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To Study Impact of Al_2O_3 Additive in Nahar and Karanja biodiesel to reduce harmful emission of diesel fuel with EGR on diesel engine using ANN.

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ABSTRACT: Consumption of fossil fuels to meet increasing demand of globalization is increased considerably resulting in depletion of fossil fuel reserves. Stringent environmental norms and increase in greenhouse gases emissions has forced researchers to search alternatives to fossil fuels. Biodiesel (Methyl Ester) is one of the alternatives that can be used as fuel in conventional diesel engine without any design modifications. This project deals with synthesizing good quality of Methyl Ester from Mexican seeds which is available cheaply in rural areas and grown in marginal lands. Different blends of Nahar and Karanja are prepared in order to investigate the properties of blends and if necessary eco-friendly additives are added with blends. Also, it deals with validation of properties of synthesized Nahar and Karanja oil Methyl ester according to ASTM 6751-96 standards.

KEYWORDS: Biodiesel, Blend, Methyl ester, Investigate.

I.

INTRODUCTION

“It is an alternative fuel similar to conventional fuel or fossil fuels, it can be produced from chemically reacting vegetable oil, animal oil or fats, waste cooking oil”. Blend of biodiesel e.g. B20 - 20% of biodiesel and 80% of diesel. Before petroleum diesel fuel became popular, Rudolf Diesel, the inventor of the diesel engine in 1897, experimented with using vegetable oil (biodiesel) as fuel. Biodiesel is an animal or vegetable oil based diesel fuel that burns without the emission of much soot, carbon oxide and particulate matter. It consists of long chain of mono-alkyl esters and is produced by trans-esterifying vegetable oil or animal fat. In this process, the animal or vegetable oil is converted into biodiesel when one mole of triglyceride reacts with three moles of alcohol to produce a mole of glycerol and three moles of mono-alkyl esters. Biodiesel like petro-diesel is made of hydrocarbon chains that do not contain sulfur, or aromatics compounds in its composition. It is an alternative fuel that is obtained from renewable resources that burns in diesel engines with less environmental pollutants

II. LITERATURE REVIEW

N. Dutta, N. Karak, S.K. Dolui with title 'Structural analysis, rheological behavior and the performance of films for surface coatings' application of heated and unheated Nahar seed oil. The structural analysis and, rheological behavior of unheated Nahar seed oil and the heated at two different. [1] Mohammed Adeel Ansari and Dr. Amar P. Pandhare "Production of Hybrid Oil Biodiesel (Nahar Oil and Waste Cooking Oil) and Quality Testing" present work deal with the property, performance & emission characteristics of biodiesel obtained by mixing Nahar oil methyl ester with waste cooking oil methyl ester Nahar seed oil. found that the improves fuel properties, engine performance. [2] L.C. Meher, Vidya S.S. Dharmagadda and S.N. Naik "Optimization of alkali-catalyzed transesterification of Pongamia pinnata oil for production of biodiesel" in 2005 transesterification of Karanja oil with methanol for the production of biodiesel optimized for production catalyst concentration, alcohol/oil molar ratio, temperature, and rate of mixing quantified by HPLC and HNMR method. [3] Dilip Kumar Bora and Rupanjali Nath's "Use of Nahar oil Methyl ester (NOME) in CI Engine" in 2007 overviews the application of NOME in CI Engine by comparing performance and smoke opacity with convectional Diesel Fuel. use of biodiesel engine reduce particulates, hydrocarbons and CO. [4] In The paper of Vismaya, W. Sapna Eipeson, J.R. Manjunatha, P. Srinivas, T.C. and Sindhu Kanya, "Extraction and recovery of karanjin: A value addition to Karanja (Pongamia pinnata) seed oil" in 2010 Karanja (Pongamia pinnata) seed oil contains karanjin, a bioactive molecule with important biological attributes. develop a facile method for efficient recovery of karanjin. seed oil was subjected to liquid-liquid extraction with methanol. Recover pure form and high yield affords value addition to the seed oil. [5] Gaurav Dwivedi, Siddharth Jain, and Mahendra Pal Sharma "Pongamia as a Source of Biodiesel in India" in 2011 Study the Pongamia Pinnata trees Plantation and their soil erosion stoping property economic value from unused reservoir lands. estimated annual production of oil from its seeds developed as the alternative source of fuel by replacing diesel. [6] S. Jaichandar, K. Annamalai' tile of paper 'Effects of open combustion chamber geometries on the performance of Pongamia biodiesel in a DI diesel engine' The present work investigates the effect of varying the combustion chamber geometry on the performance of a diesel engine using biodiesel in terms of brake specific fuel consumption, brake thermal efficiency as well as exhaust emissions and combustion characteristics. Engine tests have been carried out using a blend of 20% Pongamia Oil Methyl Ester (POME) with standard diesel as fuel and with three types of combustion chambers namely Hemispherical combustion chamber, Toroidal combustion chamber, and Shallow depth combustion chamber without altering the compression ratio of the engine. [7] Pooja Ghodasara and Mayur Ghodasara "Experimental Studies on Emission and Performance Characteristics in Diesel Engine Using Bio-Diesel Blends And EGR (Exhaust Gas Recirculation)" in 2012 investigate the usage of biodiesel blends and EGR simultaneous to reduce NOx emission along with other regulated pollutants from diesel engine without any engine modification. blends of biodiesel like B-20, B-50, and B-100 are used to compare the engine performance and parameters such as brake thermal efficiency, exhaust gas temperature, and emission characteristics. [8] Hossain Mohammad Imran, Arafat H. Khan, M. Shahinul Islam, Niher R. S, Asaduzzaman Sujana and A.M. Sarwaruddin Chowdhury "Utilization of Karanja (Pongamia pinnata) as a Major Raw Material for the Production of Biodiesel" in 2012 achieved process involved transesterification of Karanja oil with methanol in the presence of a catalyst (NaOH), to yield biodiesel as the main product and glycerin as a by-product. evaluated-ignition of biodiesel with commercial diesel found that diesel engines run smoothly in the ratio of commercial diesel to biodiesel. [9] Bobade S.N and Khyade V.B. "Preparation of Methyl Ester (Biodiesel) from Karanja (Pongamia Pinnata) Oil" in 2012 Derived that source of energy in the form of biodiesel, Pongamia pinata is one of the most suitable species due to its various favorable attributes like its hardy nature, high oil recovery and quality of oil, deals with transesterification of Karanja oil and properties like density, viscosity, flash point, cloud point and pour point. [10] In The paper of "Bobade S.N. and Khyade V.B" titled "Detail study on the Properties of Pongamia Pinnata (Karanja) for the Production of Biofuel" in 2012 states that efforts to use plant oil and their esters (biodiesel) as a fuel in compression ignition (CI) engines. Detail study intends to identify all advantages and disadvantages of Pongamia pinata as a sustainable feedstock for the production of Biodiesel equivalent to fossil fuel. [11] In this paper "Baste S.V, Bhosale A.V and Chavan S.B." title "Emission

Characteristics of Pongamia Pinnata (Karanja) Biodiesel and Its Blending up to 100% in a C.I. Engine” The study is initiated to investigate the potential of Karanja oil as a source of biodiesel. feasibility of Karanja oil for the production of biodiesel optimization of different parameters for high yield /conversion of Karanja oil to biodiesel. fuel properties of esterified Karanja oil and its blend with diesel fuel at different proportions are studied including engine tests. [12]P. K. Halder, N. Paul and. R. A. Beg “Prospect of Pongamia pinnata (Karanja) in Bangladesh: A Sustainable Source of Liquid Fuel” in 2014 This paper outlines the medical and energy aspects of Pongamia pinnata and production and cultivation of Pongamia pinnata in unused land and reduced the emission of CO₂, CO, HC, and NO_x compared to pure diesel. [13]

In The paper of Mohammad Aslam, Prashant Saxena, and Anil K. Sarma1 "Green Technology for Biodiesel Production From Mesua Ferrea L.Seed Oil" in 2014 the non-edible Mesua ferrea L. (MFL) seed oil with an acid value 18.8 mg KOH/g of oil, was transesterified in the presence 1 MPa hydrogen pressure and also without the application of external pressure at 250–275 °C for 1 hour found negligible Ethanol and fulfill the demand of 100% Green Technology for biodiesel production. [14] Dilip Kumar Bora, Rajib Saha, Madhurja Saikia, Biswajit Shyam, and Bichitra Bikash “Biofuel production from Mesua ferrea L seed oil” in 2014 find the possible environmental benefits and the current concern over the depletion of fossil fuel sources. efficient methods to produce biofuel is Catalytic cracking performed in presence of catalysts and analyzed results of the product sample. [15] Mohammad Aslam, Prashant Saxena and Anil K. Sarma “Green Technology for Biodiesel Production From Mesua Ferrea L.Seed Oil” in 2014 the non-edible Mesua ferrea L. (MFL) seed oil with an acid value 18.8 mg KOH/g of oil, was transesterified in the presence 1 MPa hydrogen pressure and also without the application of external pressure at 250–275 °C for 1 hour. The resultant biodiesel was separated using a rotary vacuum evaporator and purified using a molecular sieve and carbon columns. fulfill the demand for 100% Green Technology for biodiesel production. [16] Montu Moni Bora, Riblu Deka, Nuruddin Ahmed, Dilip Kumar Kakati ‘Karanja (Milletia pinnata (L.) Panigrahi) seed oil as a renewable raw material for the synthesis of alkyd resin’. Non-edible vegetable oils are an important class of bio-resource for producing polymeric materials due to their large abundance, low cost, and renewability. Karanja (Milletia pinnata) tree is an evergreen, drought-resistant, nitrogen-fixing tree belonging to the Leguminosae family. Karanja seed oil (~27 wt%) mainly consisting of triglycerides is a good source of non-edible vegetable oil for synthesizing alkyd resin. [17] In this paper H J Yadav “Transesterification of Karanja oil for production of Biodiesel as an alternate fuel in Diesel Engines” in 2015 An attempt is made to assess the suitability of Karanja oil for diesel engine operation, without any modifications in its existing construction. the acid value of this oil is high, reduce it by the process of esterification followed by Transesterification. by this way methyl ester produced and gives the good result & properties are comparable to diesel. [18] Anuchaya Devi, Vijay K. Das Velentina Das and Dhanapati Deka “Fuel Quality Assessment of Biodiesels Produced through Alcoholysis from Pongamia glabra, Mesua ferrea, and their blend: A novel yet cinch approach” in 2015 annual seed yield, the life span of the seed-bearing tree, and most importantly the oil content of the seeds. Reduced acid value via esterification before going to alcoholysis. recorded remarkable fuel quality enhancement in the blended biodiesel. [19] Rupesh L. Patel, C.D. Sankhavarar with title ‘Biodiesel production from Karanja oil and its use in diesel engine: A review’. Biodiesel is a renewable resource produced from like the vegetable oil and animal fats. India is the 70% petroleum product import for another country. Biodiesel is emitting the less harmful gases compared the diesel fuel. Biodiesel production from local resources provides energy security; reduces the import bill, generates employment, and reduced emissions of harmful gasses. Karanja trees can grow on the sides of roads, canals, and boundary portions of agricultural lands with minimum care. [20]B. Rajesh Kumar, S. Saravanan, D. Rana, A. Nagendran’ title of paper ‘Combined effect of injection timing and exhaust gas recirculation (EGR) on performance and emissions of a DI diesel engine fuelled with next-generation advanced biofuel – diesel blends using response surface methodology (Karanja and Nahar EGR method ’ Advanced biofuels like dimethyl-carbonate (DMC), isobutanol and n-pentanol can be derived from nonfood based biomass feedstock without unsettling food supplies and biodiversity. An experimental and statistical investigation was carried out to analyze the effects of injection-timing and exhaust gas recirculation (EGR) on the performance and emissions of a DI diesel engine by using advanced biofuel (containing 8 wt%

oxygen). [21]Arun Kumar Gupta, Mani Rahul Kiro, and Goutam Deo “Biodiesel production from a free fatty acid-containing Karanja oil by a single-step heterogeneously catalyzed process” in 2016 production of biodiesel using a single-step solid-phase acid-catalyzed process. Tested Different types of zeolites and Amberlyst15 catalysts achieved biodiesel yield of 93% using a single-step process with Amberlyst15 as a catalyst at 120 °C. [22]Shaban, M. A1 and H. M. Aly “PRODUCTION AND PERFORMANCE EVALUATION OF BIODIESEL FROM PONGAMIA TREE OIL” in 2016 Performed Experiment on four strokes, two cylinders, direct injection, and naturally aspirated Diesel engine blends with Diesel fuel operating on 10%, 20%, 30%, and 40%. test the effects of Pongamia oil biodiesel inclusion in Diesel engines on power, specific fuel consumption (SFC), thermal efficiency, emission composition changes, and exhausts temperature. [23]Devarapaga Madhu, Supriya B. Chavan, Veena Singh, Bhaskar Singh, and Yogesh C. Sharma “An economically viable synthesis of biodiesel from a crude Millettia pinnata oil of Jharkhand, India as feedstock and crab shell derived catalyst” in 2016 study that Biodiesel has emerged as a prominent source to replace petroleum diesel. synthesized through esterification followed by transesterification in a two-step process. done using proton NMR spectroscopy. Reaction parameters such as reaction time, reaction temperature, the concentration of catalyst, and stirrer speed were optimized. [24]K. Sivaramakrishnan' in with title 'Investigation on performance and emission characteristics of a variable compression multi-fuel engine fuelled with Karanja biodiesel–diesel blend' The performance and emission of a single-cylinder four-stroke variable compression system multi-fuel engines when fueled with 20%, 25% and 30% of Karanja blended with diesel are investigated and compared with standard diesel. Conduct the experiment compression ratios is 15:1, 16:1, 17:1, and 18:1. [25]Prashant B Tadalagi, Rajesh Gurani, and Malikasab Bagawan “Smoke Emission Levels for CI DI Engine using Blends of combinations of Biodiesel and Diesel Fuel” in 2018 focused on the blends of biodiesel (delivered from Waste Cooking oil WCO and Pongamia) blends and their impact on the smoke emissions of cars. [26]

Mr.R.G.Biradar, Dr. C. L. Prabhune, and Mrs. Supriya Bobade “Performance and Emissions Analysis of Diesel Blended with Nahar Biodiesel in VCR Compression Ignition Engine” in 2018 fuel properties of biodiesel such as kinematic viscosity, calorific value, flash point, carbon residue, and specific gravity were found Emissions of CO, HC, CO₂, and O₂ are reduced as compared to pure diesel showed reasonable efficiency, lower smoke, CO₂, CO, and HC. [27]Santosh Kumar Dash, Pradip Lingfa and Supriya B. Chavan “An experimental investigation on the application potential of heterogeneous catalyzed Nahar biodiesel and its diesel blends as diesel engine fuels” in 2018 In this study, an attempt has been made to use an abundantly available underutilized high oil content (67% of Nahar seed kernel) feedstock derived biodiesel in a compression ignition engine. and conclude that the emission of the various harmful gas will be reduced using Biodiesel. [28] Mahantesh.M. Shivashimpi, S.A. Alur, S.N. Topannavar, B.M. Dodamani' in title ‘Combined effect of combustion chamber shapes and nozzle geometry on the performance and emission characteristics of C.I. engine operated on Pongamia Performance of the engine improve by the modifying the shape of the combustion chamber and nozzle geometry. The present work investigated the combined effect of combustion chamber shapes and nozzle geometry on the performance and emission characteristics of POME biodiesel-fueled diesel engines. [29] In this Article Pradip Lingfa, Supriya B. Chavan, and Santosh Kumar Dash "Combustion analysis of a single cylinder variable compression ratio small size agricultural DI diesel engine run by Nahar biodiesel and its diesel blends” in 2019 explores the combustion characteristics of a single cylinder four strokes variable compression ratio direct injection diesel engine run by Nahar biodiesel (BD) and its six different blends (B5, B10, B20, B30, B40, and B50).and recommended that use biodiesel up to B40 Blend at initial Level. [30]S Dyundi, S Matolia, A Singla, D Kumar, YSingh, A Sharma, S Bhurat and A K Upadhyay “Review on Biodiesel Production and Emission Characteristic of Non-Edible Vegetable Oil” in 2019 to extract the bio-diesel from oil either by edible oil or by non-edible oil Transesterification process is used and quality of biodiesel edible oil and its influence on internal combustion engines performance and emissions characteristics. [31] A.Ranjith Prabhu , Arjun Sushil, Vishnuprasad P.P, Vishwadev and K.V.Suresh “A Review on Honge (Pongamia Pinnata) Biodiesel as an Alternative fuel for Diesel Engine” in 2019 lower the carbon monoxide (CO) and Hydrocarbon (HC) emissions compared to those of a spark ignition (SI) engine. Due to the Agricultural origin of the biofuels,

they emit less CO₂ (Carbon dioxide) and CO (Carbon monoxide) with the lean burn capability of biofuel. process of esterification followed by trans-esterification reduced the Acid value of this oil to be used as an alternative fuel in CI Engine . [32]‘V. Dananjayakumar , Mallesh B. Sanjeevannavar , Shailesh M. Golabhanvi , M.A. Kamoji’ with the title 'Experimental analysis of CI engine using zirconia ceramic powder coated piston fuelled with Karanja biodiesel' The purpose of this research work is to find the performance of bio -diesel-fueled compression ignition engine with and without Zirconia ceramic powder as a thermal barrier coating on the piston head by using plasma spray technique. [33] ‘Sunil Kumar’ with the title 'Production and optimization from Karanja oil by adaptive neuro-fuzzy inference system and response surface methodology with modified domestic microwave’. In this study, Karanja oil was investigated under different operating conditions such as Methanol: oil molar ratio, catalyst, Volume, and time with microwave power to produce the biodiesel. ANFIS tool was adopted for modeling and prediction. RSM and ANFIS models describe correlation coefficients of 0.85 and 0.95 respectively. [34]‘Sudip Mitra , Anamika Ghose , Nihal Gujre , Sanjana Senthilkumar , Pallabi Borah Ankita Paul , Latha Rangan’ with the title ‘A review on environmental and socio-economic perspectives of three promising biofuel plants *Jatropha curcas*, *Pongamia pinnata*, and *Mesua ferrea*’. To the best of our knowledge, this is the first concerted and comparative assessment of *Jatropha curcas*, *Pongamia pinnata*, and *Mesua ferrea* as biofuel resources, with the concurrent evaluation of the environmental and socio-economic perspectives. Their environmental perspectives are critically assessed in this review based on the roles in phytoremediation, bioabsorption, carbon sequestration, and soil conditioning. The detailed analysis of biogas, biopesticide, cosmetic products, and biofuel yield, reinforces the economic potential of the three plants under review. [35] ‘Anh Tuan Hoang, Sandro Nizeti, Hwai Chyuan Ong, Wieslaw Tarelkod, Van Viet Phame, Tri Hieu Lee, Minh Quang Chau, Xuan Phuong Nguyen’ with the title 'A review on application of artificial neural network (ANN) for performance and emission characteristics of a diesel engine fueled with biodiesel-based fuels (Karanja and Nahar by ANN method)’. Biodiesel has been emerging as a potential and promising biofuel for the strategy of reducing toxic emissions and improving engine performance. . Artificial neural networks (ANN) were data-processing systems, which were used to tackle many issues in engineering and science, especially in some fields where there was a failure of the conventional modeling approaches. The use of ANN is trained, tested, and validated data was introduced to the performance and emission characteristics of a diesel engine is the fuel of the biodiesel base fuel. [36] ‘Krishna Shrivastavaa, S.S. Thipseb, I.D. Patil’ with title ‘Optimization of diesel engine performance and emission parameters of Karanja biodiesel-ethanol-diesel blends at optimized operating conditions. The study of Karanja biodiesel, ethanol, and blending in the context of the Indian subcontinent and also focuses on its effects on engine performance, emission and combustion responses. For the experiment carried on the four-stroke single-cylinder diesel engine at the constant speed 1500rpm and inject pressure is 210 bar. The combustion parameters as Cylinder pressure, Ignition delay, Combustion duration, Start of combustion, End of combustion, Rate of pressure rise, Mean effective pressure, and net heat release rate were observed at full load, which also support an optimal combination of input parameters. [37]Yew Heng Teoh , Heoy Geok How , Farooq Sher , Thanh Danh Le , Hwai Chyuan Ong , Huu Tho Nguyen, and Haseeb Yaqoob “Optimization of Fuel Injection Parameters of *Moringa oleifera* Biodiesel-Diesel Blend for Engine-Out-Responses Improvements" in 2021 measured and investigated measured processing of biodiesel from non-edible *Moringa Oleifera* was investigated using a single-step transesterification technique. study of injection pressure and the start of injection (SOI) timing for MB50 fuel was optimized using response surface methodology (RSM). [38]In the paper of Niraj B Dole 1, Rahul B Barjibhe 2 “Character traits of Hybrid Bio-Fuel as performance and exhaust emissions in a Diesel Engine.” In 2022 This research aims to use non-edible oil seeds that are cheap in rural areas and grown on poor soil. To evaluate the quality of blends, numerous blends of Undi and residual cooking/fired oil are prepared, and if necessary, eco-friendly additives are applied to the blends.[39]

III. CRITICAL LITERATURE REVIEW

- Biodiesel is produced by means of transesterification. Transesterification is the reaction of a lipid with an alcohol to form esters and a byproduct, glycerol. It is, in principle, the action of one alcohol displacing another from an ester, referred to as alcoholysis. In transesterification mechanism, the carbonyl carbon of the starting ester (RCOOR^1) undergoes nucleophilic attack by the incoming alkoxide (R^2O^-) to give a tetrahedral intermediate.(2,14,15,18,22)
- ANN model is built to simulate the actual engine behavior in order to obtain the output parameters of thermal performance and emission constituents corresponding to the optimum input parameters obtained. The neural network input and output layers created to match the grid input and output columns.(36)
- Engine performances and emission characteristics of karanja oil methyl ester blended with diesel were carried out on variable compression diesel engine. Application of Taguchi method in combination with grey relational analysis had been applied for solving a multiple response optimization problem.(38,37,34,27,25,23)
- There is consensus in the literature that many waste materials can be used as feedstocks for other processes, by recovering their active and chemical components, avoiding the environmental and human health problems associated with improper disposal. However, waste streams usually consist of several components, of which only a few are valuable materials. If there is a positive balance between usability and availability, the required component can be economically recovered for use as a raw material.(23)
- Using biodiesel produced from transesterification of waste cooking, delivered an optimum engine load at about 52% of full load. Therefore, the current study seems to suggest that, with biodiesel produced from pyrolysis process, the engine could be run closer to its full capacity without adversely jeopardising its efficiency and fuel consumption. Nonetheless, it is clear that conventional diesel still delivered better engine performance overall across the full range of engine load.(31,36,25)

IV.

CONCLUSION

Primarily, how ANN worked was similar to the brain of human as it has consisted of some processing elements called 'neurons'. ANN could tackle various difficulties in science and engineering, especially for many domains in which traditional and numerical approaches were insufficient. In general, the estimation by an ANN was quicker, compared to the traditional simulation software and mathematical models because ANN models are believed to study data recorded previously as well as to learn the relationship between the controlled/uncontrolled variables and the input parameters, on which ANN models could effectuate non-linear regressions. For ANN application in diesel engines, ANN was applied widely to identify a number of engine operating factors fueled by biodiesel and its blending. In general, findings from this current work could show the critical role of the ANN model in the optimization of the engine performance and emission characteristics fueled with biodiesel-based fuels, as well as the prediction of the best condition in the core correlation of inputs and outputs.

The fact shows that the selection of the experimental design is very important aiming to fit a suitable mathematical function for the predicting progress, as well as to assess the quality and performance of the as-used ANN model related to the achieved data from the experiments of the performance and emission characteristics of diesel engines running on biodiesel-based fuels. Therefore, it is preferable to use individual models in ANN structure for predicting engine performance and emissions rather than using combined models. In conclusion, the ANN model was able to predict the characteristics of performance and engine-out emissions with an accuracy higher than 95%.

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