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Medhat Elkelawy Prof. Dr, Eng.

Mechanical Power Engineering Departments, Faculty of Engineering, Tanta University, Tanta, Egypt,
medhatelkelawy@f-eng.tanta.edu.eg

Hagar Alm-Eldin Bastawissi

Faculty of Engineering, Tanta University, hagaralmeldin@f-eng.tanta.edu.eg

Ahmed Abou El-Yazied Prof. Dr.

Faculty of Agriculture, Ain Shams University, ahmed_abdelhafez@agr.asu.edu.eg

Saad El-malla Dr. Eng.

Mechanical Power Engineering Department, Faculty of Engineering, Assuit University,

saad_PG1230149@sit.aun.edu.eg

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Experimental Investigation on Combustion and Emission Characteristics of Co-combustion of Pulverized Biomass with Diesel Fuel in an Industrial Burner

Medhat Elkelawy^{1*}, Hagar Alm-Eldin Bastawissi², Ahmed Abou El-Yazied³, and Saad El-malla⁴

^{1*} Ph.D. Professor, Mechanical Power Engineering Department, Faculty of Engineering, Tanta University – email: medhatelkelawy@f-eng.tanta.edu.eg

² Department of Mechanical Power Engineering, Faculty of Engineering, Tanta University, Tanta, Egypt – email: hagaralmeldin@f-eng.tanta.edu.eg

³ Ph.D. Professor, Faculty of Agriculture, Ain Shams University – email: ahmed_abdelhafez@agr.asu.edu.eg

⁴ Ph.D., Mechanical Power Engineering Department, Faculty of Engineering, Assuit University – email: saad_PG1230149@sit.aun.edu.eg

Abstract: This study presents the combustion and emission results obtained from a laboratory furnace equipped with a 35 kW industrial burner that utilizes co-combustion of pulverized biomass and diesel fuel. The experiment compared the co-combustion of pulverized biomass and diesel fuel with diesel fuel alone. Three different loading ratios of pulverized biomass from residual beet samples were used. Temperatures were measured at various positions inside the furnace to analyze combustion performance. It was observed that increasing the biomass loading ratios led to higher flame temperatures and improved combustion compared to diesel fuel alone. The concentrations of pollutants such as Co, HC, and soot emissions were measured for the co-combustion of different ratios of biomass with diesel fuel. The results showed a decrease in emissions compared to diesel fuel alone. By increasing the biomass loading ratios, emissions of nitrogen oxides, carbon monoxide, unburned hydrocarbons, and soot were reduced by approximately 25%, 50%, 23%, and 30% respectively, compared to diesel fuel alone. Overall, this study demonstrates the potential of co-firing biomass derived from agricultural residues with conventional fuel in industrial burners. These findings contribute to the understanding of biomass co-firing technology and support the development of sustainable and cleaner energy generation practices.

Keywords: Pulverized biomass, diesel, co-combustion, emission, temperature.

I. INTRODUCTION

The need to transition from conventional fossil fuels to renewable energy sources is increasing due to the depletion of fossil fuels and their negative environmental impacts, such as contributing to global warming and harmful emissions [1-5]. To meet global energy needs, reduce environmental impacts, and minimize fuel consumption, it is urgent to find alternative renewable fuels. Biomass is considered a promising choice in addressing energy and pollution challenges [6-20].

Biomass refers to a mass of biological material created through living processes like photosynthesis. It is

primarily composed of carbon, with oxygen, hydrogen, nitrogen, sulfur, and chlorine also present in varying amounts [21]. Biomass is highly oxygenated due to its carbohydrate nature. Compared to traditional fossil fuels, biomass has lower sulfur content, reducing pollutants like sulfur and nitrogen oxides [22]. It also emits fewer greenhouse gases, contributing to global warming. Additionally, biomass is an abundant and cost-effective renewable fuel [23-25].

In developing nations, biomass is already a significant energy source. Biomass direct combustion in fired furnaces is a common method for producing heat from renewable biomass fuel [26-32]. However, it has drawbacks such as low combustion efficiency and large emissions of unburned volatile vapors and solid fuel particles [33]. To address these challenges, co-combustion has emerged as a developed technology [34]. Co-combustion involves blending biomass with other fuels like coal or natural gas to improve combustion efficiency, reduce emissions, and utilize existing infrastructure [35, 36]. A 5% biomass substitution of coal energy in all coal-fired power plants could result in a significant reduction in CO₂ emissions [37-41].

Agricultural and agro-industrial waste can be used as biomass fuel for power generation, offering a solution to waste disposal problems [42]. Crop residues and agro-industrial residues are the main categories of agricultural residues. Co-combustion of biomass fuels with coal has been extensively studied, as coal is a primary fuel source in many power generation systems [43]. Research has shown positive results in terms of reducing emissions and improving combustion efficiency [44].

Various studies have investigated the co-combustion characteristics, emission properties, and combustion efficiency of biomass-coal blends [45-48]. The results

have shown reduced emissions of nitrogen oxide (NO_x) and sulfur dioxide (SO₂), improved carbon burnout, and increased combustion efficiency [49]. Particle size and volatile matter content of biomass fuels can influence emission properties and particle burnout performance [50-52]. Co-combustion of torrefied biomass under oxy-fuel conditions has also been studied, revealing differences in radiative heat flow and gas concentration measurements.

In summary, biomass is a promising renewable fuel option to address energy and pollution challenges [53-56]. Co-combustion of biomass with other fuels can improve combustion efficiency, reduce emissions, and leverage existing infrastructure [57, 58]. Agricultural and agro-industrial waste can be utilized as biomass fuel, offering a solution to waste disposal problems. Extensive research has been conducted on biomass-coal co-combustion, showing positive results in terms of emissions reduction and combustion efficiency [59].

II. MATERIAL AND METHOD

A. Fuel Characterization and Biomass Preparation.

Biomass and diesel fuel have different characteristics, with distinct compositions and properties. Biomass, such as agricultural residues, typically has a higher volatile matter content, which refers to the portion of the fuel that can vaporize and combust during the combustion process. This high volatile matter content contributes to the combustibility of biomass [60-65]. Biomass also has a higher oxygen content compared to fossil fuels like diesel. The presence of oxygen in biomass fuels promotes combustion and can contribute to lower emissions of certain pollutants during combustion. Additionally, biomass usually has a lower nitrogen content and little to no sulfur content, resulting in lower emissions of pollutants [66-70].

Cellulose and lignin are recognized as the main components of agricultural residues and many other types of biomasses. Cellulose is a complex carbohydrate found in the cell walls of plants, while lignin is a structural polymer that provides rigidity and strength. Both cellulose and lignin contribute to the energy content of biomass and undergo thermal decomposition during combustion [71-75]. The moisture content of green biomass can negatively impact the combustion process. If the moisture content is too high, more fuel is needed to support combustion, which may hinder the goal of producing energy through biomass combustion for captive use or the market [76-79].

To effectively burn biomass fuel, it must be treated after collection and processing. This treatment involves drying the biomass and reducing its water content. The biomass is then mechanically processed by crushing and chopping it into small pieces. The smaller the fuel particles, the faster

and more complete the combustion process. The solid fuel is then fed into the combustion furnace through the force of its weight and the mechanical movement of the air.

Table 1. The properties of the sugar beet biomass sample used in the experiment.

Properties	Biomass
Protein %	10%
Fat %	8.9%
Carbohydrate %	15%
Ash %	9.4%
Moisture %	10%
Sugar percentage %	3%
Cellulose %	30%
Hemicellulose %	26.8%
Pectin %	24.2%
Lignin %	4.1%

Table 2. The properties of commercial diesel used in experiments.

Experiment	Method	Diesel
Density @ 15.56 °C	ASTMD-4052	0.8370
Kinematic viscosity, cSt @ 40 °C	ASTM D-445	4.38
Total sulfur, wt %	ASTMD-4294	0.231
Total acid number, mg KOH/g	ASTM D-664	0.056
Pour point, °C	ASTM D-97	0
Ash content, wt.%	ASTM D-482	Nil
Cetane index	ASTM 4737	50
Copper corrosion	ASTM D-130	1a
Calorific value KJ / Kg	ASTM D-240	44547



Figure 1. The samples of agriculture pulverized biomass.

B. Experimental setup

A laboratory-scale furnace was designed and constructed to study the reaction flow, flame, and exhaust in a co-combustion system involving biomass and diesel fuel. The furnace utilized an industrial swirl-type burner (CUENOD, France Manufacturing) with a maximum heat capacity of 350 kW. Four R-type thermocouples were positioned radially inside the flame body and mounted on a multidimensional linear traversing mechanism to measure temperature [80-86]. Additionally, an R-type thermocouple was installed in the exhaust pipe to measure the temperature of the exhaust gas and determine flame temperature profiles [87-92].

To measure the concentration of emission gases (CO, CO₂, HC, O₂, and NO_x), a Garboard-5020 emission gas analyzer was used [93-101]. The Gasboard-6010 Opacity Meter was employed to detect and measure the opacity of smoke emitted from the burner, covering the entire opacity spectrum from 0 to 100% as shown in figure 2 and 3.

Figure 4 illustrates the biomass fuel cycle, which includes a biomass tank and a glass tube for measuring the

volume of biomass. The residual agricultural beet samples were dried, shredded, and ground into a powder. These samples were placed in the biomass tank and mixed with diesel fuel in the required proportions by suspending them in the air at a constant rate. The pulverized biomass was delivered to the industrial burner facility through a pipe-feeding system for the pilot-scale experiment [102-106]. Due to the volatile nature of the biomass, the combustion response of the pulverized biomass was expected to be homogeneous [107-115].

The fuel was fed into the burner by gravity from the tank above, and a fuel pump driven by the burner's motor was used to control the fuel flow rate. The airflow rate was regulated by valves and an on/off electronic control panel to maintain a constant rate of 100 mL/m³ and prevent blockages during the transportation of biomass particles, ensuring uniform delivery to the burner. Throughout all combustion tests, the diesel fuel flow rate was fixed at 0.14 Liters per minute. Three different solid loading ratios (L1, L2, and L3) were used in the experiment by increasing the amount of solid fuel while keeping the air flow rate constant.

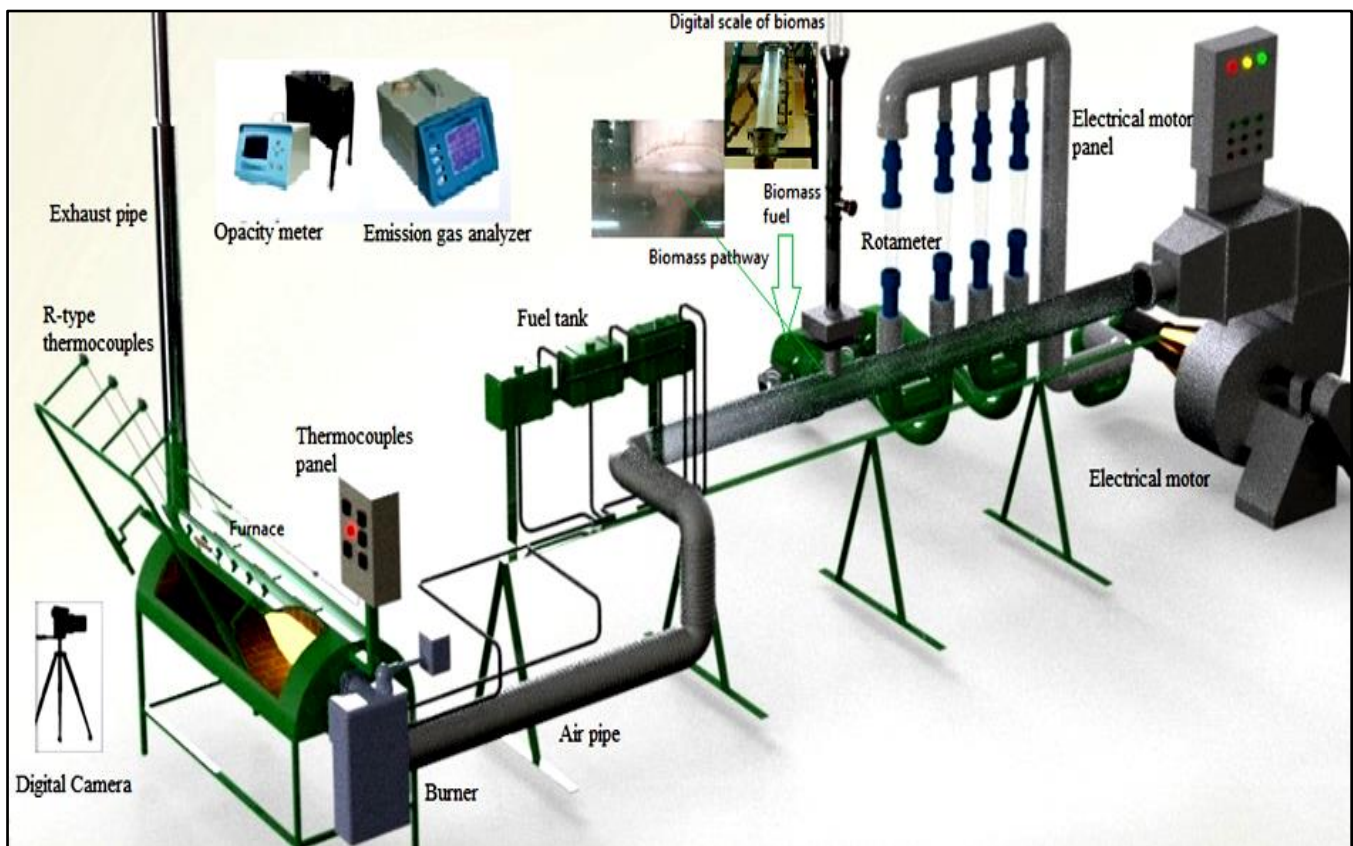


Figure 2. A schematic diagram of the test rig.



Figure 3. Photo of experimental test rig set-up.

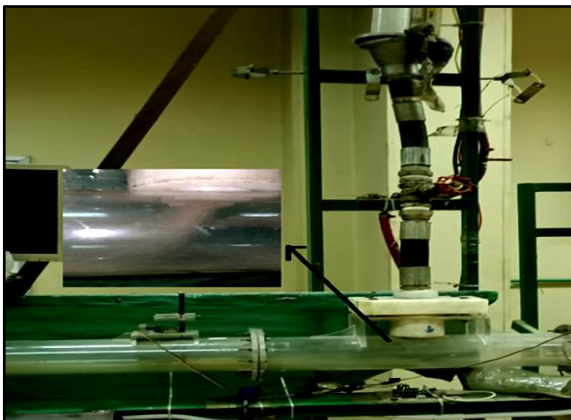


Figure 4. Biomass Cycle Pathway

C. uncertainty analysis.

The instruments and sensors used in experiments caused some errors in the experimental results, so an uncertainty analysis was performed to ensure the accuracy of the results. Uncertainty calculations focused on burner operating parameters such as the flow rate of tested fuel and air flow rate, as well as emissions (CO, UH, smoke opacity, NOx, and temperature). Tables 3 present data on the experimental value range and precision of instrumentations and sensors. The root-sum-squared (RSS) method as shown in equation (1) was used in this study to

determine the uncertainty of the independent variables and the errors associated with the measured parameters [55].

$$W_R = \left(\left(\frac{\partial R}{\partial x_1} w_1 \right)^2 + \left(\frac{\partial R}{\partial x_2} w_2 \right)^2 + \dots + \left(\frac{\partial R}{\partial x_n} w_n \right)^2 \right)^{\frac{1}{2}} \quad (1)$$

Where R is the function uncertainty, WR is the dependent variable total of uncertainty. W1, W2, and Wn are the uncertainties of the independent variables of experimental operating parameters measured X1, X2,... , Xn.

Table 3. Specification of measurement equipment.

Instrument	Parameter	Range	Percentage Uncertainty
fuel meter type aquametro VZO 8	flow rate of liquid fuel	4:200 l/h	Error value $\pm 1\%$ Repeatability $\pm 0.2\%$
Gas flow meter	Flow meter of gas	0.025:4 m ³ /h	$\pm 1\%$
Rotameter	Flow meter of air	18:180 m ³ /hr	$\pm 6\%$
R-type thermocouple	Temperature of flame	0 °C to +1600 °C	Error value ± 1.50 °C Repeatability $\pm 0.25\%$
Inclined manometer	Air Mass flow rate of air	0 °C to +1600 °C	$\pm 0.2\%$
	CO	0-10%	Error value $\pm 3\%$

Instrument	Parameter	Range	Percentage Uncertainty
Gasboard-5020 exhaust analyzer			Repeatability ±0.06%
	HC	0-9999 ppm	Error value ±5% Repeatability ±12 ppm
	NOx	0-5000 ppm	Error value ±5% Repeatability ±25 ppm
Opacity Meter Gasboard-6010.	Soot emission	0-100%	Error value ±3%
Digital scale	Loading solid ratio	0.002-100 Kg	±1

D. Solid Fuel Samples

The solids loading ratio, L , is defined as the ratio of the material's mass flow rate to the air's mass flow rate during conveyance. This dimensionless ratio, which has a constant value along a pipeline's length regardless of air pressure, temperature, and conveying air velocity, is a very helpful characteristic. Here, it is described as equation (2).

$$L = \frac{\dot{m}_p}{\dot{m}_a} \quad (2)$$

Where L is the solids loading ratio, dimensionless, \dot{m}_p mass flow rate of solid fuel, and \dot{m}_a mass flow rate of air. According to the equation, the loading ratio increases as the amount of solid fuel to constant air ratio increases,

The waste residual agricultural beet samples were dried, shredded, and ground into a powder-like consistency. The samples are placed in a prepared tank and pushed by air into the path of entering the industrial burner in the required proportions for the experiment, which are mixed with diesel fuel. Table 4 shows the mass flow rates of solid fuel and air used in the experiment to calculate the solid loading ratio.

Table 4 : Loading conditions "mass flow rate of solide fuel additives"

Loading conditions	The mass flow rate of solid ml/min	The mass flow rate of air m3/hr	Solid loading ratio L
L1	2.5	1.67	1.2
L2	4	1.67	1.8
L3	6	1.67	2.7

III. RESULTS AND DISCUSSIONS

A burner was preheated with diesel fuel for 15 minutes before switching to biomass-diesel co-firing without interrupting its operation. Various parameters such as temperature, fuel flow rate, air flow rate, emissions, and soot opacity were measured.

A. The effect of different solid loading ratios on the oxygen concentration in the exhaust:

Figure 5 shows the percentage of oxygen concentration in the exhaust gases emitted by the co-combustion of biomass and conventional diesel at different solid loading ratios. Biomass has a higher oxygen content compared to conventional fuel due to its carbohydrate structure.

As the solid loading ratio increases, the percentage of oxygen in the exhaust also increases. This is because less oxygen is consumed during fuel combustion when co-firing biomass with diesel. The increased levels of volatile matter in biomass consume oxygen quickly, reducing oxygen availability to diesel and preventing oxygen from reaching diesel particles close to the burner. The oxygen concentration rises to 1.5%, 14%, and 38% for solid loading ratios L1, L2, and L3, respectively, compared to conventional diesel fuel.

B. The effect of different solid loading ratios on carbon monoxide (CO) emissions:

Carbon fuels emit carbon monoxide when there is insufficient oxygen available for combustion. Figure 6 shows the variations in CO levels for different solid loading ratios. Diesel fuel emits a significant amount of carbon monoxide compared to other fuel types. As the solid loading ratio increases, carbon monoxide levels also increase. This is because adding more biomass to the mixture results in delayed oxidation and slower reaction times for solid fuel. CO emissions decrease to 66%, 50%, and 33% for solid loading ratios L1, L2, and L3, respectively, compared to diesel fuel.

C. The effect of different solid loading ratios on nitrogen oxide (NOx) emissions:

Figure 7 illustrates the NOx emissions from co-firing biomass and diesel at different solid loading ratios. The higher the biomass content in the fuel mixture, the lower the NOx emissions. Co-firing biomass and diesel effectively reduce NOx emissions compared to pure diesel. NOx emissions decrease by 16%, 25%, and 33% for solid loading ratios L1, L2, and L3, respectively, compared to diesel fuel. This is due to the high volatile content and low nitrogen content of biomass, which aids in the conversion of NO into N₂.

D. The effect of different solid loading ratios on unburned hydrocarbon (HC) emissions:

Figure 9 shows the HC emissions of co-combustion biomass and diesel at different solid loading ratios. HC emissions decrease as the solid loading ratio increases. This is a result of good mixing and the availability of

oxygen, which promote the fuel oxidation process and reduce the quantity of unburned hydrocarbons in combustion gases.

E. The effect of different solid loading ratios on smoke opacity:

Figure 10 demonstrates the differences in soot emissions for various solid loading ratios. Co-firing biomass and diesel produce less soot than diesel alone. Soot emissions decrease by 20%, 30%, and 38% for solid loading ratios L1, L2, and L3, respectively. This is because biomass has a lower sulfur content than diesel, and the swirler burner provides sufficient mixing for good combustion.

F. The effect of different solid loading ratios on exhaust gas temperature:

Figure 11 shows the exhaust gas temperature for co-combustion of different solid loading ratios of biomass and diesel. The exhaust gas temperature slightly increases as the solid loading ratio increases compared to pure diesel combustion. This is due to the addition of pellet biomass fuel, which generates more heat.

G. The effect of different solid loading ratios on the maximum flame temperature of the combustion chamber:

The maximum flame temperature of the combustion chamber was studied for different solid loading ratios of biomass and diesel. Figure 12 shows that increasing the solid loading ratio results in a higher maximum flame temperature. Pulverized biomass, compared to diesel fuel D100% and different ratios of solid loading, has a higher oxygen concentration, which leads to faster combustion and a higher peak temperature. Increasing the solid loading ratio increases the fuel-to-air ratio, resulting in more fuel being burned in the furnace and raising the maximum flame temperature.

The maximum flame gas temperature increases by 835 oC, 847 °C, and 856 °C for loading ratios of L1, L2, and L3, respectively. Figure 13 shows the relationship between oxygen content, loading ratio, and maximum temperature. It is evident that a high concentration of oxygen promotes oxidation reactions, improving combustion and raising the flame temperature. Increasing the loading solid ratio also increases the maximum flame temperature due to the high proportion of oxygen in biomass.

H. The effect of different solid loading ratios on the flame temperature in the centerline of the furnace.

Figure 14 illustrates the distribution of flame gas temperatures along the central line of the burner outlet

regions for different fuel mixtures. The distance between the burner nozzle and the measuring point is shown by the curve in the figure. The gas flame temperature in the burner outlet zone decreases consistently as the distance between the burner and the end of the furnace increases. This decrease is attributed to radiative heat transfer between the wall and the combustion products. The maximum flame temperature occurs within the measurement range of 30-40 cm. Increasing the solid loading ratio affects the average temperature inside the furnace and the maximum flame temperature. This is related to the increase in oxygen content during the co-combustion of biomass with diesel, as more CO reacts with oxygen, producing CO₂ and high heat capacity. The maximum flame gas temperature increases by 835 oC, 847 oC, and 856 oC for loading ratios of L1, L2, and L3, respectively.

I. The effect of different solid loading ratios on the flame pictures and flame structure.

To visualize the flame structure, flame pictures were captured using a digital camera. The flame pictures were compared to understand the behavior of the flame in the case of co-combustion between biomass and diesel. The flame occurred at different solid loading ratios of biomass. From the flame photos and maps, it is evident that the general flame structure remains unchanged for loading ratios L1, L2, and L3. Pulverized waste agriculture biomass enters the furnace chamber with the main swirler air stream, and the resulting centrifugal force causes it to be inclined outwards at the same angle as the swirler plate. Figure 15 shows the combustion of distributed biomass in a turbulent air combustion environment. When solid fuel is burned, ultrafine particles are released during the devolatilization phase and the burning phase of refractory components.

The diesel-air combustion exhaust gas quickly heats and burns the biomass, and the particles move with the direction of the flame, resulting in bright yellow spirals. Due to the swirl effect, the volatiles disperse throughout the combustion chamber. Combustion improves when diesel is co-fired with biomass due to the rapid release of volatile matter from the biomass, leading to complete combustion and intense flame. Figure 16 shows the effect of the loading solid ratio on the flame shape, with the intensity of the flame increasing with the proportion of loading solid biomass. The swirling movement of the fuel from inside the burner to the combustion zone ensures good mixing of biomass and diesel. The small size of the biomass particles also contributes to better burning and a higher brightness intensity of the flame.

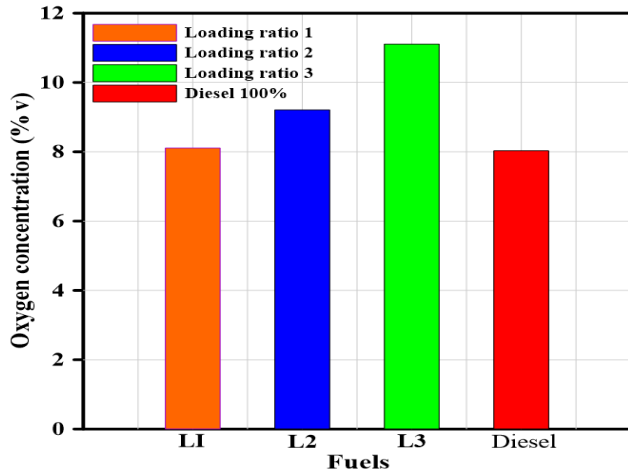


Figure 5. The percentage of oxygen released from co-firing biomass and diesel.

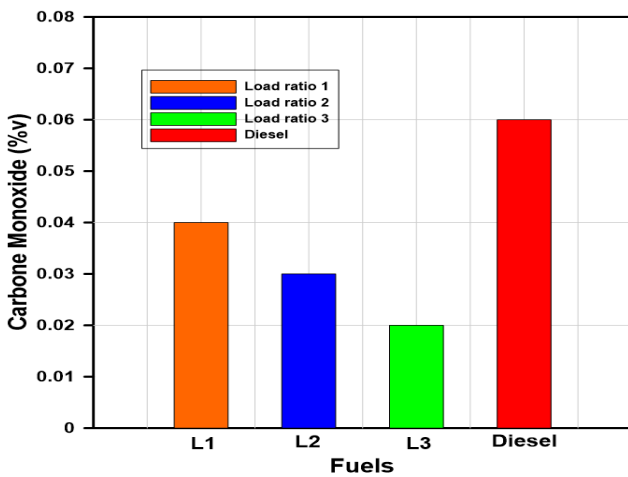


Figure 6. The variations of CO emission with different solid loading ratio biomass.

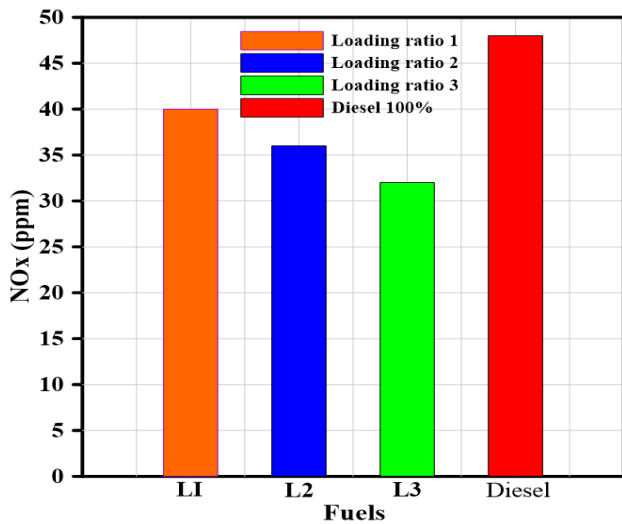


Figure 7. The variations of NOx emission with different solid loading ratio biomass.

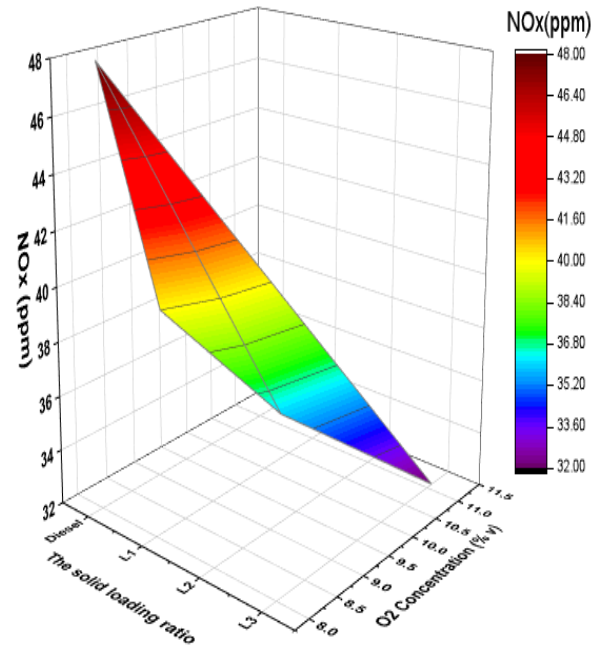


Figure 8. 3-D plotted the relationship between oxygen concentration and NOx emission at different solid loading ratios.

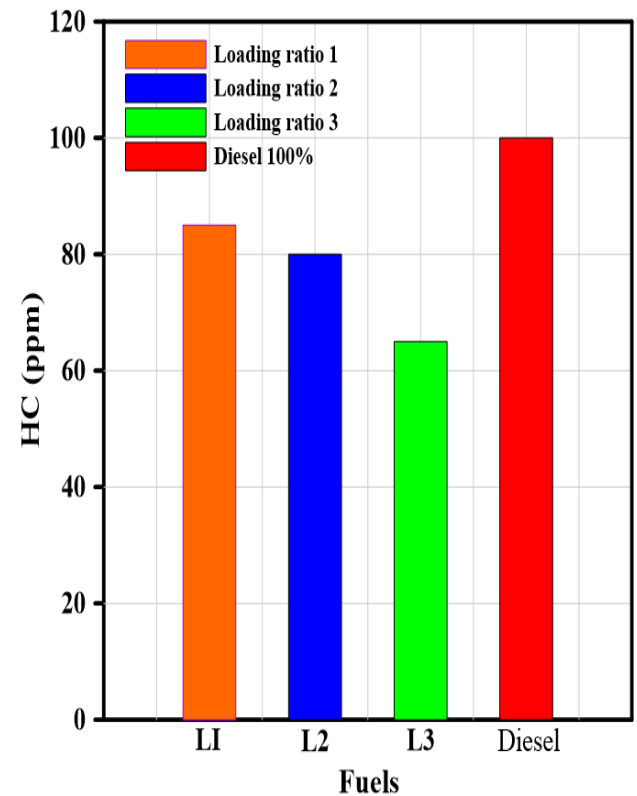


Figure 9. The variation of HC emission against solid loading biomass ratio.

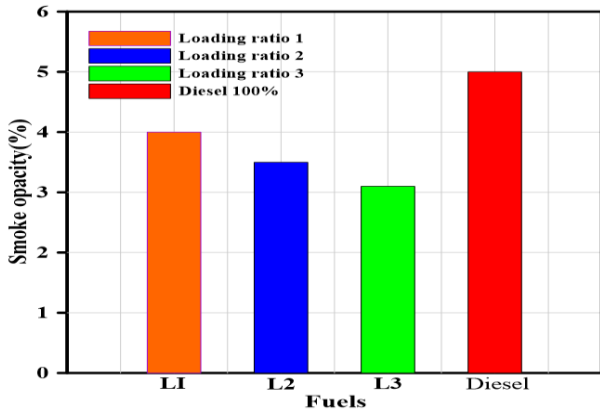


Figure 10. The variations of smoke opacity emission with different solid loading ratio biomass.

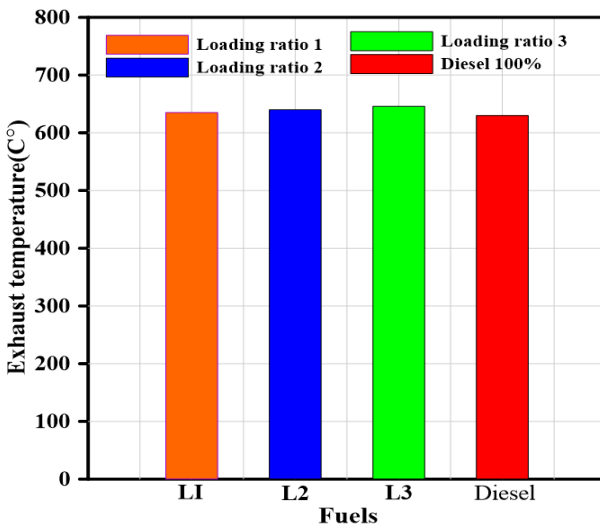


Figure 11. The Exhaust flame temperature of co-combustion between pellet biomass and diesel.

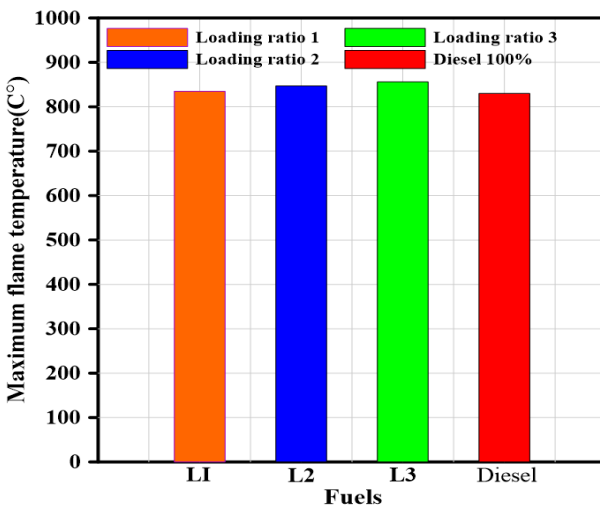


Figure 12. The maximum flame temperature of co-combustion between pellet biomass and diesel.

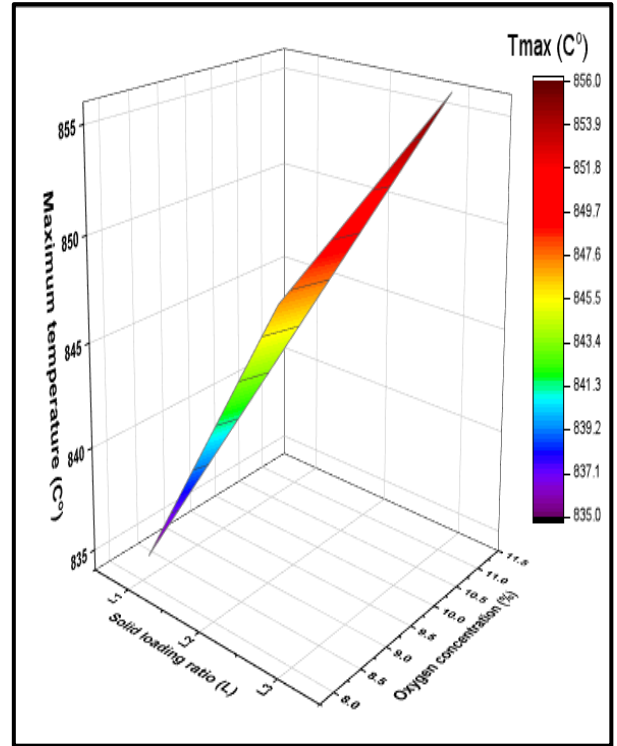


Figure 13. 3-D plotted the relationship between oxygen concentration and maximum flame temperature at different solid loading ratios.

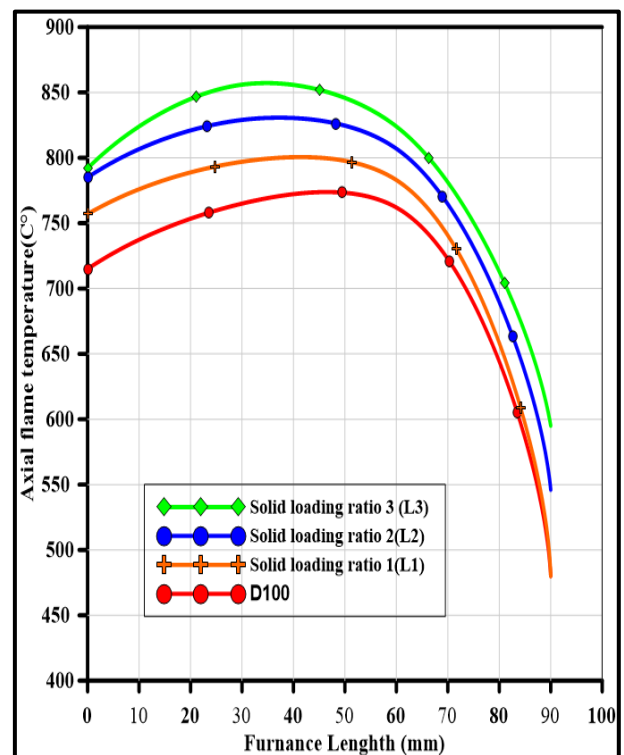


Figure 14. The flame temperature at the centreline of a furnace at a different solid loading ratio.



Figure 15. The ultrafine particles of biomass produced by co-firing diesel with biomass.

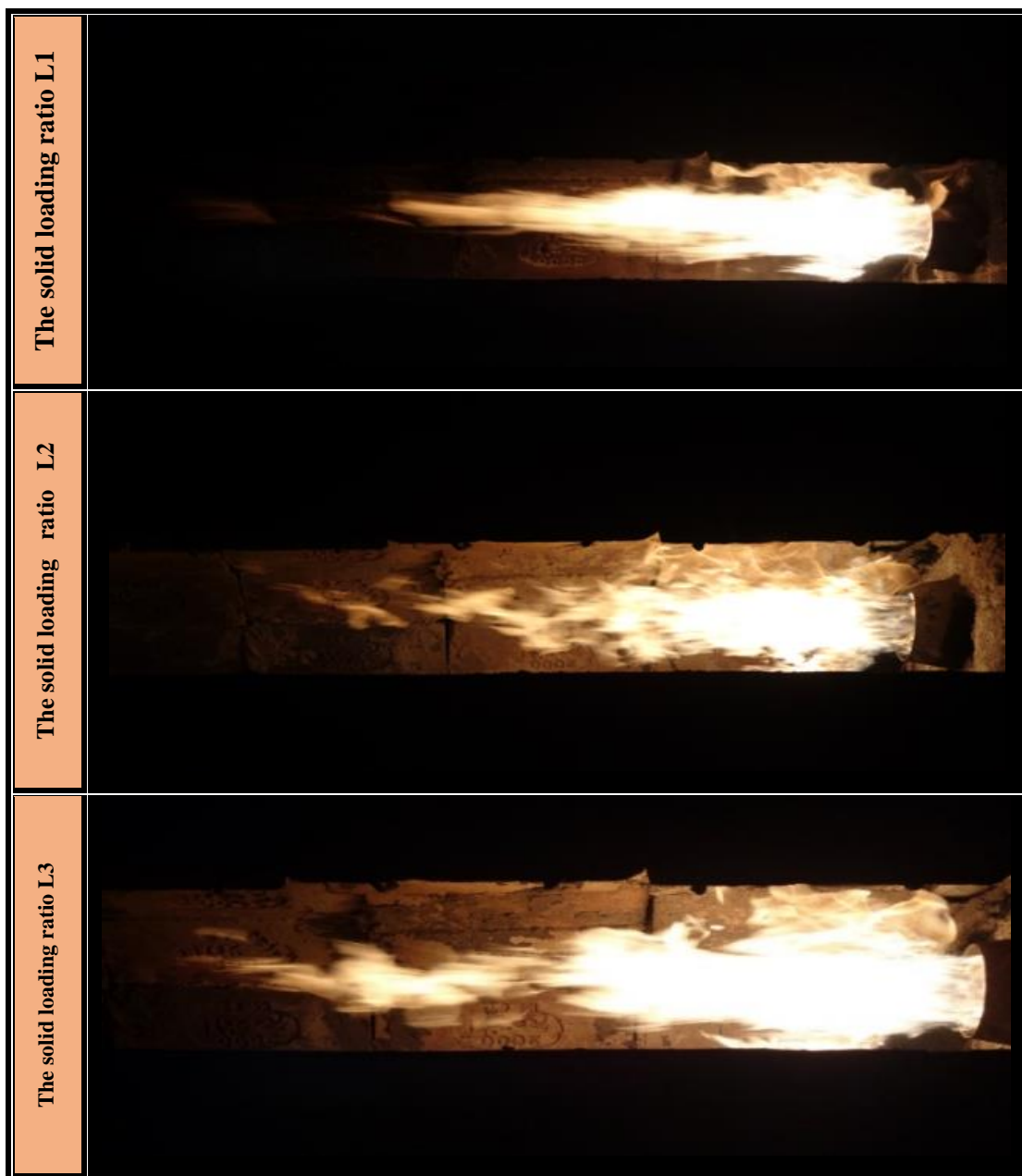


Figure 16. The images of flames of different loading solid ratio.

IV. CONCLUSION

The co-combustion of biomass and liquid fuels is an important method for utilizing solid waste from agriculture to generate energy. This study demonstrates the potential of co-firing pulverized biomass derived from agricultural residues with conventional fuel in industrial burners. The co-firing process improves combustion efficiency and shows that biomass can be used in existing industrial burners with minimal modifications. These findings contribute to the understanding of biomass co-firing technology and support the development of sustainable and cleaner energy generation practices. The study also found that increasing the biomass loading ratios enhances combustion and reduces emissions. For example, when three samples of solid fuels (L1, L2, and L3) were tested in co-combustion with diesel, the emissions of pollutants such as CO, UH, NO_x, and soot decreased compared to diesel. The decrease in emissions ranged from around 66% to 33% for CO, 5% to 7% for UH, 16% to 33% for NO_x, and 20% to 38% for soot, depending on the solid loading ratio. Additionally, as the loading solid ratios increase, the temperature of the exhaust gas and the maximum flame temperature of the biomass co-combustion with diesel also increase.

REFERENCES

- [1] H. A. E. Bastawissi, M. Elkelawy, H. Panchal, and K. K. Sadasivuni, "Optimization of the multi-carburant dose as an energy source for the application of the HCCI engine," *Fuel*, vol. 253, pp. 15-24, 2019.
- [2] S. E.A.El, E. Medhat, A.-E. Hager, Bastawissi, M. S. Mahmoud, P. Hitesh, S. Kishorkumr, *et al.*, "Investigation and performance analysis of water-diesel emulsion for improvement of performance and emission characteristics of partially premixed charge compression ignition (PPCCI) diesel engines," *Sustainable Energy Technologies and Assessments*, vol. 36, p. 100546, 2019.
- [3] M. Elkelawy, H. Bastawissi, S. C. Sekar, K. Karupphasamy, N. Vedaraman, K. Sathiyamoorthy, *et al.*, "Numerical and experimental investigation of ethyl alcohol as oxygenator on the combustion, performance, and emission characteristics of diesel/cotton seed oil blends in homogenous charge compression ignition engine," SAE Technical Paper 0148-7191, 2018.
- [4] M. Elkelawy, H. A.-E. Bastawissi, E. El Shenawy, M. M. Shams, H. Panchal, K. K. Sadasivuni, *et al.*, "Influence of lean premixed ratio of PCCI-DI engine fueled by diesel/biodiesel blends on combustion, performance, and emission attributes; a comparison study," *Energy Conversion and Management: X*, vol. 10, p. 100066, 2021.
- [5] M. Elkelawy, H. A.-E. Bastawissi, E. El Shenawy, M. Taha, H. Panchal, and K. K. Sadasivuni, "Study of performance, combustion, and emissions parameters of DI-diesel engine fueled with algae biodiesel/diesel/n-pentane blends," *Energy Conversion and Management: X*, vol. 10, p. 100058, 2021.
- [6] M. Elkelawy, H. A.-E. Bastawissi, K. K. Esmaeil, A. M. Radwan, H. Panchal, K. K. Sadasivuni, *et al.*, "Maximization of biodiesel production from sunflower and soybean oils and prediction of diesel engine performance and emission characteristics through response surface methodology," *Fuel*, vol. 266, p. 117072, 2020.
- [7] M. Elkelawy, H. A.-E. Bastawissi, K. Khaled, Esmaeil, M. Ahmed, Radwan, P. Hitesh, K. Kishor, Sadasivuni, *et al.*, "Experimental studies on the biodiesel production parameters optimization of sunflower and soybean oil mixture and DI engine combustion, performance, and emission analysis fueled with diesel/biodiesel blends," *Fuel*, vol. 255, pp. 1-12, 2019.
- [8] M. Elkelawy, E. El Shenawy, H. A.-E. Bastawissi, M. M. Shams, and H. Panchal, "A comprehensive review on the effects of diesel/biofuel blends with nanofluid additives on compression ignition engine by response surface methodology," *Energy Conversion and Management: X*, vol. 14, p. 100177, 2022.
- [9] M. Elkelawy, E. El Shenawy, S. khalaf Abd Almonem, M. Nasef, H. Panchal, H. A.-E. Bastawissi, *et al.*, "Experimental study on combustion, performance, and emission behaviours of diesel/WCO biodiesel/Cyclohexane blends in DI-CI engine," *Process Safety and Environmental Protection*, vol. 149, pp. 684-697, 2021.
- [10] M. Elkelawy, S. E.-d. H. Etaiw, M. I. Ayad, H. Marie, M. Dawood, H. Panchal, *et al.*, "An enhancement in the diesel engine performance, combustion, and emission attributes fueled by diesel-biodiesel and 3D silver thiocyanate nanoparticles additive fuel blends," *Journal of the Taiwan Institute of Chemical Engineers*, vol. 124, pp. 369-380, 2021.
- [11] M. Elkelawy, S. E.-d. H. Etaiw, H. A.-E. Bastawissi, M. I. Ayad, A. M. Radwan, and M. M. Dawood, "Diesel/biodiesel/silver thiocyanate nanoparticles/hydrogen peroxide blends as new fuel for enhancement of performance, combustion, and Emission characteristics of a diesel engine," *Energy*, vol. 216, p. 119284, 2021.
- [12] M. Elkelawy, S. E.-d. H. Etaiw, H. A.-E. Bastawissi, H. Marie, A. M. Radwan, M. M. Dawood, *et al.*, "WCO biodiesel production by heterogeneous catalyst and using cadmium (II)-based supramolecular coordination polymer additives to improve diesel/biodiesel fueled engine performance and emissions," *Journal of thermal analysis and calorimetry*, pp. 1-17, 2022.
- [13] A. M. Elzahaby, M. Elkelawy, H. A.-E. Bastawissi, S. M. El_Malla, and A. M. M. Naceb, "Kinetic modeling and experimental study on the combustion, performance and emission characteristics of a PCCI engine fueled with ethanol-diesel blends," *Egyptian journal of petroleum*, vol. 27, pp. 927-937, 2018.
- [14] A. Kabeel, M. Elkelawy, H. A. El Din, and A. Alghrubah, "Investigation of exergy and yield of a passive solar water desalination system with a parabolic concentrator incorporated with latent heat storage medium," *Energy conversion and management*, vol. 145, pp. 10-19, 2017.
- [15] E. Medhat, E. Abd, Kabeela, S. E.A.El, P. Hitesh, E. Ahmed, A.-E. Hagar, Bastawissi, *et al.*, "Experimental investigation on the influences of acetone organic compound additives into the diesel/biodiesel mixture in CI engine," *Sustainable Energy Technologies and Assessments*, vol. 37, p. 100614, 2020.
- [16] E. Medhat, E.-d. Safaa, H. Etaiw, A.-E. Hagar, Bastawissi, M. Hassan, E. Ahmed, P. Hitesh, *et al.*, "Study of Diesel-Biodiesel

- Blends Combustion and Emission Characteristics in a CI Engine by adding Nanoparticles of Mn (II) Supramolecular Complex," *Atmospheric Pollution Research*, vol. 11, pp. 117-128, 2020.
- [17] S. C. Sekhar, K. Karuppasamy, R. Sathyamurthy, M. Elkelawy, H. A. E. D. Bastawissi, P. Paramasivan, *et al.*, "Emission analysis on compression ignition engine fueled with lower concentrations of *Pithecellobium dulce* biodiesel-diesel blends," *Heat Transfer—Asian Research*, 2018.
- [18] S. C. Sekhar, K. Karuppasamy, N. Vedaraman, A. Kabeel, R. Sathyamurthy, M. Elkelawy, *et al.*, "Biodiesel production process optimization from *Pithecellobium dulce* seed oil: Performance, combustion, and emission analysis on compression ignition engine fuelled with diesel/biodiesel blends," *Energy conversion and management*, vol. 161, pp. 141-154, 2018.
- [19] E. Shenawy, M. Elkelawy, H. A.-E. Bastawissi, and H. Panchal, "Comparative study of the combustion, performance, and emission characteristics of a direct injection diesel engine with a partially premixed lean charge compression ignition diesel engines," *Fuel*, vol. 249, pp. 277-285, 2019.
- [20] A. Singh, S. Sinha, A. K. Choudhary, H. Panchal, M. Elkelawy, and K. K. Sadasivuni, "Optimization of performance and emission characteristics of CI engine fueled with *Jatropha* biodiesel produced using a heterogeneous catalyst (CaO)," *Fuel*, vol. 280, p. 118611, 2020.
- [21] X. Qian, "Statistical Analysis and Evaluation of the Advanced Biomass and Natural Gas Co-Combustion Performance," Morgan State University, 2019.
- [22] T. B. Johansson, H. Kelly, A. K. Reddy, and R. H. Williams, "Renewable fuels and electricity for a growing world economy: defining and achieving the potential," *Energy Studies Review*, vol. 4, 1992.
- [23] E. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, M. Taha, H. Panchal, K. kumar Sadasivuni, *et al.*, "Effect of cultivation parameters and heat management on the algae species growth conditions and biomass production in a continuous feedstock photobioreactor," *Renewable energy*, vol. 148, pp. 807-815, 2020.
- [24] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, and H. A.-E. Bastawissi, "Investigative research of diesel/ethanol advanced combustion strategies: A comparison of Premixed Charge Compression Ignition (PCCI) and Direct Dual Fuel Stratification (DDFS)," *Fuel*, vol. 345, p. 128143, 2023.
- [25] A. M. Elbanna, C. Xiaobei, Y. Can, M. Elkelawy, and H. A.-E. Bastawissi, "A comparative study for the effect of different premixed charge ratios with conventional diesel engines on the performance, emissions, and vibrations of the engine block," *Environmental Science and Pollution Research*, vol. 30, pp. 106774-106789, 2023.
- [26] A. M. Elbanna, C. Xiaobei, Y. Can, M. Elkelawy, H. A.-E. Bastawissi, and H. Panchal, "Fuel reactivity controlled compression ignition engine and potential strategies to extend the engine operating range: A comprehensive review," *Energy Conversion and Management: X*, vol. 13, p. 100133, 2022.
- [27] H. A. El-Din, M. Elkelawy, and Z. Yu-Sheng, "HCCI engines combustion of CNG fuel with DME and H₂ additives," SAE Technical Paper 0148-7191, 2010.
- [28] M. Elkelawy, "Experimental investigation of intake diesel aerosol fuel homogeneous charge compression ignition (HCCI) engine combustion and emissions," *Energy and Power Engineering*, vol. 6, p. 513, 2014.
- [29] M. Elkelawy, H. A. E. Bastawissi, E. S. A. El-Shenawy, H. Panchal, K. Sadashivuni, D. Ponnamma, *et al.*, "Experimental investigations on spray flames and emissions analysis of diesel and diesel/biodiesel blends for combustion in oxy-fuel burner," *Asia-Pacific Journal of Chemical Engineering*, vol. 14, p. e2375, 2019.
- [30] M. Elkelawy, H. A.-E. Bastawissi, A. M. Radwan, M. T. Ismail, and M. El-Sheekh, "Biojet fuels production from algae: conversion technologies, characteristics, performance, and process simulation," in *Handbook of algal biofuels*, ed: Elsevier, 2022, pp. 331-361.
- [31] M. Elkelawy, E. El Shenawy, H. Bastawissi, and I. El Shennawy, "The effect of using the WCO biodiesel as an alternative fuel in compression ignition diesel engine on performance and emissions characteristics," in *Journal of Physics: Conference Series*, 2022, p. 012023.
- [32] M. Elkelawy, E. El Shenawy, S. A. Mohamed, M. M. Elarabi, and H. A.-E. Bastawissi, "Impacts of EGR on RCCI engines management: A comprehensive review," *Energy Conversion and Management: X*, vol. 14, p. 100216, 2022.
- [33] S. Yang, "The behavior of biomass pellets during combustion in a thermogravimetric furnace," 2001.
- [34] L. D. B. Pestaño and W. I. José, "Development of Torrefaction Technology for Solid Fuel Using Renewable Biomass," in *Gasification for Low-grade Feedstock*, ed: IntechOpen, 2018.
- [35] M. Elkelawy, Z. Yu-Sheng, H. A. El-Din, and Y. Jing-zhou, "A comprehensive modeling study of natural gas (HCCI) engine combustion enhancement by using hydrogen addition," SAE Technical Paper 0148-7191, 2008.
- [36] M. Elkelawy, Z. Yu-Sheng, A. E.-D. Hagar, and J.-Z. Yu, "Challenging and future of homogeneous charge compression ignition engines; an advanced and novel concepts review," *Journal of power and energy systems*, vol. 2, pp. 1108-1119, 2008.
- [37] E. Agbor, X. Zhang, and A. Kumar, "A review of biomass co-firing in North America," *Renewable and Sustainable Energy Reviews*, vol. 40, pp. 930-943, 2014.
- [38] M. A. E. Elkelawy, E. El Shenawy, S. A. Mohamed, M. M. Elarabi, and H. A.-E. Bastawissi, "Impacts of Using Egr and Different Di-Fuels on Rcci Engine Emissions, Performance, and Combustion Characteristics," *Energy Conversion and Management: X*, vol. 15, p. 100236, 2022.
- [39] M. M. El-Sheekh, M. Y. Bedaiwy, A. A. El-Nagar, M. Elkelawy, and H. A.-E. Bastawissi, "Ethanol biofuel production and characteristics optimization from wheat straw hydrolysate: Performance and emission study of DI-diesel engine fueled with diesel/biodiesel/ethanol blends," *Renewable Energy*, vol. 191, pp. 591-607, 2022.
- [40] S. E.-d. H. Etaiw, M. Elkelawy, I. Elziny, M. Taha, I. Veza, and H. A.-E. Bastawissi, "Effect of nanocomposite SCP1 additive to waste cooking oil biodiesel as fuel enhancer on diesel engine performance and emission characteristics," *Sustainable Energy Technologies and Assessments*, vol. 52, p. 102291, 2022.
- [41] D. Mevada, H. Panchal, H. A. ElDinBastawissi, M. Elkelawy, K. Sadashivuni, D. Ponnamma, *et al.*, "Applications of evacuated tubes collector to harness the solar energy: a review,"

- International Journal of Ambient Energy*, vol. 43, pp. 344-361, 2022.
- [42] C. A. Raju, K. Prem, K. Sunil, K. S. Bhimareddy, and C. Ramya, "Studies on densification and conversion of wastes as fuel briquettes for power generation," *Materials Today: Proceedings*, vol. 44, pp. 1090-1107, 2021.
- [43] J. Royo, P. Canalís, D. Quintana, M. Díaz-Ramírez, A. Sin, and A. Rezeau, "Experimental study on the ash behaviour in combustion of pelletized residual agricultural biomass," *Fuel*, vol. 239, pp. 991-1000, 2019.
- [44] A. Demirbas, "Combustion characteristics of different biomass fuels," *Progress in energy and combustion science*, vol. 30, pp. 219-230, 2004.
- [45] H. Thakkar, K. K. Sadasivuni, P. Ramana, H. Panchal, M. Suresh, M. Israr, *et al.*, "Comparative analysis of the use of flash evaporator and solar still with a solar desalination system," *International Journal of Ambient Energy*, vol. 43, pp. 1561-1568, 2022.
- [46] J. G. Vaghasia, J. K. Ratnadhariya, H. Panchal, K. K. Sadasivuni, D. Ponnamma, M. Elkelawy, *et al.*, "Experimental performance investigations on various orientations of evacuated double absorber tube for solar parabolic trough concentrator," *International Journal of Ambient Energy*, vol. 43, pp. 492-499, 2022.
- [47] J.-z. Yu, Z. Yu-Sheng, M. Elkelawy, and Q. Kui, "Spray and combustion characteristics of HCCI engine using DME/diesel blended fuel by port-injection," SAE Technical Paper 2010.
- [48] D. Magalhaes and F. Kazanc, "Influence of biomass thermal pre-treatment on the particulate matter formation during pulverized co-combustion with lignite coal," *Fuel*, vol. 308, p. 122027, 2022.
- [49] S. Munir, W. Nimmo, and B. Gibbs, "Co-combustion of agricultural residues with coal: turning waste into energy," *Energy & fuels*, vol. 24, pp. 2146-2153, 2010.
- [50] W. Ghani, A. Alias, R. Savory, and K. Cliffe, "Co-combustion of agricultural residues with coal in a fluidised bed combustor," *Waste Management*, vol. 29, pp. 767-773, 2009.
- [51] C. Casaca and M. Costa, "Co-combustion of biomass in a natural gas-fired furnace," *Combustion Science and Technology*, vol. 175, pp. 1953-1977, 2003.
- [52] D. Zabrodiec, A. Massmeyer, J. Hees, O. Hatzfeld, and R. Kneer, "Flow pattern and behavior of 40 kWth pulverized torrefied biomass flames under atmospheric and oxy-fuel conditions," *Renewable and Sustainable Energy Reviews*, vol. 138, p. 110493, 2021.
- [53] D. Vamvuka, "Overview of solid fuels combustion technologies," *Handbook of Combustion: Online*, pp. 31-84, 2010.
- [54] S. Caillat and E. Vakkilainen, "Large-scale biomass combustion plants: an overview," *Biomass combustion science, technology and engineering*, pp. 189-224, 2013.
- [55] R. J. Moffat, "Describing the uncertainties in experimental results," *Experimental Thermal and Fluid Science*, vol. 1, pp. 3-17, 1988/01/01/ 1988.
- [56] S. S. Thanapal, *Effect of co-firing torrefied woody biomass with coal in a 30 kWt downfired burner*: Texas A&M University, 2014.
- [57] X. Wang, Z. U. Rahman, Z. Lv, Y. Zhu, R. Ruan, S. Deng, *et al.*, "Experimental study and design of biomass co-firing in a full-scale coal-fired furnace with storage pulverizing system," *Agronomy*, vol. 11, p. 810, 2021.
- [58] L. Sun, Y. Yan, R. Sun, W. Zhu, M. Yuan, H. Qi, *et al.*, "Effects of bluff-body cone angle on turbulence-chemistry interaction behaviors in large-scale semicoke and bituminous coal co-combustion," *Fuel Processing Technology*, vol. 221, p. 106915, 2021.
- [59] C. Axt, A. Maßmeyer, S. Pielsticker, and R. Kneer, "Spatially-Resolved experimental investigations of combustion characteristics in a solid fuel doped methane swirl flame and the influence on the formation of ultrafine particulate matter," *Combustion and Flame*, vol. 244, p. 112223, 2022.
- [60] E. Abd, Kabeel, E. Medhat, A. E. Hagar, Bastawissi, and M. Ahmed, Elbanna, "An experimental and theoretical study on particles-in-air behavior characterization at different particles loading and turbulence modulation," *Alexandria Engineering Journal*, 2019.
- [61] S. F. Abd El Fattah, M. F. Ezzat, M. A. Mourad, M. Elkelawy, and I. M. Youssef, "Experimental Investigation of the Performance and Exhaust Emissions of a Spark-Ignition Engine Operating with Different Proportional Blends of Gasoline and Water Ammonia Solution," *Journal of Engineering Research*, vol. 5, pp. 38-45, 2022.
- [62] H. Bastawissi, Z. Yu-Sheng, M. Elkelawy, and A. Bastawissi, "Detailed 3D-CFD/chemistry of CNG-hydrogen blend in HCCI engine," SAE Technical Paper 0148-7191, 2010.
- [63] H. A. E.-D. Bastawissi and M. Elkelawy, "Computational evaluation of nozzle flow and cavitation characteristics in a diesel injector," *SAE International Journal of Engines*, vol. 5, pp. 1605-1616, 2012.
- [64] H. A.-E. Bastawissi and M. Elkelawy, "Investigation of the flow pattern inside a diesel engine injection nozzle to determine the relationship between various flow parameters and the occurrence of cavitation," *Engineering*, vol. 6, p. 923, 2014.
- [65] H. A. El-Din and M. Elkelawy, "Study of combustion behaviors for dimethyl ether as an alternative fuel using CFD with detailed chemical kinetics," *Alexandria Engineering Journal*, vol. 56, pp. 709-719, 2017.
- [66] H. A. El-Din, Y.-S. Zhang, and M. Elkelawy, "A computational study of cavitation model validity using a new quantitative criterion," *Chinese Physics Letters*, vol. 29, p. 064703, 2012.
- [67] M. Elkelawy, H. Alm Eldin Mohamad, E. Abd Elhamid, and M. A. El-Gamal, "A Critical Review of the Performance, Combustion, and Emissions Characteristics of PCCI Engine Controlled by Injection Strategy and Fuel Properties," *Journal of Engineering Research*, vol. 6, pp. 96-110, 2022.
- [68] M. Elkelawy, H. Alm Eldin Mohamad, A. K. Abdel-Rahman, A. Abou Elyazied, and S. Mostafa El Malla, "Biodiesel as an Alternative Fuel in Terms of Production, Emission, Combustion Characteristics for Industrial Burners: a Review," *Journal of Engineering Research*, vol. 6, pp. 45-52, 2022.
- [69] M. Elkelawy, H. Alm Eldin Mohamad, M. Samadony, A. M. Elbanna, and A. M. Safwat, "A Comparative Study on Developing the Hybrid-Electric Vehicle Systems and its Future Expectation over the Conventional Engines Cars," *Journal of Engineering Research*, vol. 6, pp. 21-34, 2022.
- [70] M. Elkelawy, H. Alm Eldin Mohamad, M. Samadony, A. M. Elbanna, and A. M. Safwat, "Effect of Battery Charging Rates for Electric Hybrid Vehicle on Fuel consumption and emissions

- behaviors in different road conditions: a comparative Study with Conventional Car," *Journal of Engineering Research*, vol. 6, pp. 142-154, 2022.
- [71] M. Elkelawy, H. A.-E. Bastawissi, A. K. Abdel-Rahman, A. Abou El-Yazied, and S. Mostafa El malla, "Effect of multifunctional fuel additive in diesel/waste oil biodiesel blends on industrial burner flame performance and emission characteristics," *International Journal of Ambient Energy*, vol. 44, pp. 1382-1395, 2023.
- [72] M. Elkelawy, A. El-Shenawy, H. A. E. Mohamad, and S. Abd Al Monem, "Experimental Investigation on Spray Characteristics of Waste Cooking Oil Biodiesel/Diesel Blends at Different Injection Parameters," *Journal of Engineering Research*, vol. 3, pp. 29-34, 2019.
- [73] M. Elkelawy, A. Kamel, A. Abou-Elyazied, and S. M. El-malla, "Experimental investigation of the effects of using biofuel blends with conventional diesel on the performance, combustion, and emission characteristics of an industrial burner," *Egyptian Sugar Journal*, vol. 19, pp. 44-59, 2022.
- [74] M. Elkelawy, Z. Yu-Sheng, H. El-Din, Y. Jing-Zhou, A. El Zahaby, and E. El Shenawy, "Experimental Study on Flash Boiling and Micro-Explosion of Emulsified Diesel Fuel Spray Droplets by Shadowgraph Technology," *Transactions of CSICE*, vol. 27, pp. 306-308, 2009.
- [75] M. M. El-Sheekh, A. A. El-Nagar, M. Elkelawy, and H. A.-E. Bastawissi, "Bioethanol from wheat straw hydrolysate solubility and stability in waste cooking oil biodiesel/diesel and gasoline fuel at different blends ratio," *Biotechnology for Biofuels and Bioproducts*, vol. 16, p. 15, 2023.
- [76] M. M. El-Sheekh, A. A. El-Nagar, M. Elkelawy, and H. A.-E. Bastawissi, "Maximization of bioethanol productivity from wheat straw, performance and emission analysis of diesel engine running with a triple fuel blend through response surface methodology," *Renewable Energy*, vol. 211, pp. 706-722, 2023.
- [77] W. Hua, W. Chenliang, M. Elkelawy, and J. Guangjun, "Influence of Ambient Pressure on Gas Ingestion in Diesel Nozzle after End of Injection," *Transactions of the Chinese Society for Agricultural Machinery*, vol. 48, pp. 364-369, 2017.
- [78] A. Kabeel, M. Elkelawy, H. A.-E. Mohamad, A. M. Elbanna, H. Panchal, M. Suresh, *et al.*, "The influences of loading ratios and conveying velocity on gas-solid two phase flow characteristics: a comprehensive experimental CFD-DEM study," *International Journal of Ambient Energy*, vol. 43, pp. 2714-2726, 2022.
- [79] A. Kabeel, E. ElShenawy, M. Elkelawy, H. Bastawissi, and M. M. Elshanshoury, "Numerical Investigation of Combustion in HCCI Diesel Engine Fuelled with Biodiesel Blends," *Engineering Research Journal (ERJ)*, vol. 7, pp. 1-10, 2019.
- [80] M. H. Aboubakr, M. Elkelawy, H. A.-E. Bastawissi, and A. R. El-Tohamy, "The influence of using HHO with sunflower and soybean oil biodiesel/diesel blend on PCCI engine characteristics," *Journal of Engineering Research*, vol. 7, p. 15, 2024.
- [81] H. Alm Eldin Mohamad, M. Elkelawy, and M. Ramon, "Computational fluid dynamics study on a solar chimney with different ground materials," *Journal of Engineering Research*, vol. 7, pp. 176-185, 2023.
- [82] E. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, and M. M. Shams, "EXPERIMENTAL STUDY ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF PPCCI ENGINE FUELED WITH BIODIESEL/DIESEL BLENDS," *Engineering Research Journal*, vol. 41, pp. 119-132, 2018.
- [83] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, H. A.-E. Bastawissi, and H. Xu, "Statistical analysis of ethanol/diesel dual-fuel combustion of compression ignition engines in RCCI mode using multi-injection strategies," *Sustainable Energy & Fuels*, vol. 7, pp. 2749-2763, 2023.
- [84] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, and H. A. Elden, "Knock Recognition System in a PCCI Engine Powered by Diesel," *Highlights in Science, Engineering and Technology*, vol. 15, pp. 94-101, 2022.
- [85] M. Elkelawy, E. Abd Elhamid, H. Alm Eldin Mohamad, and I. Abd-Elhay Elshennawy, "Effect of CuO Nanoparticles on Performance and Emissions Behaviors of CI Engine Fueled with Biodiesel-Diesel Fuel Blends," *Journal of Engineering Research*, vol. 6, pp. 230-239, 2022.
- [86] M. Elkelawy, A. K. Abdel-Rahman, A. Abou-Elyazied, and S. M. El-malla, "Experimental investigation on emission and combustion characteristics of an industrial burner using biogas co-fired with diesel and biodiesel," *Egyptian Sugar Journal*, vol. 19, pp. 29-43, 2022.
- [87] M. Elkelawy, H. Alm Eldin Mohamad, S. Abo-Samra, and I. Abd-Elhay Elshennawy, "Nanoparticles Additives for Diesel/Biodiesel Fuel Blends as a Performance and Emissions Enhancer in the Applications of Direct Injection Diesel Engines: A comparative Review," *Journal of Engineering Research*, 2023.
- [88] M. Elkelawy, H. Alm Eldin Mohamad, and M. A. El-Gamal, "Experimental Investigation of the Biodiesel Direct Injection and Diesel Fuel as Premixed Charge on CI-Engine Emissions, Performance, and Combustion Characteristics," *Journal of Engineering Research*, vol. 7, pp. 177-187, 2023.
- [89] M. Elkelawy, H. Alm Eldin Mohamad, M. Samadony, and A. S. Abdalhadi, "Utilization of Ammonia Hydroxide/Diesel Fuel Blends in Partially Premixed Charge Compression Ignition (PPCCI) Engine: A Technical Review," *Journal of Engineering Research*, 2023.
- [90] M. Elkelawy, H. Alm Eldin Mohamad, M. Samadony, and A. S. Abdalhadi, "Impact of Utilizing a Diesel/Ammonia Hydroxide Dual Fuel on Diesel Engines Performance and Emissions Characteristics," *Journal of Engineering Research*, vol. 7, pp. 262-271, 2023.
- [91] M. Elkelawy, H. Bastawissi, A. Abdel-Rahman, A. Abou-elyazied, and S. El-malla, "Experimental investigation of the effects of diesel-bioethanol blends on combustion and emission characteristics in industrial burner," in *Journal of Physics: Conference Series*, 2023, p. 012018.
- [92] M. Elkelawy, H. Bastawissi, E. El Shenawy, and M. El-Gamal, "Effects of using a novel fuel vaporizer on partially premixed charge compression ignition (PPCCI) engine emissions, performance, and combustion characteristics," in *Journal of Physics: Conference Series*, 2023, p. 012017.
- [93] M. Elkelawy and H. A.-E. Bastawissi, "Numerical study on the hydrogen fueled SI engine combustion optimization through a combined operation of DI and PFI strategies," *Energy and Power Engineering*, vol. 5, p. 513, 2013.

- [94] M. Elkelawy, H. A.-E. Bastawissi, and A. M. Elbanna, "Solid particles injection in gas turbulent channel flow," *Energy and Power Engineering*, vol. 8, pp. 367-388, 2016.
- [95] M. Elkelawy, E. S. A. El Shenawy, H. A.-E. Bastawissi, and M. M. Shams, "Impact of Carbon Nanotubes and Graphene Oxide Nanomaterials on the Performance and Emissions of Diesel Engine Fueled with Diesel/Biodiesel Blend," *Processes*, vol. 11, p. 3204, 2023.
- [96] M. Elkelawy, H. A. El-Din, A. M. El-Banna, R. Sathyamurthy, and N. Prakash, "Computational study of different turbulence models for air impingement jet into main air cross stream," *International Journal of Fluid Mechanics Research*, vol. 46, 2019.
- [97] M. Elkelawy, Z. Yu-Sheng, H. A. El-Din, and Y. Jing-zhou, "Detailed simulation of liquid DME homogenization and combustion behaviors in HCCI engines," SAE Technical Paper 0148-7191, 2008.
- [98] M. M. El-Sheekh, A. A. El-Nagar, M. Elkelawy, and H. A.-E. Bastawissi, "Solubility and stability enhancement of ethanol in diesel fuel by using tri-n-butyl phosphate as a new surfactant for CI engine," *Scientific Reports*, vol. 13, p. 17954, 2023.
- [99] E. El-Shenawy, M. Elkelawy, H. Bastawissi, and M. Taha, "Growth conditions of the algae species biomass in a continuous feedstock photo bioreactor by controlling the solar thermal radiation and climate temperature," in *The International Conference on Applied Mechanics and Mechanical Engineering*, 2018, pp. 1-19.
- [100] G. Jiang, Zhang, Y., Elkelawy, M., Xiao, G., "Visualization experiment of internal flow of nozzle and spray construction for various fuels," *Transactions of the Chinese Society for Agricultural Machinery*, vol. 45, pp. 22-29, 2014.
- [101] J. Yu, Y. Zhang, M. Elkelawy, and H. Zhang, "Investigation and numerical simulation of DME flash boiling spray characteristics," *Chinese Internal Combustion Engine Engineering*, vol. 30, pp. 45-50, 2009.
- [102] H. Alm ElDin Mohamad, M. Elkelawy, and O. A. I. HENDAWI, "An overview of the Effect of using HHO on Spark ignition and direct injection engines combustion, performances, and emissions characteristics," *Journal of Engineering Research*, vol. 6, pp. 240-246, 2022.
- [103] H. A.-E. Bastawissi, E. El Shenawy, M. Elkelawy, and O. Hendawy, "Experimental Investigation on the Effect of using Oxy-Hydrogen Gas on Spark Ignition Engines Performances, and Emissions Characteristic," *Journal of Engineering Research (ERJ)*, vol. 7, pp. 32-41, 2023.
- [104] H. A. Eldin, M. Elkelawy, and M. Ramon, "Computational fluid dynamics study on a solar chimney with different ground materials," *Journal of Engineering Research*, vol. 7, p. 11, 2023.
- [105] M. Elkelawy and H. A.-E. Bastawissi, "Improving Performance of a Hybrid Electric Vehicle by Impeding on Board Photovoltaic Panels," in *5th International Conference on Scientific Research ISR-2019 RENEWABLE ENERGY & WATER SUSTAINABILITY Sharm El Sheikh-Egypt*, 2019.
- [106] M. Elkelawy, H. A.-E. Bastawissi, M. O. Elsamadony, and A. S. Abdalhadi, "Engine Performance and Emissions Improvement Study on Direct Injection of Diesel/Ammonia Dual Fuel by Adding CNG as Partially Premixed Charge," *Journal of Engineering Research*, vol. 7, p. 12, 2024.
- [107] M. Elkelawy, E. El Shenawy, H. Alm-EldinBastawissi, I. A. Mousa, and M. M. A.-R. Ibrahim, "Effects of Fuel Equivalence Ratio and Swirl Vane Angles on Premixed Burner Turbulent Flame Combustion Characteristics," *Journal of Engineering Research*, vol. 7, p. 15, 2024.
- [108] E. A. E. Elshenawy, M. A. Elkelawy, M. K. El-fakharany, H. A.-E. Bastawissi, and M. M. Shafey, "STUDY OF THE PERFORMANCE AND EMISSION CHARACTERISTICS OF DI DIESEL ENGINE FUELLED WITH BIODIESEL-DIESEL BLENDS," 2020.
- [109] T. Hemin, k. Kishor, Sadasivuni, P. V. Ramana, P. Hitesh, M. Suresh, I. Mohammad, *et al.*, "Comparative analysis of the use of flash evaporator and solar still with a solar desalination system," *International Journal of Ambient Energy*, pp. 1-8, 2020.
- [110] A. Kabeel, M. Elkelawy, H. A. El-Din, A. M. El-Banna, R. Sathyamurthy, and N. Prakash, "Computational Study of Different Turbulence Models for Air Impingement Jet into Main Air Cross Stream," *International Journal of Fluid Mechanics Research*, pp. 459-475, 2019.
- [111] E. Medhat, A. E. El- Shenawy, A. Hagar, El-Din Moham, and K. Salma, Abd-ALMonem, "Experimental Investigation on Spray Characteristics of Waste-Cooking-Oil Biodiesel/Diesel Blends at Different Injection Parameters," *Engineering Research Journal (ERJ)*, vol. 4, 2019.
- [112] E. Medhat, A. E. M. Hagar, and H. Osama, "Enhancing Spark Ignition Engine Performance and Emissions Behaviors through duel Effect of Hydrogen peroxide and Petrol Fuel "THERMOL-P" Additives," in *The 3rd MRCE International Conference on: Materials Engineering and Nanotechnology*, 2023, p. 36.
- [113] E. Medhat and H. A. E. Mohamad, "Effect of Using Multifunctional "THERMOL-P" Fuel Additives in the Commercial Gasoline Fuel on SI engine Emissions and Performance Characteristics," in *The 3rd MRCE International Conference on: Materials Engineering and Nanotechnology*, 2023, p. 18.
- [114] D. P. Mevada, Hitesh EldinBastawissi, Hagar Alm Elkelawy, Medhat Sadashivuni, Kishorkumar Ponnamma, Deepalekshmi Thakar, Nishant Sharshir, S. W., "Applications of Evacuated tubes collector to harness the solar energy: A Review," *International Journal of Ambient Energy*, pp. 1-27, 2019.
- [115] E. A. E. Shenawy, M. Elkelawy, M. Q. M. Al-Fakhrani, H. A.-E. Bastawissi, and M. Moustafa, "Effect of the Injection Pressure on the Fuel Spray Characteristics of Diesel/Biodiesel Blends," in *5th International Conference on Scientific Research ISR-2019 RENEWABLE ENERGY & WATER SUSTAINABILITY Sharm El Sheikh-Egypt*, 2019.