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Application of Artificial Neural Network for Predicting Engine Characteristics of an IC Engine with Alternative Fuel: A Review

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Abstract - *Biodiesel can possibly extraordinarily add to the maintainability of transportation fuels. There are complications and nonlinearity involved in biodiesel production and consumption processes which make it difficult to design, optimization, monitoring, and control such systems. Researchers now have new options for simulating such complicated systems thanks to machine learning (ML). ML also outperforms traditional systems in terms of capabilities and expansion potential. Among the existing ML methodologies, the artificial neural network (ANN) technology is the most widely used in biodiesel research. ANN has acquired appeal in dealing with difficult nonlinear real-world engineering and scientific challenges. Neural network models have been demonstrated to be effective in making such predictions in a few studies. The development of more capable neural network models for more accurate results is still under investigation. This review examines several machine learning (ML) approaches, with a focus on ANN, to forecast the engine characteristics of IC engines running on alternative fuels.*

Key Words: Biodiesel, Optimization, Machine Learning, Artificial Neural Network, Prediction.

1. INTRODUCTION

More than 80% of worldwide energy needs are as of now met by petroleum derivatives like petrol, coal, and flammable gas demonstrating human society's overwhelming reliance on these finite non-renewable energy supplies. Until this point in time, the IC engine has demonstrated to be quite possibly the most proficient power generating machine. However, the company's major issue is that excessive NOx emissions and particulate matter creation have hampered its market expansion. In light of the nonlinearity and intricacy of the combustion system assessing engine attributes are testing and tedious. Engine Characteristics Prediction plays a critical role in efficiently managing projects in terms of more precise estimating, pursuing and monitoring , Artificial Neural Networks are perhaps the most widely recognized approach for foreseeing engine qualities. Artificial Neural Networks, Fuzzy Logic, and Statistical Procedures (including multivariate analysis, etc) are some of the methodologies commonly used to forecast Engine Characteristics. The artificial neural network (ANN) technique, which has origins in mathematics and neuroscience, may be a viable choice for dealing with nonlinearities and complications. ANN is an information-processing system that is designed to perform activities such as learning, remembering, choosing, and inferring without the use of external aid, all of which are elements of the human brain. The structure of a basic ANN is three layered. Artificial Neural Cells are made up of inputs, weights, activation functions, and results. A neural network can be trained to do a given task by altering the weights between nodes. Inputs, weights, assuming function, an activation function, and results make up the least complex fake synapses.

2. REVIEW OF ANN MODEL AS A PREDICTIVE TOOL

Esonye Chizoo et al.(2019) Modeled ANN to expect and model engine behavior and do so using feed-forward ANN and Nelder-Mead's Simplex Technique, the fuel used was biodiesel seed oil petrodiesel that was tested on a diesel engine with different loading conditions. PCA2 Qs1007 type gas analyzer from Bacharach was used to record smoke content on time. Nelder-Mead (NM) method simplex and various Levenberg-Marquardt statistical information many results the artificial brain network was used to upgrade MLP output ,a network with backpropagation was used indirectly do alignment between information and outcome factors. With correlation values ranging from 0.90 to 0.99, ANN created and NM models have shown narrower and larger differences in the expected accuracy. Without nitrogen oxides, other responses is shown to be surprisingly low central deviation (AAD), root means square error (RMSE), and standard predictive error (SEP). Using NM close answers were posted [1]. Created models that bring out the best results that can be used see engine performance and extraction.

M. Ghanbariet et al.(2017) tried to show the Operating and discharge characteristics of the CI engine using nanoparticles to add substances to biodiesel-diesel mixtures by the Genetic Programming(GP) method [2]. At the beginning of the show and outflows of a diesel engine running on a mixture of nano-diesel-biodiesel fuel were considered. Mixing nanoparticles to diesel and biodiesel fillers have been improved Qualifications for diesel engine performance, for example, brake power and torque release, and brake specific fuel consumption (bsfc) compared to net fuel, as shown in test results. In comparison to pure diesel fuel, CO2 emissions expanded by 17.03 percent limit, but CO comes from biodiesel- the concentration of diesel and nanoparticles was very low. UHC output decreased by 28.56 percent in silver

and mixed charge of diesel-biodiesel, however, increased by 14.21 percent with fuels containing CNT nanoparticles. Like nanoparticles added to the mixed filling, NOx levels are extended compared to net fuel [2]. Genetic system(GP) - A similarly based model presented in this study in find presentation and outgoing CI parameters motor depending on nano-fuels and engine speed. Collecting training and testing knowledge, trial research was tried. The best models are selected by the root mean square root (RMSE) and the coefficient of mathematical determination method (R2). The GP model was showed that you have the option to see the engine performance and exit requirements in accordance coefficient (R2) of 0.93-1, and RMSE of approximately 0.1 [2]. Results have shown that the GP model is a dynamic tool for foresight performance and carbon emissions CI engine.

Mehmet Tekin & Suat Saridemir(2017) made a model that uses ANN to anticipate engine display as well as emits smoke with varying degrees of ethanol gas mixes. The test was completed using the Honda GX 390 a single-cylinder oil engine, four-stroke, and flash start (SI). A DC dynamometer was used to control 11 Engine speed ranges from 1250 to 3750 rpm stages 250 rpm. Three different oils (E0, E10, E20, E30, and E40) were tested on all vehicle values. Non-leaded fuel (E0), ethanol gas mixes E10, E20, E30, and E40 are used [3]. The numbers behind the E address are standard for the absolute volumetric ratio of ethanol. Ethanol the average purity (Merck) was 99.5 percent. Emissions from exhaust like Carbon monoxide and carbon dioxide , consumption of fuel and engine torque was limited during the test. It was not information taken up to catch torque and speed less than 1% flexibility. All through preliminary all in all, the excess air (lambda) was kept as close to the stoichiometric section as possible. The study even explored the use of an ANN indicating engine anticipation power, torque, and power output from the SI engine operates on demand for a combination of petroleum and methanol. Normal backpropagation was found to be correct the best optimizer for ANN model preparation. From then point forward, the ANN show has not yet fully launched stone for expected comparisons with trial findings. The input layer covers the type of fuel as well engine speed, while the output layer includes torque, power, exhaust output, Tex, and BSFC, ANN model it was considered an equipped engine performance, exhaust, Tex, and BSFC.

S. Raghuvaran et al.(2020) Post Actions Neural Network model to test performance once and for all exhaust C.I diesel fuel engine containing palm biodiesel oil. Methyl ester of palm oil was used to create a biodiesel and combinations were tested in a single cylinder, four strokes, cool water CI diesel engine. QROTECH QRO-402 for gas type A discharge analyzer was used to measure its discharge smoke gases. The investigation even explored its effect under different loading condition , the test engine was allowed to run regularly until then The fuel in the previous investigation was completely eaten before starting a new experiment. Variations amoung attributes were studied [4] . Increasing the amount of biodiesel in base fuel diesel slightly affected CO emissions from the lower and middle engine loads, unaffected by the extra pre-mixed air dependence burning. Because of the high oxygen content in biodiesel complete combustion was achieved. fire temperature, the oxygen concentration in fuel, and time key factors contributing to NOx emissions. Compared to conventional diesel fuel, NOx emanations are reduced to mix PB10, PB20, and PB40, Due to more prominent flammable temperature and presence of oxygen at biodiesel concentrations, NOx emissions were a very high part of the load compared to pure diesel. As of preparation, 80% of test information was selected aimlessly, and the excess 20% was used for anticipation and approval. R2 high for NOx, CO, and HC from The ANN release model were 0.9883, 0.9989, and 0.999, separately. The optimization function used to judge the accuracy of the model was MSE(Mean Squared error), in result the MSE came out to be 0.0004.

Syed Javed et al.(2015) The information from a driving test for a conventional diesel engine used diesel/biodiesel as an essential fuel and hydrogen in double oil mode passed down for different adjustments ANN models in this study. Load, biodiesel blend level, and the level of hydrogen flow applied to the input layer. Working with exhaust and performance parameters was the output horizontal attribute. By separating neurons from hidden cells, the ANN model was prepared for separate training strategies and combinations of transfer work like effect. Logarithmic sigmoid and hyperbolic tangent Levenberg-Marquardt sigmoid transmission function detected excellent reciprocity recognition [5]. The Output of ANN was very close to test result.

Ayat Gharehghani et al.(2019) Experiments have tried this function of determining the attraction of using diesel, biodiesel, water, and cerium oxide nanoparticles as fuel for the delivery of low yield toxins. The disadvantages of NOx rise exit these findings have confirmed that biodiesel will continue to improve fire energy while nanoparticles form reduce HC and CO emissions. A border is made to determine engine performance in the PEDE diesel engine performance test. Sensitivity analysis was used to determine the PEDE model [6]. The result clearly displayed that the draft function best when biodiesel contain equal amount of fuel and water, each being 6%.Amount of CeO2 is 80ppm. To reduce output extraction, water and biodiesel playoffs have been a significant impact on this study.

Mustafa canacki et al.(2006) Rather than boring experimental testing, the use of ANN forecasts engine performance and output was deeply recommended for this study. Performance and finishing diesel engine smoke running on biodiesel as well petroleum diesel were tested [7]. The results are exhaust emissions, although the feature of the input layer were the same and corresponds to each fuel.

Erdi Tosunet al.(2016) In this study, two different modeling methods were used for measurement performance and exhaust information obtained from a diesel engine: Line degradation and ANN modeling. Reading the algorithm was a Levenberg-Marquardt algorithm. Compared to the effects of linear regression, ANN the display method provided the most accurate results models are expected [8]. The best connection for information was obtained from both LR and ANN. Models can be improved by providing new data. ANN models can be used to detect the operation and output of a diesel engine with different power.

Suman Dey et al.(2020) For one four-stroke diesel engine, the ANN model was used for anticipation of motor performance and finishing features of diesel palm a biodiesel-ethanol compound. There were four outputs to network structures BSEC, NOx, UHC, and CO2 [9]. Usually accuracy, small error, and high coefficient of interaction prices have provided an accurate predictor of exhaustion knowledge and performance of vehicles. An incomprehensible strategy converted to a very significant reduction in output compared to different mixtures. Direct interest palm biodiesel and ethanol in biodiesel-palm diesel-The ethanol mixture was shown using energy calculation methods.

B.Ghobadian et al.(2009) Information collected from a four-stroke diesel engine used for cooking waste Biodiesel fuel was used to create and prepare for ANN in this study. Back-to-back training method has expressed satisfaction with seeing engine torque, the use of certain fuels, as well as parts of the exhaust gas different engine speeds, and fuel mixing rates [10]. ANN has been shown to be a useful predictor in light of the fact that information is expected and limited especially related. The ANN model provides accuracy and integrity.

C.N.Ude et al.(2020) In this study, the effectiveness of the cottonseed oil methyl esters produced by CaO was tested, and predictions were made using the material neural network. The engine was tested using diesel, biodiesel, and their compounds. When 20% are refined cottonseed oil methyl easter added, heat efficiency and power increase by 3.7 and 1.1 percent, respectively, and carbon emissions are reduced [11]. With strong brakes, BSFC, and BTE for various engine speeds and percentages of fuel combinations, the correlation coefficient in the ANN model was very good near 1. ANN has proven to be an effective guessing tool thanks to the engine.

P Rishikesh Menon et al.(2018) A mathematical model is created in this study to link engine parameters with biodiesel content and to propose an optimal biodiesel composition for improved fuel efficiency. The data from a naturally aspirated engine and a heavy-duty turbocharged diesel engine running on various biodiesels is used to create an ANN model. As inputs were tested and found to be satisfactory, the resulting model's firmness was within the training range [12]. The appropriate biodiesel mix was determined using an ANN and a genetic algorithm to limit nitrogen oxide emissions. BSFC and NOx levels were also lowered.

Vinay Kumar. D et al. (2013) With the inclusion criteria of Engine load, fuel components, and coating type as well as the output properties of BSFC, BTE, CO, HC, and NOx diesel engine output, ANN having a three layered structure (one input layer, single dense layer, and a final output layer) was formed [13]. ANN model results from backpropagation used in these subjects were highly correlated with those found for example, with a common error associated with less than 6.8%.

Mir Majid Etghani et al.(2013) For the best biodiesel mixes and diesel engine speed, the performance of a multi-purpose neural network model was improved. The components of the input layer combined the percentage with engine speed, while in the output layer the components were Energy, BSFC, PM, NOx, CO, and CO2 [14]. TOPSIS has been used to improve the model created for six different objectives (Preferences Planning Strategy as the Best Solution)

S.V. Channapattana et al. (2016) Made an ANN model to anticipate Engine conduct with an average relative error of under 1.91 percent utilizing streamlined engine attributes acquired from a weighted multi objective optimization of four distinct attributes of a GA (Genetic Algorithm) where the fitness function was a regression model and the performance attributes considered as reactions (dependent factors) were BSEC, EGT, and BTE.CO, CO2, NOx, HC, and smoke obscurity were the exhaust constituents examined as reactions [15].

3. CONCLUSION

Engine characteristics are influenced by changes in engine speed and power over time, as well as fuel type. When it comes to contending for projects, the ability to predict these characteristics can be of greater use to researchers and companies striving to reduce engine emissions and improve performance. Research suggests that Artificial Neural Network is an effective non-model modeling tool for the line relationships that occur between variables under consideration, among the various methods available that serve as predictive tools. The creation of such a system will undoubtedly benefit in the timely and cost-effective completion of projects. It may also entice investors to invest in the automobile industry, which will eventually lead to increased profits.

REFERENCES

[1] Esonye C, Onukwuli OD, Ofoefule AU, Ogah EO. Multi-input multi-output (MIMO) ANN and Nelder-Mead's simplex based modeling of engine performance and combustion emission characteristics of biodiesel-diesel blend in CI diesel engine. *Appl Therm Eng* 2019; 151:100–14.

[2] Ghanbari M, Najafi G, Ghobadian B, Yusaf T, Carlucci AP, Kiani MKD. Performance and emission characteristics of a CI engine using nano particles additives in biodiesel-diesel blends and modeling with GP approach. *Fuel* 2017; 202:699–716.

[3] Mehmet Tekin & Suat Saridemir (2017): Prediction of engine performance and exhaust emissions with different proportions of ethanol-gasoline blends using artificial neural networks, International Journal of Ambient Energy, DOI:10.1080/01430750.2017.1410225

[4] Raghuvaran S, Ashok B, Veluchamy B, Ganesh N. Evaluation of performance and exhaust emission of CI diesel engine fuel with palm oil biodiesel using an artificial neural network. *Mater Today Proc* 2020. doi:10.1016/j.matpr.2020.06.344

[5] Javed S, Murthy YVVS, Baig RU, Rao DP. Development of ANN model for prediction of performance and emission characteristics of hydrogen dual fueled diesel engine with jatropha methyl ester biodiesel blends. *J Nat Gas Sci Eng* 2015; 26:549–57.

[6] Gharehghani A, Pourrahmani H. Performance evaluation of diesel engines (PEDE) for a diesel-biodiesel fueled CI engine using nano-particles additive. *Energy Convers Manag* 2019; 198:111921.

[7] Canakci M, Erdil A, Arcaklioglu ˘ E. Performance and exhaust emissions of a biodiesel engine. *Appl Energy* 2006;83:594–605

[8] Tosun E, Aydin K, Bilgili M. Comparison of linear regression and artificial neural network model of a diesel engine fueled with biodiesel-alcohol mixtures. *Alexandria Eng J* 2016; 55:3081–9.

[9] Dey S, Reang NM, Majumder A, Deb M, Das PK. A hybrid ANN-Fuzzy approach for optimization of engine operating parameters of a CI engine fueled with diesel-palm biodiesel-ethanol blend. *Energy* 2020; 202:117813.

[10] Ghobadian B, Rahimi H, Nikbakht AM, Najafi G, Yusaf TF. Diesel engine performance and exhaust emission analysis using waste cooking biodiesel fuel with an artificial neural network. *Renew Energy* 2009; 34:976–82.

[11] Ude CN, Onukwuli OD, Nwobi–Okoye C, Anisiji OE, Atuanya CU, Menkiti MC. Performance evaluation of cottonseed oil methyl esters produced using CaO and prediction with an artificial neural network. *Biofuels* 2020; 11:77–84.

[12] Menon PR, Krishnasamy A. A composition-based model to predict and optimize biodiesel-fuelled engine characteristics using artificial neural networks and genetic algorithms. *Energy Fuels* 2018;32:11607–18

[13] Kumar DV, Kumar PR, Kumari MS. Prediction of performance and emissions of a biodiesel fueled lanthanum zirconate coated direct injection diesel engine using artificial neural networks. *Procedia Eng* 2013; 64:993–1002.

[14] Etghani MM, Shojaeefard MH, Khalkhali A, Akbari M. A hybrid method of modified NSGA-II and TOPSIS to optimize performance and emissions of a diesel engine using biodiesel. *Appl Therm Eng* 2013; 59:309–15.

[15] Channapattana S V, Pawar AA, Kamble PG. Optimisation of operating parameters of DI-CI engine fueled with second generation Bio-fuel and development of ANN based prediction model. *Appl Energy* 2017; 187:84–95.