exchanges or other parallel trading venues – in this aspect ETFs resemble, for instance, the listed companies whose equities may also be traded through stock exchanges [1]. Another similarity between ETFs and listed companies refers to the legal form of the aforementioned securities as in both cases they are equities (i.e. the shares of ETFs can be transacted in a manner similar to other equities which includes access to operations such as short trading or availability of derivatives linked to these securities) [2]. It should be stressed that the legal form of the shares of ETFs and their trading method are not their unique feature in the investment funds industry as this attribute is similar in case of the other category, i.e. closed-end funds. However, what distinguishes ETFs from all other types of investment funds (and may be perceived as the main reason for which they can be perceived as innovative financial products), including not only the closed-end funds but also the largest category, i.e. mutual funds, is the mechanism of the creation and redemption of the shares of ETFs, labeled as 'in-kind' process – it includes the exchange of the shares of ETFs for the portfolios of the securities (or other assets, depending on the type of ETF) [3]; these operations are conducted above all between the managing company and authorized entities (known as 'authorized participants'). Nevertheless, these transactions do not involve the main group that participates in the entire operations of ETFs – investors who buy or sell the shares of ETFs; in other words, analogically to the stock market, ETFs markets consist in fact of two segments: primary (it covers the creation and redemption of the shares of ETFs) and secondary (it covers mostly the transactions conducted exclusively in the shares of ETFs and is accessed by either individual or institutional investors as well as authorized participants or market makers). This structure is unique in the investment funds industry yet it needs to be added that there are some ETFs (in particular in Europe but also in other regions, depending on the offered exposure)

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that for various reasons utilize a different structure that does not include in-kind creation and redemption but rather involves exchange of cash for shares of the fund [4]. Another important feature of ETFs (it does not, though, refer to all available funds – see the comment below) is the fact that in their basic form they are passive investment products that offer rates of return that aim to follow the performance of the selected assets, in vast majority measured with the results of the stock market (or other) indexes calculated and published by some well-known financial company. Finally, it should be added that the category of ETFs is becoming increasingly more diversified – it currently is not limited to the equity passive funds (the initial category; they remain, though, the largest group in all possible dimensions) but includes also other groups such as fixed income ETFs or funds that offer exposure to commodities. One of the relatively most recent categories of ETFs is sustainable investing ETFs that are discussed in this paper.

The second process that has taken place in the global financial system over the last several years is the rapidly growing assets of various forms of sustainable (principles-based) investing which can now be perceived as an increasingly important part of the investment industry, at least with regard to the advanced economies. This trend may also be observed with regard to the investment funds. Sustainable investing can be understood, following the definition of the Swiss Sustainable Finance, as the type of investment approach that focuses on the various factors from the ESG group [5]. ESG includes three types of factors that are regarded as of key importance from the perspective of the sustainable development [6]: environmental (e.g., environmental governance), social (e.g., the rights of worker or education initiatives), and (corporate) governance (e.g., governance policies within the company). Sustainable investing ETFs (the other name used throughout the paper is 'ESG ETFs") may therefore be defined as the subcategory of ETFs that take into account the sustainable investing aspects in their investment strategies – in most cases it means that the aim of such funds is to track the performance of some ESG index that is constructed with the focus on the adherence to the ESG principles; in order to achieve this aim the sustainable investing ETFs usually hold in their portfolios the equities of companies that are included in the tracked index by its provider. As there are various types of ESG indexes (with various specific profiles) [7], the category of ESG ETFs has become rather diversified and it includes even funds with the exposure to the fixed income securities, not necessarily equities.

The main aim of this paper is to examine the portfolios of the world's largest sustainable investing ETFs in order to determine whether the assets they hold are consistent with the main principles of the principles-based investing. Moreover, some of the consequences of the possible deviations, in terms of, e.g., changes in the assets of funds are assessed. In order to reach the stated aim, the in-depth analysis of the portfolios of the 10 largest ESG ETFs is performed; the research methods include also the correlation analysis of the selected indicators of the size and financial performance of the examined funds, in relation to their ESG scores.

The paper consists of five parts. The first part is Introduction. It is followed by the second part that explains the methodology and data sources. The third, main part of the paper is strictly empirical and it presents and discusses the results of the study. Finally, the fourth part concludes the paper.

2. MATERIALS AND METHODS

The core research method utilized in this paper is the analysis of the portfolios of the sustainable investing ETFs in terms of their ESG scores. Two ESG scores are used, awarded by two leading international financial companies: MSCI ESG quality score and Morningstar's Sustainability Score [8]; additional indicator applied in this context is MSCI Weighted Average Carbon Intensity. The key indicator of the position of certain fund on the market for ESG ETFs is its total net assets (for comparability purposes the assets are expressed in common currency – US dollars). In order to gain more comprehensive insight into the consistency of the assets held by the analyzed ETFs with the ESG principles, the largest holdings of the selected ETFs are considered. In order to establish the potential relationships between the compliance with the ESG principles and their popularity (measured in terms of the assets they gathered, either in absolute values or changes over time) as well as the possible linkages between ESG scores and financial performance (measured using mean monthly return), the correlation coefficients between the relevant metrics are examined.

Data on 10 largest ESG ETFs in Europe and the United States are used in the analysis (there are almost no such funds outside these two regions). Due to data availability reasons the time period of the analysis is 2010-2017 (assets of ESG ETFs were negligible prior to 2010) and monthly data are used (the study covers the January 2010 – December 2017 time period). The assets and performance indicators of the ETFs were extracted from the Lipper's database that is provided by Thomson Reuters. Information about the ESG scores and detailed composition of the holdings of the funds were extracted from the most recent reports published by the providers of ETFs; in case of missing information in the reports, the necessary indicators were gathered from online financial databases. One of the key problematic issues of the study was the identification of the funds that adhere to the definition of the ESG ETFs – the classification was made based on the reports published by Deutsche Bank and online databases (in case of conflicting results it was assumed that particular fund can be included in the examined category).

3. RESULTS AND DISCUSSION

The assets of the ESG ETFs have increased substantially over the least several years, reaching in both regions approximately 8 billion USD at the end of 2017. It should be stressed, though, that over the majority of the 2010-2017 time period the assets of US sustainable investing ETFs have been much larger than the assets of their European counterparts – one of the reasons is the relatively longer history of the ESG segment of the US ETFs market (first such funds were launched approximately one year earlier than in Europe). Nevertheless, in both regions sustainable investing ETFs remain a very small part of either regional ETFs market or assets allocated to the ESG investing strategies (apart from ETFs, e.g., ESG mutual funds) – their shares have stayed below 1% of the relevant values.

Table 2.Ten largest ESG ETFs – basic information

Full name of the fund	Fund type	Lipper's classification	Primary exchange	Total net assets (billion USD)
iShares MSCI KLD 400 Social ETF	Equity ETF	Equity US	NYSE Arca Consolidated	1.00
Lyxor World Water UCITS ETF D-EUR	Equity ETF	Equity Global	Euronext Paris	0.74
iShares Global Water UCITS ETF USD (Dist)	Equity ETF	Equity Sector Utilities	London Stock Exchange	0.66
iShares MSCI USA ESG Select ETF	Equity ETF	Equity US	NYSE Arca Consolidated	0.64
Ishrs Eur Crp Bd Sri 0-3 Ucits Etf Dist	Bond ETF	NA	London Stock Exchange	0.56
UBS ETF MSCI World Socially Resp UCITS (USD) Ad	Equity ETF	Equity Global	Xetra	0.56
UBS ETF-MSCI USA Socially Responsible U (USD)Ad	Equity ETF	Equity US	Xetra	0.52
iShares MSCI ACWI Low Carbon Target ETF	Equity ETF	Unclassified	NYSE Arca Consolidated	0.50
UBS ETF - MSCI EMU Soc Responsible U ETF (EUR) Ad	Equity ETF	Equity EuroZone	Xetra	0.50
Guggenheim Invest Solar ETF	Equity ETF	Equity Sector Energy	NYSE Arca Consolidated	0.45

Table 1 includes a list of the 10 largest ESG ETFs in the world, sorted according to the total net assets as of end of December 2017 in the descending order (names provided in the first column were extracted from the Lipper's database as of mid-2017 – some changes in the further months were possible due to, e.g., merger of the funds). There are some substantial conclusions that can be formulated based on the information presented in Table 1.

To begin with, despite the aforementioned relatively larger size of the ESG ETFs in the United States in comparison to Europe, the majority of the largest sustainable investing ETFs (6 out of 10) shown in Table 1 have their primary listing location on the European stock exchanges (above all in the United Kingdom (on the London Stock Exchange) and in Germany (on Xetra)). However, it needs to be emphasized that the largest ESG ETF in the world (as of end of 2017) was iShares MSCI KLD 400 Social ETF, listed primary on NYSE ARCA Consolidated – it was the only analyzed ETF that accumulated approximately 1 billion USD in assets under management which proves that this category of the innovative funds remains still small, regardless whether we consider the size of the whole group or of particular funds. The assets of the remaining funds presented in Table 1 were significantly smaller than in case of the category's leader as they ranged between 0.45 billion USD (Guggenheim Invest Solar ETF – 10th position) and 0.74 billion USD (Lyxor World Water UCITS ETF D-EUR). Examination of the changes in the values of the total net assets (see Figures 1 and 2) shows that the trends observed for the particular funds were to large extent similar. The period of their noticeable development started approximately in 2013 or early 2014 but the growth of their assets accelerated substantially in the late 2016 and early 2017 – in case of all analyzed ESG ETFs it was the time of rapid increases in the total net assets that may be expected to continue over the next years, in line with the general trends on the regional ETFs markets and changes in the popularity of sustainable investing in the two regions. What may also be noticed with regard to both Figure 1 and 2 is the relatively short life-span of some of the world's largest ESG ETFs which were launched during the studied time period – see, for instance, Ishrs Eur Crp Bd Sri 0-3 Ucits Etf Dist or iShares MSCI ACWI Low Carbon Target ETF; despite their late inception they managed to accumulate substantial assets. Another interesting conclusion refers exclusively to one fund, i.e. Guggenheim Invest Solar ETF – its assets were characterized by the highest volatility thus reflecting large changes in its popularity and value of its portfolio which reflected to some degree the events on the linked market (of companies that focus on the solar energy technologies [9]).

The second key conclusion that can be drawn from Table 1 is that almost all among the largest ESG ETFs (9 out of 10) offer exposure to the equity market (to be more precise, they offer exposure to the tracked ESG indexes linked to the stock market). This result reflects the general structure of the global ETFs markets that are dominated by the equity funds. The only exception that can be noticed on the list provided in Table 1 is the single bond ETF: Ishrs Eur Crp Bd Sri 0-3 Ucits Etf Dist (the name in the Lipper's database is in fact abbreviated), with approximately 0.56 billion USD of total net assets. Examination of the list of the largest ESG ETFs also shows that the group of the global leaders remains highly concentrated in terms of their providers as half of the funds are managed under the BlackRock's iShares label. The remaining ETFs are also managed by some of the world's leading providers.

Finally, the list of the largest sustainable investing ETFs shown in Table 1 can be analyzed in terms of the specific exposure offered by these funds, i.e. their investment themes. A few groups can be distinguished. First, the most general one (without the focus on any specific ESG theme) which includes, for example, the global leader iShares MSCI KLD 400 Social ETF; this group is the largest. Second, there are two funds (2nd and 3rd largest in the world) which focus on the companies related to water such as water infrastructure and water utilities (their benchmarks are highly similar). There are also two funds that are different from these two categories: first, the aforementioned Guggenheim Invest Solar ETF and, second, ACWI Low Carbon Target ETF that concentrates on the equities of companies that limit their carbon footprint (therefore it may also be included in the first, general category).

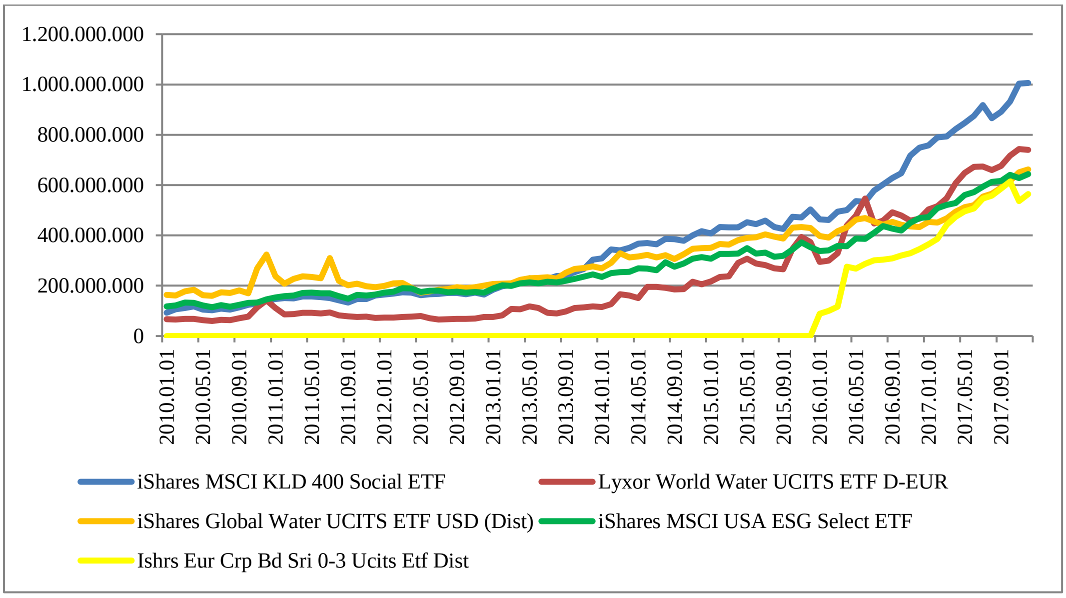

Figure 1.Evolution of total net assets of the largest ESG ETFs (USD) – part 1.

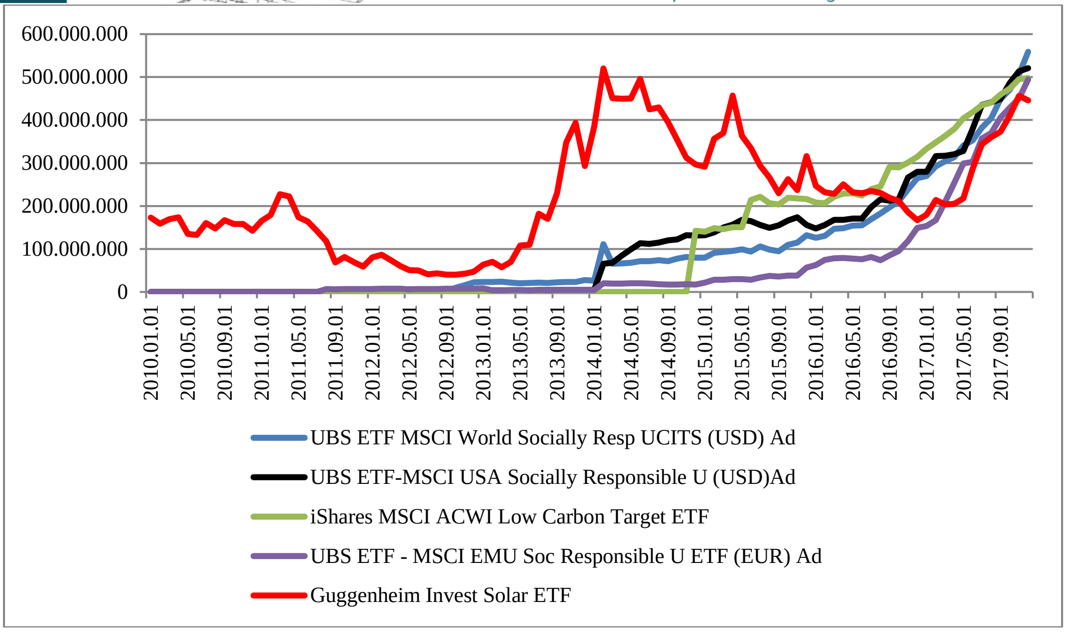

Figure 2.Evolution of total net assets of the largest ESG ETFs (USD) – part 2.

Table 2 presents the ESG scores of the portfolios of the world's largest sustainable investing ETFs – these scores correspond to the assessment of the companies that issued the securities held in the portfolios of the funds. Prior to their discussion, some methodological remarks are necessary. The exact methods of the calculation of the discussed indexes are not presented (they are available on the websites of MSCI and Morningstar). What is important taking into account the aim of this study is their range. MSCI ESG quality score ranges between 0 to 10 while the Morningstar's Sustainability Score is based on the 0-100 scale; in both cases the higher values correspond to higher ESG quality of the portfolios of the funds. Additionally, MSCI Weighted Average Carbon Intensity is shown – it corresponds to the carbon footprint of the companies whose securities are managed by ETFs (in the perspective of the compliance with the ESG principles, the lower values are more wanted). In terms of the MSCI score, the highest results were reached by UBS ETF - MSCI EMU Soc Responsible U ETF (the value of 9.0, much higher than for any other fund on the list). Moreover, it attained also the highest score when the Morningstar's ranking is taken into account, and it seems to be the leader in terms of the limitation of the portfolio's carbon footprint (see the lowest value of the carbon intensity indicator). The worst results with regard to both ESG scores were reached by the ETF with the focus on the solar energy (to some extent it is not surprising as this fund has slightly different investment focus and it concentrates exclusively on the selected industry that consists of companies not necessarily with high ESG ratings). Similar results can be noticed for the other ETFs that do not belong to the group of the funds with the general ESG focus, i.e. the ones that offer exposure to the water companies (they are characterized by the highest weighted average carbon intensity in the entire group) or low carbon footprint (interestingly, the latter does not provide access to investments with weighted carbon intensity that is substantially lower than in case of the remaining funds as there are some with even lower values of this indicator). Finally, it should be stated that the global leader, iShares MSCI KLD 400 Social ETF, is characterized by the ESG scores that are close to the average values for the entire group of the largest funds which means that it does not distinguish itself in this aspect either positively or negatively. Based on the information shown in Table 2 it can thus be concluded that, at least with regard to the sustainable investing ETFs with the general investment theme, they are characterized by relatively high ESG scores which means that their investment portfolios are generally consistent with the ESG principles as declared by the providing companies. However, in case of the other categories the results are less clear-cut. In case of the ETFs linked to the water or solar energy indexes the low ESG scores are not necessarily a sign of deviations from the declared investment policies – these funds simply concentrate on the sectors in which such results can be observed. Most stipulations refer to the results of ACWI Low Carbon Target ETF which is ranked rather low in terms of all indicators. In order to address this issue in more detail, in the next paragraph we examine the composition of the selected portfolios.

Table 2.Ten largest ESG ETFs – ESG scores

Name of the fund	MSCI ESG quality score	Morningstar's Sustainability Score	MSCI Weighted Average Carbon Intensity
iShares MSCI KLD 400 Social ETF	6.7	49.74	139.63
Lyxor World Water UCITS ETF D-EUR	5.8	NA	227.80
iShares Global Water UCITS ETF USD (Dist)	5.7	49.33	264.29
iShares MSCI USA ESG Select ETF	8.1	52.26	107.22
Ishrs Eur Crp Bd Sri 0-3 Ucits Etf Dist	6.9	54.53	124.39
UBS ETF MSCI World Socially Resp UCITS (USD) Ad	7.8	54.07	154.20
UBS ETF-MSCI USA Socially Responsible U (USD)Ad	7.3	51.09	174.70
iShares MSCI ACWI Low Carbon Target ETF	5.8	48.25	158.20
UBS ETF - MSCI EMU Soc Responsible U ETF (EUR) Ad	9.0	61.64	63.99
Guggenheim Invest Solar ETF	5.4	40.56	187.69

Tables 3, 4, and 5 present the largest holdings in the portfolios of the three selected among the largest ESG ETFs: first, the biggest fund (see Table 3), second, the one with the highest ESG score (see Table 4), and, third, the only non-equity fund (see Table 5). Table 3 explicitly proves that the major holdings of the world's largest sustainable investing ETF are equities of companies from the information technology or communication sector (the only two exceptions are the securities of Cisco and Home Depot). This structure closely reflects the main constituents of the MSCI KLD 400 Social Index which is tracked by the fund which means that reaches it fundamental investment aim. However, in spite of the fact that these securities meet the requirements necessary for their inclusion in the aforementioned index, their significance from the perspective of the main concepts of the sustainable investing is to some extent doubtful (in most cases they fit rather well in the 'G' group of the ESG factors but the other elements are less clear-cut). The same stipulations apply to the main holdings of the two next ETFs. The structure of the portfolio of UBS ETF - MSCI EMU Soc Responsible U ETF (EUR) Ad (presented in Table 4) is substantially different in terms of the geographical coverage as it includes the European companies (the tracked index is MSCI EMU SRI 5% Issuer Capped Total Return Net which includes exclusively companies from the European Economic and Monetary Union). It is also much more diversified in terms of the covered industries (at least with regard to the largest constituents). However, again it can be regarded as modification of the mainstream stock market index, mostly through the exclusion of the companies with the lowest ESG scores. Consequently, the ETFs based on these and similar indexes can in fact be viewed as a subset of equity funds with exposure to the major stock markets, yet with strong focus on the sustainability as the feature imposed in order to attract various groups of ESG-focused investors. Finally, Table 5 shows the 10 largest holdings of the single examined bond ETF. The majority of holdings are corporate bonds issued by the banking companies (they constitute approximately 46% of the total portfolio and almost all among the top 10 holdings). Their selection was based on the credit rating of the issuing company as well as their ESG ratings and exclusion of certain industries (such as tobacco companies); only bonds denominated in EUR are included. Again, it can be stated that even though the fund's portfolio adheres to the declared rules that take into account the ESG factors, the fund is also a modification of the conventional ETF. Nevertheless, it may also be stated that probably it is one of the reasons of their success and explanation of the accumulation of substantial assets – this type of funds appears to be more preferred by investors than funds with clear-cut ESG profile (e.g., the ones that invest exclusively in companies that deal with the environmental issues). Furthermore, their rather high ESG scores (in particular in case of by UBS ETF - MSCI EMU Soc Responsible U ETF) mean that their possible contribution to the sustainable development should not be disregarded.

Table 3. iShares MSCI KLD 400 Social ETF – 10 largest holdings (as of 8th April 2019)

Name	Weight (%)
MICROSOFT CORP	6.72
FACEBOOK CLASS A INC	3.23
ALPHABET INC CLASS C	2.91

ALPHABET INC CLASS A	2.77
VISA INC CLASS A	2.13
PROCTER & GAMBLE	2.01
INTEL CORP	1.95
CISCO SYSTEMS INC	1.92
VERIZON COMMUNICATIONS INC	1.88
HOME DEPOT INC	1.77

Table 4. UBS ETF - MSCI EMU Soc Responsible U ETF (EUR) Ad – 5 largest holdings (as of 8th April 2019)

Name	Weight (%)
SIEMENS AG	5.14
ALLIANZ SE	5.12
SAP SE	5.12
L'OREAL SA	5.05
TOTAL SA	4.82

Table 5. Ishrs Eur Crp Bd Sri 0-3 Ucits Etf Dist – 10 largest holdings (as of 26th April 2019)

Name	Weight (%)
BLK ICS EUR LIQ FUND AGEN ACC T0	4.91
RABOBANK NEDERLAND NV	0.63
CREDIT SUISSE (LONDON BRANCH) RegS	0.55
DNB BANK ASA MTN RegS	0.53
CREDIT SUISSE AG (LONDON BRANCH) MTN RegS	0.46
ALLIANZ FINANCE II BV MTN RegS	0.46
BNP PARIBAS SA MTN RegS	0.46
COOPERATIEVE CENTRALE RAIFFEISEN-B MTN RegS	0.45
COOPERATIEVE RABOBANK UA RegS	0.42
CREDIT SUISSE GROUP FUNDING GUERNS MTN RegS	0.41

The final matter addressed in the study is the relationships between ESG scores and various attributes of the analyzed 10 largest ESG funds. In order to shed more light on this issue, correlation coefficients between were calculated (see Table 6). The three variables that were juxtaposed with the utilized ESG scores are total net assets, change in total net assets and mean monthly return. The first group of correlation coefficients presented in Table 6 shows therefore whether the position in the ranking of the world's largest ESG ETFs (in terms of total net assets) is to some extent linked to the ESG scores gained by the examined funds. As it may be clearly noticed, all three correlation coefficients are very low, close to 0. It confirms the conclusion that could have been reached by the analysis of information provided in Tables 1 and 2, i.e. lack of any straightforward relationship. However, it must be emphasized that the group of 10 largest ESG ETFs is rather heterogeneous and value of the ESG score (and, accordingly, the level of ESG compliance) cannot be simply compared. Still, for the two next groups of variables some meaningful interpretations are possible. Starting with the change in total net assets (a simple measure of both changes in the popularity among investors and the value of the managed assets), it can be clearly seen that in case of either MSCI or Morningstar ESG score, the relationships seems to be positive (for carbon intensity it is almost null). It can be interpreted as limited support (see the comment below on the statistical significance) for the conclusion that to some extent the higher level of compliance with the ESG principles leads higher demand from investors and/or is associated with more pronounced increases in the prices of the fund's holdings (the reverse relationship is also possible yet rather improbable from the conceptual perspective – the calculation of ESG scores is unaffected by the changes in the value of assets as most examined funds tend to consistently track the same indexes). More insight into this issue can be gained by the analysis of the third group of variables, with the mean monthly return (i.e. average monthly return that could be gained by investing into the shares of the funds). As in case of the previous variable, the correlation with the carbon intensity indicator is close to 0. Still, for both sustainability scores it is positive – for the score published by Morningstar the value of the coefficient is the highest among all in Table 6. These results may thus be regarded as weak evidence for the positive relationship between the financial performance and level of the ESG compliance (it should be emphasized than the issue of causality is not verified – however, as noted above, it is rather improbable that changes in the returns lead to changes in the ESG scores as the latter are affected by substantially different factors). Finally, it should be added that only two values are statistically significant (at 5% significance level), for the following pair of variables: change in total net assets versus MSCI

ESG quality score, and mean monthly return versus Morningstar's Sustainability Score, which means that the other results should be interpreted with caution (the other stipulation is the low number of observations).

Table 6. Correlation between selected variables

Pair of variables	Correlation coefficient
Total net assets versus MSCI ESG quality score	-0.11
Total net assets versus Morningstar's Sustainability Score	0.00
Total net assets versus MSCI Weighted Average Carbon Intensity	0.13
Change in total net assets versus MSCI ESG quality score	0.63
Change in total net assets versus Morningstar's Sustainability Score	0.51
Change in total net assets versus MSCI Weighted Average Carbon Intensity	0.04
Mean monthly return versus MSCI ESG quality score	0.49
Mean monthly return versus Morningstar's Sustainability Score	0.70
Mean monthly return versus MSCI Weighted Average Carbon Intensity	-0.05

4. CONCLUSIONS

This paper addressed the previously neglected issue of the portfolios of the largest ETFs that take into account various aspects of sustainable investing in their investment strategies. 10 funds were included in the analysis: 6 primary listed in Europe and 4 in the United States. The size of these funds (measured using their total net assets) is rather small, as only one fund managed assets with the value of approximately 1 billion USD; the same applies to the size of the aggregate market for the sustainable investing ETFs. The group of the 10 largest is highly heterogeneous in terms of their ESG scores, listing locations, and their providers; however, all except one ETF are equity ETFs, i.e. they hold equities in their portfolios (the one exception is the bond ETF that manages corporate bonds). The leading investment theme of the examined ETFs is general ESG focus which means that they follow the stock market indexes that are modified in order to account for the ESG-compliance of the companies which compose the index. Some of the funds concentrate on different aspects such as water or solar energy industry. Analysis of the changes of the total net assets over time proves large degree of similarity between the evaluated ETFs, with the beginning of their growth in approximately 2013 and its acceleration in 2016. In the next stage of the study, the ESG scores of the funds and largest holdings of selected ETFs were analyzed in order to determine whether they can be regarded as compliant with the declared aims. The analysis has proven that in most cases their portfolios are consistent with the principles of the ethical investing, as indicated by, for example, their ESG scores issued by two leading financial corporations: MSCI and Morningstar. Interestingly, the level of compliance with the ESG factors is not necessarily linked to the position in the ranking of the largest sustainable investing funds (this conclusion is also confirmed by the correlation coefficients). The funds whose profile is other than general ESG are characterized by the relatively lowest values of the ESG scores yet it is understandable taking into consideration the fact that they focus on companies from specific industries, not necessarily the ones with the highest ESG scores. Analysis of the exact holdings of selected funds showed that even though they invest into securities issued by companies that are highly ESG-compliant (due to the construction of the tracked indexes), they may be regarded as contributing to the goals of sustainable investing only to limited extent (in particular in the environmental and social fields among ESG factors). Finally, correlation analysis leads to some interesting and potentially important conclusions as it provided some evidence for the potential relationship between the changes in total net assets as well as financial performance and ESG scores of the funds thus implying that the level of ESG compliance is one of the attributes that should possibly be considered by investors during the choice of particular fund. However, the results are far from conclusive and these issues require further in-depth analysis, based on more extensive datasets, with the application of other research methods – the current study should be perceived as starting point for the more advanced analysis.

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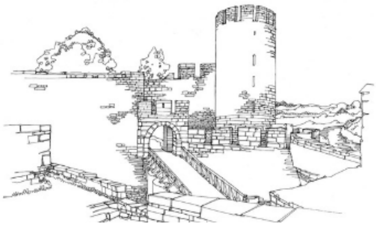

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Evaluation of Wheat Straw Gasification in Fluidized bed Gasifier using Aspen Plus

Damla Uygur[1], Ugur Ozveren[2]

Abstract

Biomass gasification is an encouraging thermochemical process that converts this residue mainly into syngas, which may be applied to electricity, generate heat, and fuels. However, the biomass gasification is quite complex and dependent on many interrelated and independent variables because of gasification reactions including water-shift and Boudouard reactions.

In this study, a novel biomass gasification model for wheat-straw was developed to simulate the air–steam gasification in a fluidized bed for syngas production using Gibbs reactor (RGIBBS) in Aspen Plus simulator, which is based on the minimization of Gibbs energy, has been used in this work for the whole gasification unit. To reveal the effects of gasification parameters; gasifier temperature, steam flow rate were investigated using sensitivity analysis.

The major evaluation criteria are estimation accuracy and generality of the developed gasifier model. The model is validated by data from literature and found relatively to be in good agreement. Results show that higher steam over air composition increases heating value of syngas.

Keywords: Biomass, Wheat straw, Fluidized bed gasifier, Aspen Plus, Gasification

1. INTRODUCTION

Biomass conversion into producer gas through thermo-chemical gasification has been considered as a serious alternative for thermal and power applications of fossil fuels [1]. However, biomass gasification includes complex thermochemical pathways, which is depends on the gasification agent **[2]**. Due to the advantages of circulating fluidized bed gasifier includes acceptance of a wide variety of feeds and good mixing of the solid phase, the use of steam as a gasification agent in circulating fluidized bed (CFB) gasifier aiming at H_2-rich gas provides higher quality product gas [3,4].

Researchers have developed steam gasification models for CFB by using ASPEN PLUS to avoid complex reaction pathways [5]. However, wheat straw gasification-gas under steam atmosphere, ASPEN PLUS has been less extensively studied.

The objective of this study was to improve an ASPEN Plus model using wheat straw as a gasifier feedstock for a CFB gasifier that can perform the prediction of gasifier performance under various operating conditions [6].

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2. MATERIALS AND METHODS

2.1. Feedstock Material

Proximate and ultimate analysis results were carried out according to ASTM Standard D 5142-04 (Netzsch 409 PC). Ultimate analysis was conducted using ASTM Standard D5373-2 (Truspec CHN-S, LECO). The results are summarized in Table 1:

Table 1. Proximate and ultimate analysis of Wheat Straw

	Proximate Analysis
Fixed Carbon (%wt)	15.19
Volatile Matter (%wt)	67.77
Moisture (%wt)	2.35
Ash (%wt)	14.42
	Ultimate Analysis
O (%wt,db)	48.07
C (%wt,db)	30.78
N (%wt,db)	0.62
H (%wt,db)	4.28
S (%wt,db)	1.83

2.2. Aspen Plus Simulation

In this study, circulating fluidized bed gasifier is used to simulate biomass gasification. The Gibbs free energy minimization theory was performed for the gasification reaction. The below assumptions are taken into consideration to simulate the CFB biomass gasification model:

- Isothermal and steady state process
- Immediately devolatilization of biomass and volatile products are CO, CO_2, H_2, H_20, and CH_4.
- All the gasification reactions included in the process reach the equilibrium
- Ash is inert that does not take part in the reactions
- Char is formed only carbon and ash

The developed CFB model for the wheat straw gasification using Aspen Plus has been given in Figure 1.

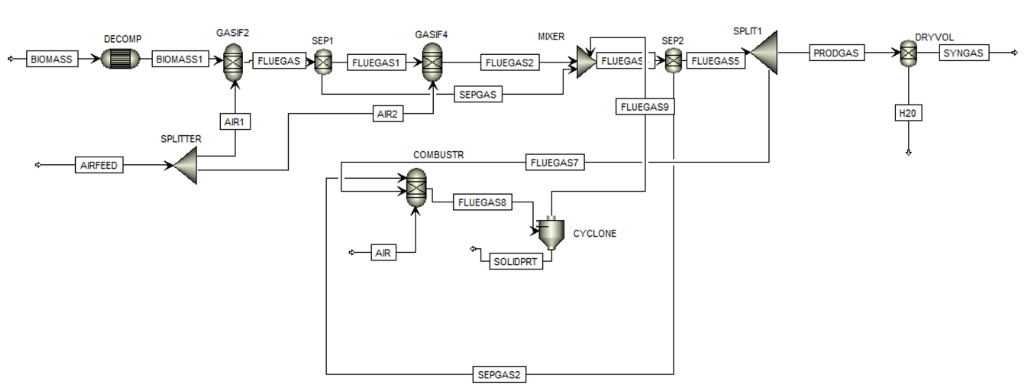

Figure 1. The ASPEN Plus main flowsheet

For the calculation of the solid, the DCOALGEN and HCOALGEN models were chosen for the density and enthalpy, respectively [7]. In the ASPEN Plus model, DECOMP signify the RYIELD reactor that decomposes raw material (BIOMASS) into routine solid elements [8]. The products of this decomposition are simplest form of each element such as O_2, H_2, S, C, N_2, and ash. The biomass is characterized as a non-conventional component in the simulation by specifying its PROXANAL and ULTANAL analysis. The feedstock material BIOMASS was placed into the DECOMP module to calculate the elemental yield.

The RGibbs blocks in the developed model are utilized to establish the chemical equilibrium between reactants and products, where gasification reactions take place in the CFB using Gibbs free energy minimization.

3. RESULTS AND DISCUSSION

3.1. Model Validation

Syngas composition obtained from experimental studies of [9] and [10] for the model validation have been given Table 3.

Table 3. Comparison of syngas compositions from literature and model

1	**Sample**	**Comp(%vol.)**	**Literature [9]**	**Model**
	Hazelnut Shell	H_2	28.9	28.9
		CO	21.7	28.4
		CO_2	31.8	32.5
		CH_4	9.5	9.1
2	**Sample**	**Comp(dry%vol.)**	**Literature [10]**	**Model**
	Pine Sawdust	H_2	22.8	22.0
		CO	43.3	42.8

CO_2	13.2	11.8
CH_4	14.4	23.1

3.2. Parametric Study

The impressions of temperature and steam flow rate on syngas product composition and on exergy were examined respectively.

3.2.1. Effect of Gasifier Temperature on SYNGAS Composition

One of the most effective parameters in the gasification process is the gasifier temperature which is directly effects the syngas composition. In this study, the gasifier temperature ranging from 845 K to 1345 K was investigated through the syngas composition. Results are shown in Figure 2.

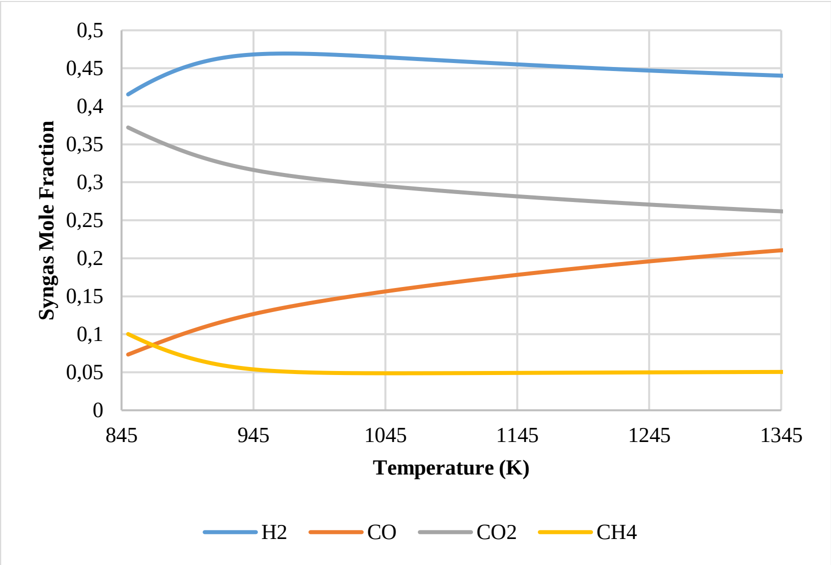

Figure 2. Effect of gasifier temperature on syngas composition

As seen in the figure 2, the H_2 mole fraction shows an increase when the bed temperature is ranging from 845 K to 945 K. After reaching a maximum temperature value at 945 K, H_2 mole fraction starts to decrease with the temperature increase because of the endothermic reactions. CO also shows a steady increase in the temperature increase, while CO_2 also shows a steady decrease due to the Boudouard reaction, which takes place at high temperatures.

3.2.2. Effect of Steam Flow Rate on SYNGAS Composition

As a gasification agent steam plays an important role in the gasification process. The entering steam flow rate to the system directly affects the amount and the content of syngas produced. Figure 3 represents the variation of syngas composition and its contents versus changing the steam flow rate.

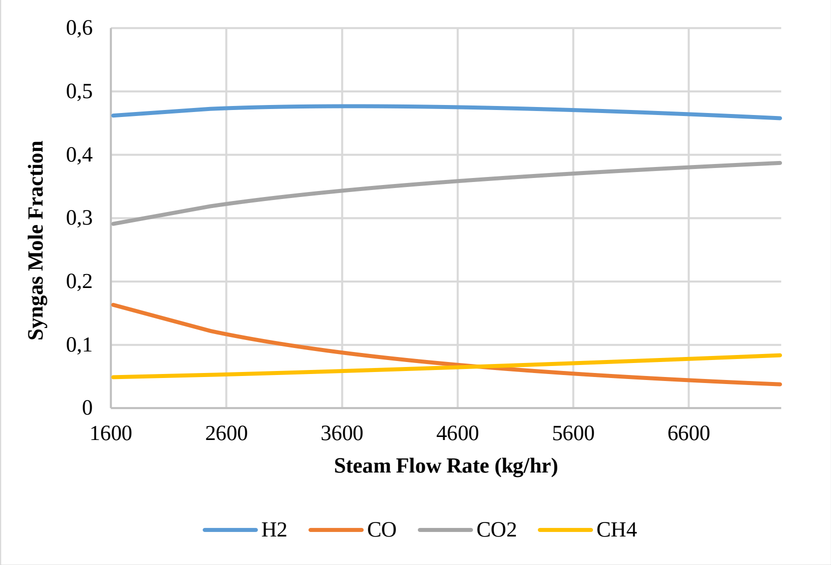

Figure 3. Effect of steam flow rate on syngas composition

According to the results, when the amount of steam increases, the amount of CO_2 shows a steady increase, while CO shows a steady decrease. H_2 is fixed after a small increase. When gasification reactions are examined according to the LeChatelier principle, the increasing amount of H_2O shifts the water shift reaction to the direction of the products and increases the CO_2 while CO consumes.

3.2.3. Effect of Gasifier Temperature on Exergy of SYNGAS

The exergy of the syngas was investigated for the temperature values between 850 K and 1350 K given in Figure 4.

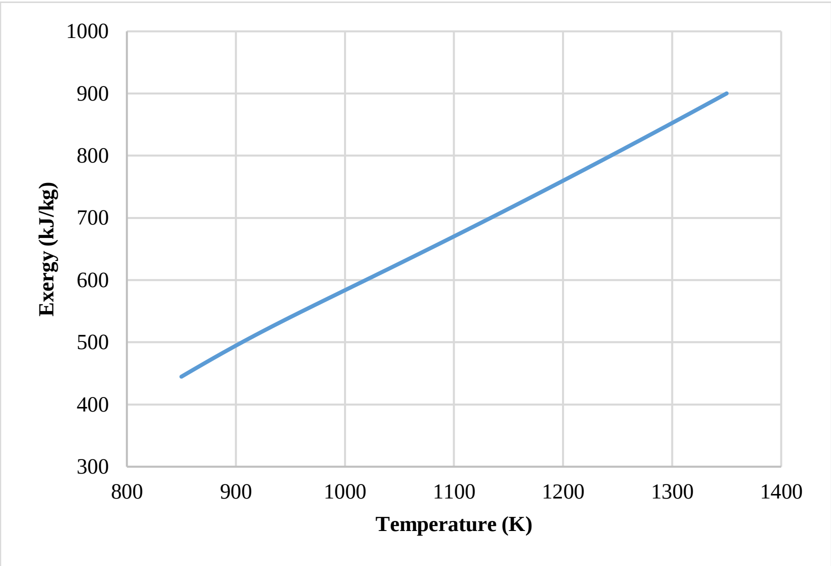

Figure 4. Effect of gasifier temperature on exergy of syngas

The exergy value of syngas increases with the temperature value because of the physical exergy and chemical exergy which includes exergy of H_2 and CO.

3.2.4. Effect of Steam Flow Rate on Exergy of SYNGAS

Steam flow rate is also an important factor to determine syngas exergy value. Steam flow rate effect on exergy of syngas can be seen in Figure 5:

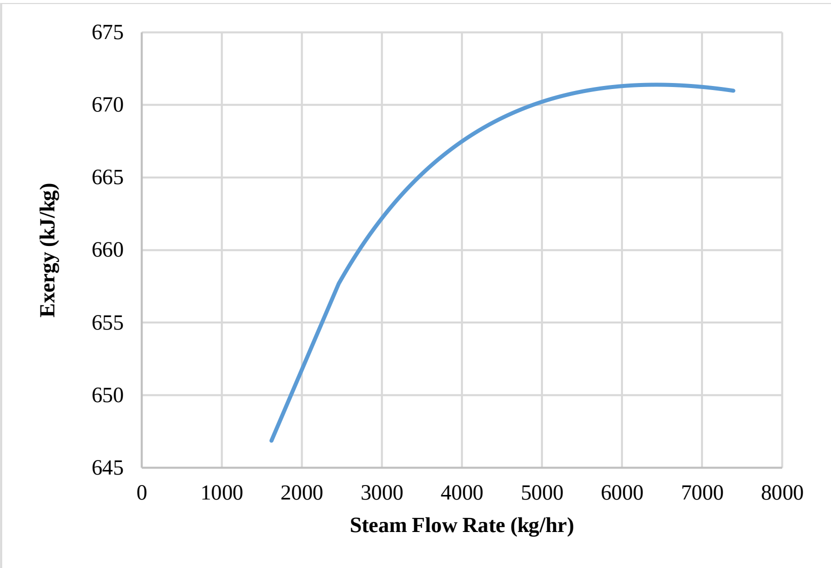

Figure 5. Effect of steam flow rate on exergy of syngas

The water gas and water shift reactions where the steam is reactant, provides an increase in the production of H_2 accordingly, the syngas exergy value rises. However, the continuous steam supply to the CFB is found on exergy in syngas dilution effect.

4. CONCLUSIONS

An Aspen Plus simulation model is designed for the gasification of wheat straw in a CFB reactor. The temperature and steam flow rate effects on CFB model was investigated. Through results of parametric studies, H_2 fraction on syngas product can be maximized by using steam atmosphere. It also increases the exergy and lower heating value of the syngas. The model estimation results are close to experimental values obtained from the literature in that case the CFB model was found to be useful for several kind of biomass gasification.

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Changi Airport* As A Model For New Istanbul Airport

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Abstract

It's obvious that Changi is the most innovative and attractive airport all over the world. Changi Airport Group (CAG) opened the Changi Airport Living Lab Program, which will collaborate with innovation-driven organizations and start-ups to improve and test new technology solutions in a live airport environment. Besides such innovations, Changi use good decorations, environmentally sustainable areas and service opportunities to differentiate. All these applications and facilities are amazing examples for Istanbul's new airport. By using these methods and adding some green places to the airport (as Changi did) Istanbul airport can create a sustainable competitive advantage and get a remarkable place in minds after grand opening. Moreover, both Changi and Istanbul are very important transit centers, which can bring huge opportunities to get advantages and require to be environmentally friendly while applying innovations. In short, in this paper, I'd like to emphasize the importance of using new technologies (especially for airports) to get more sustainable environment and more business advantages at the same time. Moreover by applying such innovations we can reduce environmental impact, prioritize economic growth and generate social progress also in Istanbul.

Keywords Sustainability, data analysis and innovations in the airports, facial recognition, new Istanbul airport, Changi airport.

1. INTRODUCTION

In today's world, most companies try to get competitive advantages over applying new technologies, innovative services, and data analysis. All these tools will be analyzed in this study. Also airports need to be aware of such kind of tools to improve their productivity and even to raise their ratings all over the world. In addition, airports are responsible to pass the tests like public expectations, regulation and cost reduction to operate efficiently. Moreover, creating a rigorous experience for passengers is one of the keys to airports attracting new customers, for instance, serving to passengers individualized opportunities to rest or entertain, creating comfortable and safe environment, achieving impressive sustainability standards, and so on. This study attempts additionally, to analyze the tools to obtain huge market place for airports and importance of applying technological innovations used in Changi Airport to new Istanbul Airport.

2. LITERATURE REVIEW

2.1 Innovation

Innovation can be simply clarified as a "new thoughts, creative idea, and new imaginations in methods or devices".

Innovation was always important factor that contributed to the success of an organization. The ability of a company to create a new idea of a better value can be a source of competitive advantage. The companies which

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have competitive advantage can improve their activity by the previously gained experience, and the sources of distinctive competences on the market. Using customers' preferences companies can easily create such innovations to make them satisfied. For example, some airports supple their passengers with free cinema or gardens or city tours for relaxing them while waiting for another flight. Additionally, other opportunities can be created for travelers by airport managers, because nowadays, it became harder to get competitive advantage even for airports.

2.3 Facial Recognition

Because of upgrade of technology, facial-recognition scans became a more attractive option for identifying the people from each other. Because cameras are cheaper and smaller, moreover, facial scans often take less time than gathering fingerprints. Innovations in business life also have made airports and airlines more eager to apply such programs — especially with the promise that they could speed the boarding process and move travelers through customs more quickly. Cameras and algorithms will play an increasingly important role in airport travel, while humans and their gray-matter-based judgment will take a backseat. For instance, instead of handing a person your license or boarding pass, you could scan it and then have a camera look at you to see if the two match. Ideally, a system like that makes the experience faster and more secure.

Maureen Meadows, a professor at Coventry University notes that airports are one area where we expect to give up our privacy. "The particular context of an airport is one where we have low expectations of privacy — we're expecting our behavior to be scrutinized," Meadows says. However, there are concerns beyond privacy. "One can still ask how reliable these systems are at identifying us, and whether there are potential negative consequences for innocent individuals," Meadows adds. "If we're going to adopt facial recognition systems, we need to be able to prove that people have thought carefully about the data set and coding that's been done," she says. Privacy advocates agree that efforts to improve the travel experience probably will be welcomed by anyone who's ever trudged through an airport with their baggage, but they say requiring people to submit to facial scanning goes too far. The government, they say, needs to do a better job of explaining why the scans are needed, how it intends to use the information and how long the information will be kept, among other things.

2.4 SUSTAINABILITY

Sustainability is commonly defined as the balance of environmental, financial, and social goals. Because of ever-changing climate, higher rates of global warming and an alarming scarcity of resources, we need to make human life more sustainable obviously. If we do not take any action to change the condition of our world now, it may be too late. There are three scientific principles of sustainability: 1. Dependence on solar energy, 2. Biodiversity, and 3.Chemical cycling. By these sustainable practices, we can decrease the environmental effects of developed infrastructure at the same time creating financial, operational and social benefits for a project and the community in general. To achieve these purposes, airports should take measures to decrease emissions, reduce noise pollution, eliminate light and visual pollution, protect wildlife and natural vegetation and lower the consumption of resources like electricity, water and land.

3. APPLICATION

It's obvious that Changi is the most innovative and attractive airport all over the world. Telegraph's 2014 Ultra travel Awards also gave the world's best airport name to Changi. This achievements can only be possible by applying innovations, artificial intelligence (facial recognition) and good data analysis which help the airport to keep its position as competitive and prominent while carrying 55million passengers annually.

If we look particularly, AI helps too much for predicting arrival times of flights earlier than usual. Steve Lee (Chief Information Officer & Group SVP (Technology) at Changi Airport Group)'s team aim to develop an AI solution that can make predictions two hours before the aircraft lands, whereas current solution provides the prediction is in only 30 minutes before the landing.

Next important point is the airport's cooperative interaction with various government agencies. One of them is with the Land Transport Authority, where taxi data allows the airport to get better information for the number of taxis waiting at various terminals, and allocate them to the most needed places.

The airport also sends employees to training programs for comprehending and handling AI and Watson. "It's not about smart equipment – it's about smart people using the equipment and technology smartly."- Lee adds.

Changi invests S$50 million to improve technological innovations at the airport over the 5 years. Besides such innovations, Changi use good decorations, environmentally sustainable areas and service opportunities to differentiate.

It seems that Istanbul airport will also use such technologies like automated robots, facial recognition, carrying vehicles between terminals, etc. By using these methods Istanbul airport can create a competitive advantage and get a remarkable place in minds after grand opening. Istanbul Airport opened to the world on 29 October 2018.

4. CONCLUSION

Now let's look closely to our case, Istanbul airport will be the new airport, and people all over the world don't have any idea yet, so it's a good chance to represent the airport, meanwhile the country, because in today's world airports became too important in improving tourism and the reputation. And applying attractive methods can help the airport to achieve its goal. Arranging the arrival time of flights properly and consequently, providing the passengers with taxi without waiting too much would most probably satisfy the travelers and make them to have a positive idea about the airport. In addition, by using environmentally sustainable products can help the airport to enter the world's top rankings in various specifications. Lastly, importance of innovative technology for achieving customer satisfaction can be measured at airport services as well. For instance, automation is one of them which helps to put certain tasks on autopilot while employees focus their energy and talent somewhere else to satisfy consumers. The wider AI learn about consumers, the more improved marketing strategies can be applied for each stage of customer lifecycle, consequently increasing satisfaction rate. It's also expected to see new advancements in customer satisfaction that's why the only way to survive and stay competitive is to use advantages of today's technologies.

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Coordination of the Common Tax Base on the Corporate Level of the EU

Matjaž Kovač

Abstract

Coordination of tax policy is one of the basic elements that can contribute to greater economic integration in the European Union. Treaty of Rome establishing the European Economic Community (EEC, the EU and the Community) in Article 2 lays down that the EEC should have as its primary task to establish a common market by gradually approximating the economic policies of the Member States, as well as to promote the harmonious economic development, constantly balanced economic growth, increased stability, accelerated raising of the standard of living and closer relations between the countries to which they belong. The Member States must remove all obstacles to the free movement of goods, services, people and capital (four freedoms). One of the elements of a stronger economic integration is the harmonization of the tax systems (e.g. the corporate tax regimes) of the 28 Member States. The European Commission proposed a common mechanism for the calculation of the corporate tax base, the consolidation of the tax bases incurred in the different Member States and the subsequent allocation of the consolidated tax base between the Member States (formulary apportionment). The system envisaged by the European Commission is already introduced by the world highly integrated economies, like the United States of America and Canada on a domestic level, where the corporate tax base shall be also allocated between the states and the provinces based on the formulary apportionment method.

Keywords: Tax Policy, Treaty of Rome, EU Common Market, Harmonization of Taxes, CCCTB

1. INTRODUCTION

In the Member States, large differences in tax structure and tax rates were found in relation to sales taxation, excise duties, corporate taxation and personal taxation [20]. In the field of direct taxation, a general turnover tax in the form of value added tax was introduced. Excise duties were even more diverse, since fiscal charges of all types were included in this category of duty. Turnover of excise duties was often carried out with the help of state monopolies on production and sale [18]. In the field of corporate taxation, there was also a similar diversity, since three taxation systems were developed, a classical system, a system of shared rates, and an input system. In the system of personal taxation, there were also large differences, in particular with regard to exemptions and financing methods [10]. The Competitiveness Pact proposed six measures aimed at creating the competitiveness of the internal market in the European Union [3]. Initially, the Competitiveness Pact was designed for the territory of the euro area Member States, but non-EU Member States were also invited to join together [10].

Creating a common corporate tax base is a very important but extremely controversial part of the Competitiveness Pact. Although the Competitiveness Pact was renamed the "Pact for the Euro", the original objective of strengthening economic integration with the Member States remained unchanged. The euro pact is intended to strengthen the coordination of economic policies between Member States with the aim of improving competitiveness and facilitating a greater degree of convergence between Member States . The euro pact also includes the coordination of Member States' fiscal policies . Direct taxation issues remain within the competence of the Member States, but in developing the company's overall tax base, fiscal neutrality must be pursued to ensure consistency between national tax systems while respecting national tax strategies, thereby indirectly contributing to the sustainability of public finances and the competitiveness of European companies. Within the framework of the EU Pact, the harmonization of tax policies includes [10]:

- exchange of best tax practices,
- avoiding harmful practices and making proposals to combat tax fraud and evasion,
- the development of a common corporate tax base.

The main objective of the Euro Pact is to promote convergence between Member States in order to reduce the economic imbalances that have contributed to the economic crisis. However, the Pact for the Euro can also have a profound political influence in terms of creating a union in the Union and contributing to the creation of a two-speed Europe. The development of a common corporate tax base was included in the Commission's proposal for a Council Directive on the Common Consolidated Corporate Tax Base (CCCTB). The European Commission has proposed a common mechanism for calculating the corporate tax base, the consolidation of tax bases from different Member States and the subsequent distribution of the consolidated tax base between the Member States in accordance with the distribution mechanism. The system proposed by the European Commission is similar to that used in other market economies, such as the United States of America and Canada, where the consolidated tax base is allocated between countries on the basis of a distribution mechanism [13].

The CCCTB system should provide more favorable conditions for investment in the single market, while reducing management costs. Enterprises would gain competitive advantages in the internal market, mainly due to the elimination of transfer prices, the transfer of losses through national systems in the group as well as the reorganization of the system. The positive effects of the introduction of the CCCTB model, on the other hand, outweigh the introduction of certain additional financial and administrative costs that should be taken into account by the national tax authorities in case of system implementation at first instance. The introduction of the CCCTB would increase the transparency of taxation across EU Member States, thereby helping to reduce fiscal uncertainty, as international companies could reasonably calculate in advance how much the real tax burden would be at the level of the whole company. This system would discourage companies from certain types of behavior for purely fiscal reasons, which would reduce the distortion of investment decisions and increase economic efficiency.

2. HARMONIZATION OF THE TAX BASE OF CORPORATE INCOME TAX

Companies wishing to make activities across the EU face high barriers and distortions of the market due to 28 different corporate tax systems. Tax obstacles to cross-border business are particularly large for small and medium-sized enterprises, which usually do not have the means to eliminate market inefficiencies. The network of conventions on the avoidance of double taxation between Member States does not provide a suitable solution. The current Union legislation on taxation of legal persons deals with only a small number of specific problems.

A system that would allow companies to treat EU corporations as a single market in relation to EU corporate income tax would facilitate the cross-border activity of resident companies in the EU and promote the objective of making the EU more competitive for international investment. Such a system could best be achieved by allowing groups of taxable companies in more than one Member State to regulate their tax matters in the EU on the basis of a single set of rules for calculating the tax base and cooperating with one tax administration. These rules should also be available to entities that are liable to pay corporate income tax in the EU and are not part of the group. Thus, under the aegis of the Commission of the EU and its working bodies, the idea of creating a system of a common consolidated corporate tax base (hereinafter CCCTB) was formed [13].

The CCCTB is used to tackle some of the major tax barriers that restrict growth in the single market. In the absence of common tax regulations, the interaction of national tax systems often leads to excessive taxation and the occurrence of double taxation. Companies are faced with major administrative and coordination costs. Such a situation creates barriers to investment in the EU and results in non-compliance with the priorities set out in the Europe 2020 Strategy - A strategy for smart, sustainable and inclusive growth [4]. The CCCTB is an important initiative which contributes to eliminating the barriers to the completion of the single market [5].

The proposed system of corporate taxation would be technically in three stages. All taxable profits and losses of each group of companies would be consolidated, irrespective of the location of individual companies in the group. The established tax base of a group of companies would be attributed to the individual group companies using the distribution formula. The tax base attributed to an individual group company would be taxed at the national tax rate of the country in which the company is located.

2.1. Implementation of the system

A common approach would ensure the coherence of national tax systems on the basis of a common tax base, but would not interfere with the rights of countries to form a tax rate. Each Member State will apply its own tax rates to its share of the taxable tax base. Differences in the determination of the tax rates of individual Member States provide for a degree of tax competition which is supposed to be maintained on the internal market. It allows Member States to take into account both their competitiveness in the EU internal market and the regulation and balancing of the budgetary needs of each Member State in tax planning [2].

In particular, the CCCTB contributes to reducing tax obstacles and administrative burdens, making it simpler and cheaper for small and medium-sized enterprises (SME), as they can expand their activities across the EU. The approach of SMEs to the CCCTB means that operating across borders use the CCCTB rules to calculate their tax base. In the event of accession to the CCCTB [16], SMEs would have less coordination costs, which would have a positive impact on the decision to commercial extension to another Member State.

The CCCTB introduces a uniform set of tax regulations in the EU Member States and uses only one tax administration model. An undertaking opting for the CCCTB ceases to be subject to a national tax arrangement in respect of all tax matters governed by the common rules of the CCCTB. A company that does not meet the conditions or does not opt for a CCCTB system is still subject to the rules applicable in national tax legislation.

With the introduction of the CCCTB, problems arising from jurisdiction contracts and the taxation of revenues generated by European companies outside the EU or outside the CCCTB area. If a practice of separate profits would remain in use in relation to non-EU countries, this would probably lead to the parallel use of different systems. This would entail an administrative burden for businesses, which would reduce the benefits of taxation through the CCCTB. The question arises, to what extent high capital mobility globally, diminishes the benefits of fiscal coordination within the EU [12].

2.2. Profits and losses

A more important advantage of the CCCTB is the ability to identify profits and losses at the level of an international company, which would enable the loss of businesses at EU level to be covered. Profits and losses of a group of companies should not be distinguished by countries in which individual subsidiaries of the group are located, all taxable profits and losses, irrespective of the location of individual companies in the group, would be consolidated. Thus, the spillover of profits between the companies of the group would lose sense, as the introduction of such a system would also eliminate the need to determine the transfer prices for transactions between individual companies of the CCCTB system [19].

The taxpayer's income must be taxable, unless explicitly exempted. The CCCTB system exempts income in the form of dividends, proceeds from the disposal of shares of a company that is not part of the group and the profit of permanent establishments abroad. In granting double taxation, most Member States exempt dividends and proceeds from disposal of shares, in order to avoid the calculation of the deduction of tax paid abroad, to which taxpayers are entitled. Taxable income should be reduced by operating expenses and some other items. Deductible operating expenses should normally include all the costs associated with the sale and expenses associated with the creation, maintenance and insurance of income. R & D costs and costs arising from the collection of equity or debt for business purposes should be deducted. A list of non-deductible expenditure should also be prepared [15]. Tangible and intangible long-term assets should be depreciated separately, while remaining required to be included in the group of assets. Depreciation in the group means simplification for tax authorities and taxpayers, since it eliminates the need to prepare and maintain the list for each type of fixed asset and its useful life [11].

When transferring the losses, taxpayers are allowed to transfer the losses to a future period for an indefinite period of time. The transfer of losses to the previous period may not be allowed. Since the loss is transferred in the future to the taxpayer to pay tax on his real income, there is no reason to limit the deadline for the transfer to the future period. The transfer of losses to the previous period is relatively rare in the practice of the Member States and entails the excessive complexity of the procedures [14].

2.3. Consolidation and distribution formula

Consolidation is an essential element of the CCCTB, as the main tax barriers faced by companies in the EU can only be addressed in this context. Consolidation eliminates formalities relating to transfer pricing and double taxation within the groups. In addition, the loss incurred by taxpayers is automatically offset by the profits generated by other members of the same group. Consolidation must include rules for the distribution of the result among the Member States in which the members of the group own their business units [17]

The distribution formula of the consolidated tax base contains three equally weighted factors (work, assets and sales). The labor factor is calculated on the basis of remuneration for work and number of employees (each item represents half). The asset factor consists of all tangible fixed assets. Intangible and financial assets should be excluded from the formula because of their mobile nature and the risks of avoiding the system. Finally, sales must be taken into account in order to ensure the fair participation of the state of destination. These factors must ensure that profits are taxed where they are earned. As an exception to the general principle, where the result of a distribution does not represent a fair amount of business activity, a substitution method is defined with a safeguard clause [8].

Example

Table 1: Calculation of the tax base on the basis of the partition mechanism - the loss shown in the Companies A; B and D in the CCCTB group

company	***sales***	***wages***	***employees***	***fixed assets***
A	*15.000*	*1.500*	*3*	*30.000*
B	*60.000*	*6.000*	*7*	*150.000*
C	*150.000*	*15.000*	*8*	*300.000*
D	*200.000*	*20.000*	*10*	*380.000*
E	*5.000*	*500*	*2*	*10.000*
sum	*430.000*	*43.000*	*30*	*870.000*
company	***sales***	***wages***	***employees***	***fixed assets***
C	*150.000*	*15.000*	*8*	*300.000*
E	*5.000*	*500*	*2*	*10.000*
sum	*155.000*	*15.500*	*10*	*310.000*

A.) We calculate the shares through a distribution mechanism, where we take into account both sales revenues, fixed assets and employment

DO = 0,33 x (sales / total sales + (0,5 x (wages / total wages) + (employees / total employees)) + axis / total axis)
DOC = 0,33 x (150,000 / 155,000 + (0,5 x (15,000 / 15,500) + (8/10)) + 300,000 / 310,000) = 0,33 x (0,968 + (0,5 x (0,968 + 0 , 8)) + 0.968) = 0.931
DOE = 0.33 x (0.032 + (0.5 x (0.032 + 0.2)) + 0.032) = 0.059

B.) We calculate shares through a distribution mechanism, where we take into account turnover and fixed assets without employment

DO = 0.5 x (sales / total sales + axis / total axis)
DOC = 0.5 x (150.000 / 155.000 + 300.000 / 310.000) = 0.5 x (0.968+ 0.968) = 0.968
DOE = 0.5 x (0.032 + 0.032) = 0.032

C.) We calculate the shares through a distribution mechanism, where we take into account the elements of employment without sales and fixed assets

DO = 0.5 x (wages / total wages + employees / total staff)
DOC = 0.5 x (15.000 / 15.500) + (8/10) = 0.5 x (0.968 + 0.8) = 0.884
DOE = 0.5 x (0.032 + 0.2) = 0.12

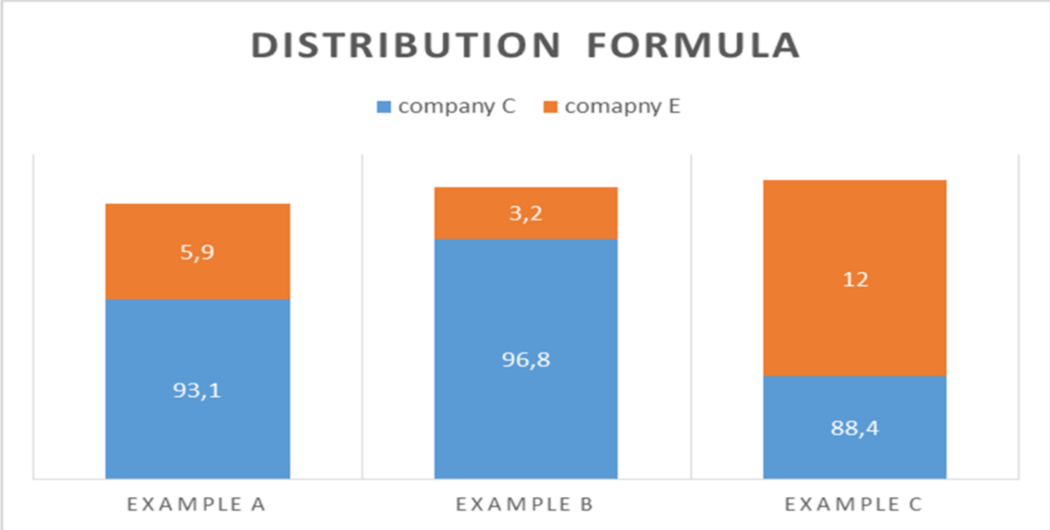

Figure 1: Distribution formula

With regard to the distribution of the tax base through the CCCTB system in companies certain discrepancies are observed. The example A shows the distribution of the tax base through all three elements of the distribution formula (sales, work and fixed assets). In the example B, we excluded the work (salaries and employees) from the distribution formula. The analysis shows that the distribution of the tax base increases with those companies that have a higher percentage of sales and consequently a higher percentage of the value of fixed assets, while the share of the distribution of the tax base in those companies with a lower percentage of sales and the value of fixed assets consequently decreases. From this point of view, such a distribution formula would be fairly fair, since companies that achieve higher sales values would possibly also be heavier taxed through a higher tax base (possibly because taxation also depends on the tax rate, which is determined by individual countries in accordance with its national law). Through the example C, we excluded from the distribution formula revenues from sales and value of fixed assets, so that only fixed costs remain - wages and the number of employees, which indirectly affects the value of fixed costs. Due to the rigid system of value of these items, there is a visible deviation in the case of companies that have low values of revenues from sales and fixed assets.

Rules on the reorganization of undertakings are also laid down to safeguard the rights of Member States in relation to taxation. In the event that a company joins the group, the market loss before the consolidation should be carried over to the future period to be deducted from the distributed share of the taxable person. If the company leaves the group, it is not allocated to the loss incurred during the consolidation period. Transactions between a taxable person and an affiliated company that is not a member of the same group is a co-subject of a price adjustment in accordance with an independent market principle, which is a generally valid criterion.

2.4. Administrative view

In the administrative area, groups of companies have the possibility of cooperating with only one tax administration (the main tax authority), which is the tax administration of the Member State in which the parent company of the group (principal taxpayer) is resident for tax purposes [1]. A general anti-abuse rule is also included, complemented by measures to limit certain types of abuse. These measures include restrictions on the deductibility of interest paid to affiliated undertakings which for tax purposes are residents of a low-tax country outside the EU that does not exchange information with the Member State of the payer on the basis of an agreement comparable to Council Directive 2011/16 / EU on mutual assistance the competent authorities of the Member States in the field of direct taxation and taxation of insurance premiums and regulations on foreign subsidiaries.

2.5 Recent changes in harmonization of the tax base of corporate income tax

The Council is considering a newly launched legislative initiative to introduce a common consolidated corporate tax base in the EU. The initiative consists of two legislative proposals:

- a proposal for a directive establishing a common tax base for corporation tax (CCTB) [7];
- a proposal for a directive establishing a common consolidated corporate tax base (CCCTB) [6] .

The previous proposal for the establishment of a common consolidated corporate tax base published in 2011 was not approved in the Council. However, technical work on the aspects of tax avoidance in 2016 led to the adoption of the anti-avoidance directive. In July 2013, EU ministers agreed that the common base for corporation tax should first be introduced, but then consolidated. Therefore, the European Commission has redrafted the proposal and divided it into two directives: the Directive on the introduction of a common corporate tax base (CCTB) and the CCCTB. The proposal included the Council's proposals for the previous (2011) proposal on the introduction of the CCCTB, in particular the compromise proposal of the Presidency of the EU Council of November 2014 and the Council's work on anti-avoidance measures. Both draft directives concern taxation, so they will need to be adopted in accordance with a special legislative procedure that requires consensus in the Council of the EU after consulting the European Parliament.

The objective of the CCTB Directive is to introduce a single set of rules for the calculation of the corporate tax base in the EU internal market. This would reduce administrative costs and improve legal certainty for businesses, as the calculation of their taxable profit would be the same in all EU countries. In addition, the new rules would help Member States to combat aggressive tax planning.

The draft CCCTB Directive lays down technical rules for profit consolidation and the distribution of the consolidated base to the eligible Member States. However, the aim of the CCCTB initiative is not to harmonize tax rates or possible tax incentives in the EU - these issues do not fall within the scope of the proposals. The setting of corporate income tax rates is a sovereign right of the Member States.

The proposed rules would be mandatory for groups of companies whose consolidated turnover exceeds EUR 750 million in the financial year and which have a permanent seat under the law of an EU Member State and belong to a taxable person who is resident for tax purposes in the EU. Small and start-up companies, whose turnover is lower than this threshold, could also be part of this system.

A very broadly defined tax base is proposed in the draft CCTB Directive. In accordance with the proposed rules, any revenue will be taxable unless explicitly exempted. The draft contains exempt revenue, which includes profits from the permanent establishment of a company in the country in which the head office of that company is located, and income from dividends or sales of shares of a company that is not part of the group. In addition, the draft rules propose a reduction in taxable income through operating expenses and other items. The proposal also contains a list of non-deductible expenditure.

The draft provides for pan-European tax relief for companies investing in research and development. R & D companies will be entitled to an additional 50% annual allowance for R & D and up to a further 25% relief for amounts exceeding EUR 20 million. Small startup companies could deduct 100% of their R & D costs, insofar as these expenditures do not exceed EUR 20 million and if these small enterprises do not have any related companies. By doing so, we would like to encourage innovation in the EU and help smaller companies to develop. Provisions against corporate tax avoidance (profit reorientation). The draft CCTB Directive contains several anti-tax avoidance provisions that include:

- the rule on the limitation of interest
- the rule of controlled foreign companies
- rules on hybrid discrepancies
- general rule on the prevention of abuse

Example
The company spends € 30 million on research and development in a given year. It will be allowed:
To deduct the total costs from your taxable income = EUR 30 million
An additional 50% for the first EUR 20 million = EUR 10 million
An additional 25% for the remaining € 10 million = € 2.5 million

In total, a R & D company can deduct 42.5 million euros from its tax base.

These rules reflect the rules already agreed by the Council under the VAT Aid Directive (ATAD Directive). Compared to the latter directive following the de minimis approach, the CCTB proposal is a step further, as it proposes that these rules be fully harmonized.

The directive contains a new tax advantage aimed at encouraging companies to use equity capital to finance growth rather than debt. For companies that, for the purpose of financing their activities, decide to increase equity, instead of borrowing, a special tax deduction will be available. These rules should help small companies to use capital markets and generally reduce the dependence of the private sector on borrowing.

Example
The company begins to use a common base in January of year X.
In the same year, it issued new shares worth EUR 10 million for investments in new premises.
The AGI rate for year X is 3% (the rate will change from year to year).
This year, the company may deduct AGI from its tax base of EUR 300 000 = EUR 10 million, multiplied by 3%. The company will also receive additional fees for the next 9 years after the issue of this equity. The exact amounts of this allowance will depend on how the equity value develops.

The Council will only consider the directive establishing a Common Consolidated Corporate Tax Base (CCCTB) only after sufficient progress has been achieved in the consideration of the directive establishing a common tax base for corporation tax, which will lead to a period in which taxpayers are temporarily they will not be able to benefit from fiscal consolidation. To resolve this problem, the proposal contains a provision for a relief mechanism to cover cross-border losses with subsequent reintegration. This rule would apply until the introduction of a common consolidated corporate tax base, when the facilitation to cover cross-border losses should become automatic. The CCCTB Directive basically suggests that the consolidated taxable profit of a multinational enterprise group be divided between those Member States in which the group operates. This would be achieved using a specially designed distribution formula. Under the proposed mechanism, each Member State will then be able to tax its distributed share of profits at its own national tax rate.

Given today's international economic environment, characterized by increasingly globalized, mobile and digital business models and the complex structures of multinational companies, governments are increasingly difficult to secure the taxation of operating income in countries where value is created. Differences between national corporate tax systems across the EU create favorable conditions in which transnational corporations can implement tax planning schemes, which most often involve redirection of profits into lower-tax jurisdictions (in so-called 'preferential tax regimes'). This activity, known as 'profit reorientation', is detrimental to the state budget and contributes to the erosion of its tax base. The practices of aggressive tax planning, most commonly used by large multinational companies, have a particularly negative effect on the competitiveness of small and medium-sized enterprises that can not afford high consultancy fees associated with such tax solutions.

3. CONCLUSION

The main advantage of fiscal harmonization at EU level (tax harmonization) is to reduce costs at the level of national tax systems, given the fact that, due to different tax systems, countries have higher costs in collecting taxes, and the mobility of tax factors is further facilitated by tax evasion, since the taxation of income from other countries are much more difficult. The advantages of fiscal harmonization are also in the elimination of disruptions in the internal market, as the free movement of goods, services, persons and capital is applicable. Due to high tax burdens in one and low in another Member State, taxpayers are motivated to transfer activities to countries with a lower tax burden. Due to differences in the amount of the tax burden, production factors are moved to countries with a lower tax burden. In the case of corporate income tax, we note that companies do not move their production to countries with lower production costs, but to countries with lower taxes, as they can outweigh the higher production costs. It may happen that in the long run, a company that is less efficient will survive in the common market, but it is also less taxed.

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Wavelet Analysis of Wind Speed and Solar Radiation Data

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Abstract

Solar energy and wind energy are the most popular among renewable energy sources. Detailed analysis of both wind and solar radiation data is very important for determining the potential. In this study, wind speed and solar radiation data of the Istanbul-Goztepe region were analyzed. The data were obtained from the Turkish State Meteorological Service. In the analyses using the short-term data, the wind speed and solar radiation data of the region were analysed statistically. In the statistical analysis, first Weibull distribution was performed, and then standard deviation, mean, skewness and kurtosis values were calculated. Average temperature values; mean sunshine duration, average global radiation values for each month were determined in the analysis. In addition, maximum, minimum and average global irradiation values were determined during the year. Wavelet analysis of both wind speed data and solar radiation data have been done and compared to the data in these studies. In the wavelet analysis, high frequency and low frequency regions were determined and seasonal transitions were determined.

Keywords: Wind speed, Solar radiation, Wavelet Analysis, Statistical Analysis.

1. INTRODUCTION

Wind energy is the most preferred among renewable energy sources [1]. It is important to make detailed analyses of the wind in terms of determining the wind potential [2[,[3]. Turkey's wind power installed capacity of 6514 MW, which represents an 8% rate according to January 2018 data. According to 2018 data, the amount of energy produced by wind energy in Istanbul is 1.236.160.70 MWh. Although Turkey has very efficient solar resources, the energy produced from the sun is very low. According to January 2018 data, the installed capacity of the solar is 23 MW and 0.03%. The amount of energy obtained from solar energy has 7,898,584 total registered users in Istanbul. Istanbul (Turkey) is the most populous city. According to 2019 data, its population does not exceed 15 million. In this context, energy consumption increases proportionally. Mobile plants are used to meet the energy demand consumed in industrial areas and dwellings [3].

Wind power can be obtained from wind power plants. Power plants are installed in productive areas in terms of wind. Since the initial costs of the power plants are high, it is very important to determine the wind potential and plant areas [3,5]. Wind data are collected regularly by meteorological stations. Because the analysis of the data is nonlinear, it is evaluated with many mathematical methods. Since the wind data are non-stationary, the analysis should be done by appropriate mathematical methods [7[,[8]. Solar collectors installed in solar power plants provide solar energy, and the initial installation costs are high. In addition, it is seen as a disadvantage that it cannot generate energy in the rainy and cloudy seasons. Both wind and solar energy are non-stationary. The Wavelet methodology is highly successful in the analysis of such non-stationary signals. The results of this method are highly satisfactory since the signal can also be detected over time in the analysis of the change [6],[8].

In this study, Istanbul-Goztepe wind speed and solar data were used. Data are from the Turkish State Meteorological Service. The data were collected in 2004, and from a height of 10m within the framework of

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international standards. Similarly, solar data were hourly and from 2004. In the study, one-year wind speed data were analyzed by using Wavelet Method.

2. MATHEMATICAL METHODOLOGY

A signal is treated as a function and evaluated in this way. Signals are grouped as continuous, discrete, analogue, and digital signs. They are also classified as random and non-random, periodic and non-periodic energy and power signals [9]. A signal is called a continuous signal if it takes all the values in finite and infinite intervals. If the signal is in the finite interval (if it is taken as a sample), these are also called digital signals. The signals used in the data analysis are called digital signals. This is done using analogue / digital converters [11]. A series of observations explaining the state of a physical size relative to one or more independent variables is called time series. In time series, the argument is usually time. When defined mathematically, it is defined as a function g (t) depending on (t). If the data is recorded continuously, the series will be called continuous series if they are recorded at certain intervals. Since the data size in the continuous series is high, discrete sequences are generated by sampling. Today, many physical sizes are shown as continuous and discrete signals, and Wavelet analysis is commonly used in the analysis of these signals [8],[12],[14]. In this study, the Continuous Wavelet Transform (CWT) is used.

2.1. Wavelet Theory and CWT

It is a transformation technique used in the simultaneous analysis of a signal, time-frequency and amplitude components. Wavelet transformation is a type of transformation used for time-frequency analysis of a signal. The Continuous Wavelet Transform is highly successful in the analysis of non-continuous signals. In Wavelet transformation, the scale parameter is indicated by a and is related to the frequency. Large scales correspond to low frequencies, and small scales correspond to high frequencies. The CWR is obtained by summing up the wavelet function along the time domain after shifting and multiplying by a scale. Wavelet functions are obtained by using scale and shift factors from a main wavelet function and can be expressed mathematically with the following equation (1) and equation (2).

$$W_f(a,b) = \int_{+\infty}^{-\infty} f(x)\Psi_{a,b}(x)dx \qquad (1)$$

Where,

$$\Psi_{a,b(x)} = \frac{1}{\sqrt{|a|}}\Psi\left(\frac{x-b}{a}\right) a,b \in \mathbb{R}, a \neq 0 \qquad (2)$$

3. APPLICATION OF THE DATA

In this study, the solar wind speed data in Istanbul-Goztepe (Turkey) were examined. The 2004 data were taken from the Turkish State Meteorological Service. The data are one-year-old and hourly. The data collected were created with the Continuous Wavelet Transform (CWT). First, CWT. Direct plotting of wind speed data analyzed the wind speed data and then the solar radiation values and solar radiation data is not sufficient to evaluate the data. Therefore, Wavelet-based analysis is required.

3.1. Wind Speed Data Analysis Using CWT

Figure 1 shows the hourly wind speed graph of Istanbul in 2004. The sampling frequency is 0.000114 Hz.
In Figure 2, CWT analysis was performed for one-year hourly data of Istanbul-Goztepe region. As can be seen from Figure 2, wind speed data CWT analysis was performed. Here, the horizontal axis indicates the number of data or time. The data of 8783 hours were collected within one year. The vertical axis is represented by a scale. The scale is inversely proportional to the frequency and the regions with high scale values show low frequencies. Here, the wind speed varies seasonally, but in autumn and winter, it is seen that wind speed is higher and high-frequency values are obtained. However, in the spring and summer seasons, wind speed values are lower, and it has low frequency and high scale values.

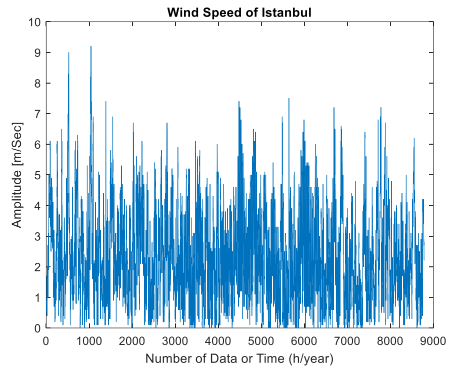

Figure 1.Wind Speed of Istanbul

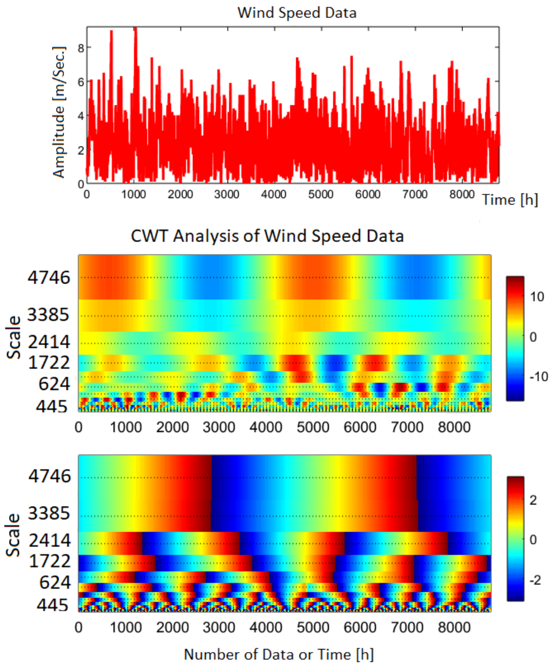

Figure 2.CWT Analysis of Wind Speed Data

In Figure 3, the same kind of Wind Speed Data Analysis was performed. High-frequency values of the wind are shown with a scale of the collar. When the graph is examined, the regions corresponding especially autumn and winter (horizontal axis 1000 and 7000) are seen as high-frequency regions. The colours here are drawn as Modulus of Coefficients.

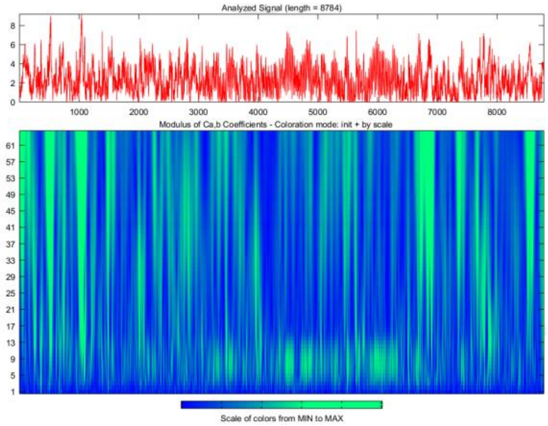

Figure 3.Complex Continuous Wavelet Analysis of Wind Speed Data

Figure 4 below shows Signal Components and Approximation. In the graph, Row data, sym4, dct, sin and cos values are plotted to compare. Here, the raw signal has the highest amplitude value, while the sym level and dct graphics are sorted with lower amplitudes.

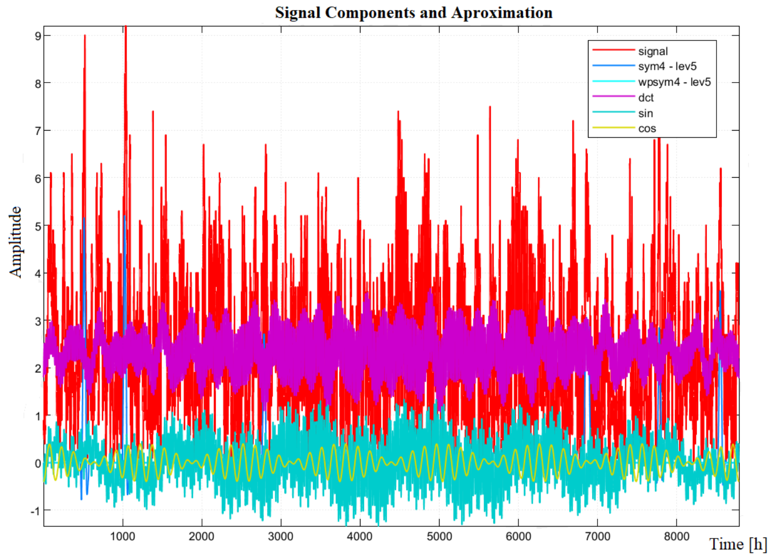

Figure 4.Signal Components and Approximation

3.2. Solar Data Analysis Using CWT

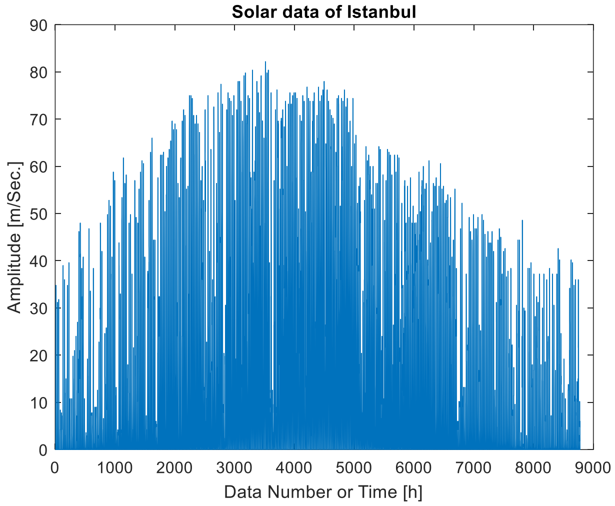

Figure 5.Solar data from Istanbul

Figure 5 shows the Solar data for the year 2004. The horizontal axis represents the number of data collected per hour, while the vertical axis is amplitude. The graph was drawn from January to December. The end of the graph shows the month of January, and the last part shows the month of December. It can be understood that the regions with the highest amplitude are given in the summer months. Similarly, daily solar data will create a similar graph.

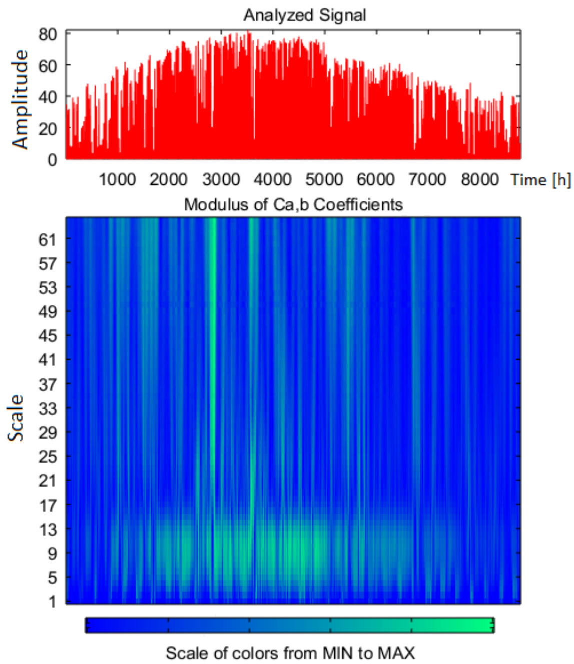

Figure 6.Complex Continuous Analysis

In the Complex Continuous Analysis, the signal consists of a filter bank that can break into high and low-frequency components. High and low-frequency components are important for determining pure frequencies and detecting long-term breezes (Fig.6).

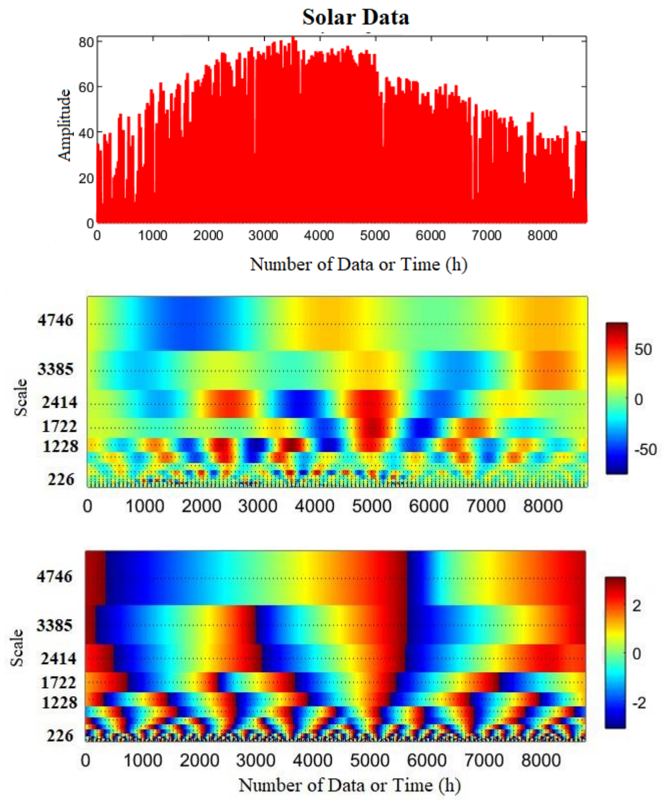

Figure 7.CWT Analysis of the Solar Data

The analysis of the CWT analysis of the solar data is shown in Figure 7. It can be seen that the data moves from winter to winter. The middle section of the graph shows the summer season, and the radiation data is higher in this period. As can be seen from the graphs, the regions with high and low wavelengths vary proportionally with scale.

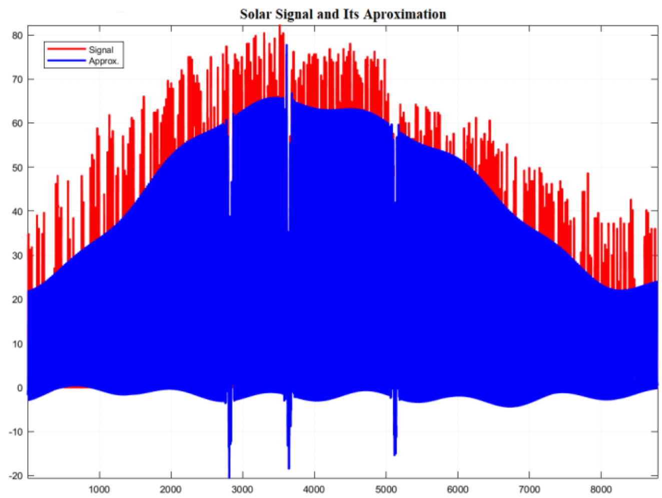

Figure 8.Solar Signal and Its Application

Figure 8 shows the graph of solar radiation data. Here is shown as the main Signal and Approximation.

4. CONCLUSION

The analysis of wind speed and solar radiation data play an important role in the investments in these areas. In this study, the one-year short-term analysis of wind and solar radiation data of Istanbul was conducted. As is known, signals in nature are constantly changing and are non-stationary. Therefore, Fourier analysis is not sufficient to detect all of the frequency components for the analysis of these signals. In this study, CWT analyzes of the data were performed, and high and low regression regions could be detected. This study may also show how the wind potential is affected by seasonal transitions in the frequency band as well as other potential calculations.

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