ISSN 2347 - 3983
Volume 8. No. 8, August 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter13882020.pdf
https://doi.org/10.30534/ijeter/2020/13882020

Analysis of Performance Using IDE Frame Work

Dr.M.Vijayakumar[1], N.Prasanna[2], M.Kishanth[3]
[1]Assitant Professor, M.Kumarasamy College of Engineering, India, vijithermal@gmail.com
[2] Assistant Professor, Kongu Engineering College, India, bemethermal@gmail.com
[3] Research Fellow, MENEC, Thanjur, India, kishanthmurali@gmail.com

ABSTRACT

The present work shows that the analysis of performance using an Integrated development environment framework. The recent world moves towards digitalization for every activity in daily life as well as research. This work shows digitalize internal combustion engine performance and emission analysis by using the visual basic tools. The experimental work carried out using lemongrass biodiesel and diesel with 1-propanol fumigation. The engine operated at six different loads and three different fumigation fuel injection timings. The results were noted and mathematical model generated based on the experimental results, from the mathematical model the simulation tool can generated by using the visual basic tools. In tool consists of two performance parameters and six exhaust gas ranges can predict by using this simulation tool. Finally, the tool value compared with the experimental data the deviation of 1.8% to -0.8% were found.

Key words : internal combustion engine, Mathematical model, fumigation, polynomial equation, visual basic

1. INTRODUCTION

Internal combustion (IC) engine is a one of the most essential devices in road transport. The development of IC engine performance and emission is more important to the nation and environment[1-3]. Internal combustion engine research consists of three two important categories are performance and emission[4,5]. Normally, brake thermal efficiency, and specific fuel consumption are considered for engine performance and unburned hydrocarbon, carbon monoxide, carbon dioxide, nitrous oxide, and smoke are noticeable exhaust gas pollution[6-8]. Most of the engine research concentrates only on these two performance parameters and six emissions. Two parameters such as Load and amount of fuel supply act as a major role for engine performance and emission. Therefore engine research consider for the different load and different fuel supply system, it causes to increase the human effort, cost, time, reduce the accuracy [9]. The mathematical model is one of the smart ways to predict the optimum combination of parameters which is produced a higher performance and lower emission and sets the optimum parameter combination for result comparison [10, 11]. During the mathematical model, preparation is challenging and the prediction of optimum values also complicates [12,13]. Complicate numerical model values execute through the Visual Basic software is one of the easiest ways to predict the optimum solution [14]. Moanes and sameer reported that the solar power system by using visual basic. The software offers a user-pleasant Graphic Interface to magnitude the scheme system according to the load necessities and site-specification. The outcome of the design for the case reading is quite in agreement with the analytical method, thus authorized the accuracy and precision of the tool [15]. Ashokumar et al mentioned that the tractor power and energy mapping. The software usage is user friendly and more efficient in predicting. This might help the researchers and engineers for the power and energy calculation of new tractor and implement models [16-18]. NaveenKumar and Pandey narrated that the calculated most favorable gear and throttle point for the most excellent fuel economy for 32 kW tractor [19].

2. EXPERIMENTAL STUDY

Single-cylinder single-acting water-cooled diesel engine used as test engine. The internal combustion engine can evaluate two categories such as performance and emission. During the engine test, so many parameters consider but all the performance parameter used to calculate brake thermal efficiency and nitrous oxide is a major pollutant in the diesel engine. Therefore, brake thermal efficiency figure.1 and nitrous oxide figure.2 only consider in an experimental study.

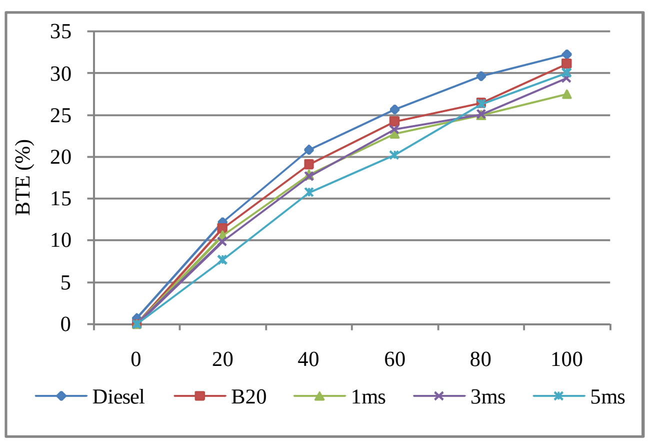

Figure 1: Brake Thermal Efficiency

In this engine, the research consists of six different loads, and five different fuel combinations were considered. Each fuel combination can investigate each and every load condition. As per the experimental results, the fumigation fuel can increase the engine performance (figure1) at the same time it reduces the NO formation (figure 2). These values consider as a base value to compare the numerical simulation values.

3. MATHEMATICAL MODEL

Today the engineers may have numerous reasons to calculate the numerical equation but the most important reason is (i) To afford the system simulation, (ii) To develop the optimization model and (iii) minimize the time and cost. In general, sensible optimization and simulation have been done with the assistance of a computer. In this study, the numerical model was derived to simulate engine performance and emission characteristics.

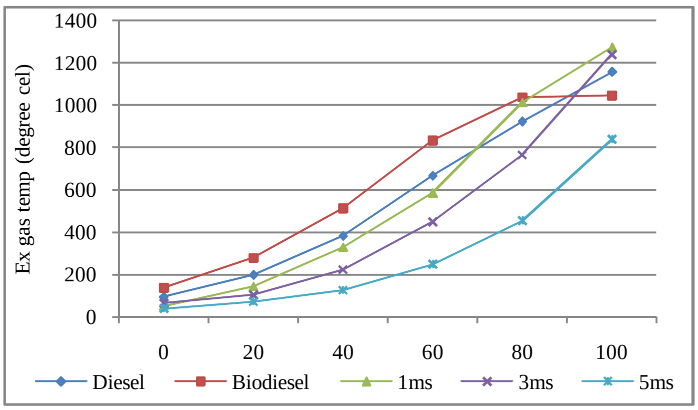

Figure 2: Engine Exhaust Nitrous Oxide

3.1. Polynomial Representations

Polynomial representation is the majority noticeable and more influential tool in a numerical simulation model. If Y is a representation of the function x, the basic polynomial form is,

$$Y = a_0 + a_1 x + a_2 x^2 + ... + a_n x^n \quad (3.1)$$

where, a_0, a_1, a_2 and a_n are the constant values, The degree of the equation is the peak exponent of *x* is n. Equation (3.1) is appropriate for only one variable in terms of another. If more than one variable unknowns like a_0, a_1 and a_2 solved by liner Equation (3.2).

$$Y = a_0 + a_1 x + a_2 x^2 \quad (3.2)$$

The matrix form of Equation (3.2) is shown in Equation (3.3)

$$\begin{vmatrix} 1 & x_0 & x_0^2 \\ 1 & x_1 & x_1^2 \\ 1 & x_2 & x_2^2 \end{vmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \end{bmatrix} = \begin{bmatrix} Y_0 \\ Y_1 \\ Y_2 \end{bmatrix} \quad (3.3)$$

3.2. Second Order Polynomial Equation

In the Second degree used three data points, it considers xy variable for the three known points able be substituted into the general form for the quadratic equation which is shown in figure 3 Stoecker (2011) [9]. In this work (Simulation) the brake thermal efficiency depends on two autonomous variables, such as load and mass of fuel injection in the fumigation system. If a polynomial expression for the brake thermal efficiency is required in terms of a second-order degree equation in L (load) and f (mass of injection in fumigation). The subsequent polynomial equation may be formed for BTE of 1-propanol electronic mode fumigation (three different injection quantity) at different load conditions. Three different points on 1ms fumigation would provide the constants in the Equation (3.4).

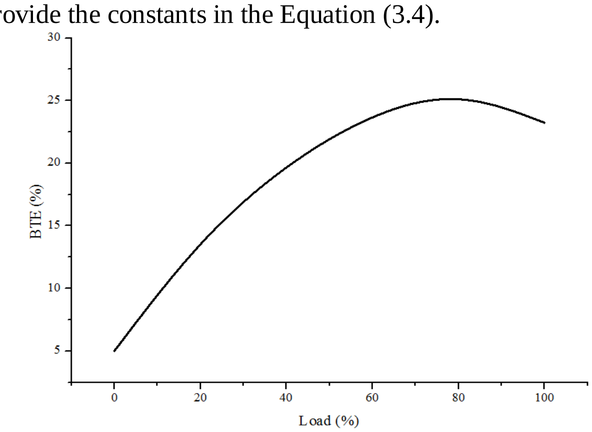

Figure 3: Quadratic equations Stoecker (2011) [9]

$$BTE_1 = a_1 + b_1 f + c_1 f^2 \quad (3.4)$$

Similarly the Equations 6.5and 6.6 for the 3ms and 5ms fumigation quantities are

$$BTE_2 = a_2 + b_2 f + c_2 f^2 \quad (3.5)$$

$$BTE_3 = a_3 + b_3 f + c_3 f^2 \quad (3.6)$$

For that reason, the constants can be expressed as a second-degree equation in terms of Load L, using the three data points (a_1, 1ms), (a_2, 3ms), (a_3, 5ms). Such an equation would have the form (Equations 5.7, 5.8 & 5.9)

$$a = A_1 + A_2 L + A_3 L^2 \tag{3.7}$$

$$b = B_1 + B_2 L + B_3 L^2 \tag{3.8}$$

$$c = C_1 + C_2 L + C_3 L^2 \tag{3.9}$$

Finally, the constants value of Equations 7, 8 and 9 were substituted put into the primary Equation 3.10.

$$\left[BTE = \{A_1 + A_2 L + A_3 L^2\} + \{[B_1 + B_2 L + B_3 L^2]*f\} + \{[C_1 + C_2 L + C_3 L^2]*f^2\} \right] \tag{3.10}$$

where, A_1, A2, A3, B1, B2, B3, C1, C2, and C3 are constant values for 1-propanol. Similar way the equation formed for SFC, HC, NO, CO, CO_2, Smoke and O_2. The derived equation of BTE, BSFC, HC, NO, CO, CO_2, smoke and O_2 are Equations 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17 and 3.18 respectively.

$$BTE = \{4.45 + (0.45*L) + (-2.37E-03*L^2)\} + \{[-16.45 + (0.681*L) + (-2.73*L^2)]*f\} + \{[13.55 + (-0.82*L) + (5.09E-3*L^2)]*f^2\} \tag{3.11}$$

$$BSFC = \{0.94 + (-1.4E-2*L) + (8.4E-5*L^2)\} + \{[1.10 + (-2.9E2*L) + (1.6E-4*L^2)]*f\} + \{[6.9E-2 + (4.4E-3*L) + (-3.2E-5*L^2)]*f^2\} \tag{3.12}$$

$$HC = \{-48.5 + (4.91*L) + (-0.03*L^2)\} + \{[2571 + (-65.3*L) + (0.37*L^2)]*f\} + \{[1132 + (19.7*L) + (-0.23*L^2)]*f^2\} \tag{3.13}$$

$$NO = \{-107 + (15.9*L) + (-2.8*L^2)\} + \{[975 + (-86.6*L) + (0.85*L^2)]*f\} + \{[-944 + (83.3*L) + (-0.97*L^2)]*f^2\} \tag{3.14}$$

$$CO = \{0.11 + (-1.9E-3*L) + (1.6E-5*L^2)\} + \{[1.91 + (-2.1E-2*L) + (5.3E-5*L^2)]*f\} + \{[2.27 + (4.5E-2*L) + (-2.5E-4*L^2)]*f^2\} \tag{3.15}$$

$$CO_2 = \{2.5 + (5.1E-2*L) + (3.3E-5*L^2)\} + \{[-0.69 + (-0.09*L) + (8E-4*L^2)]*f\} + \{[0.12 + (0.14*L) + (-1.3E-3*L^2)]*f^2\} \tag{3.16}$$

$$Smoke = \{97 + (-0.62*L) + (4.9E-3*L^2)\} + \{[-2.81 + (-0.09*L) + (-0.03*L^2)]*f\} + \{[363 + (-10*L) + (6.9E-2*L^2)]*f^2\} \tag{3.17}$$

$$O_2 = \{17.3 + (-6.6E-2*L) + (-6.5E-5*L^2)\} + \{[0.62 + (-9.96E-2*L) + (-6.13E-4*L^2)]*f\} + \{[-0.13 + (-10*L) + (1.04E-3*L^2)]*f^2\} \tag{3.18}$$

4. IDE FRAME WORK

The numerical model produced many basic formulas and a lot of constant values. Therefore, manual execution is not possible to predict the exact values. The generated the numerical formulas and execute them through the IDE framework. Equations 3.11 to 3.18 are the basic equations which were derived from the second-order polynomial equation and utilized for numerical simulation. These equations were executed through the visual basic 6.0 computer software. The visual basic form created for individual fuel and respective equations makes coding in the particular form. The sample coding of visual basic 6.0 shows in Equation (3.19). Text1 and text2 is an input of text 3 output. Text 1 is a load and text 2 is a fumigation mass flow rate. The visual basic computer tool created with the respective equation to simulate the engine performance and emission parameters. The visual basic execution page for the different load (20, 60, and 100% load) with 0.3kg/s mass flow is shown in figures 4, 5, and 6 for the execution of 1-propanol.

$$\begin{aligned} Text3.Text = {} & (4.45 + (0.45*(Val(Text1.Text)) + (-2.3E-3*Val(Text1.Text) \\ & *Val(Text1.Text)))) + ((-16.4 + (0.68*(Val(Text1.Text)) + (-2.73E-3*Val(Text1.Text) \\ & *Val(Text1.Text))*Val(Text2.Text)) + (13.5 + (-0.82*Val(Text1.Text)) + \\ & (5.09E-3*Val(TextText)*Val(Text1.Text))*Val(Text2.Text)*Val(Text2.Text))) \end{aligned} \tag{3.19}$$

This IDE frame work execute to produce two performance parameters and six exhaust emission parameters in single time input. The autonomous variable were consider as input for the execution system.

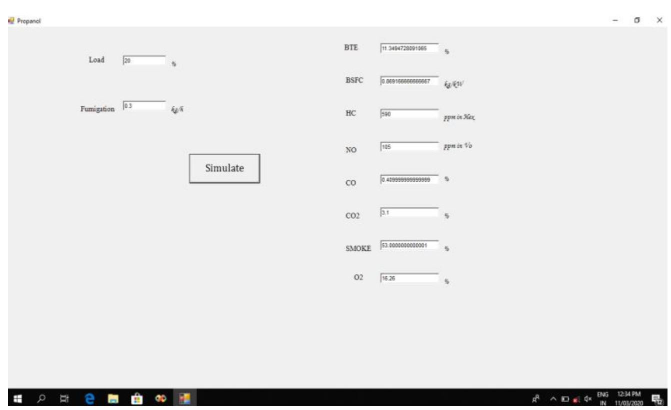

Figure 4: Visual Basic Simulation page for 20% load and 0.3kg/s mass

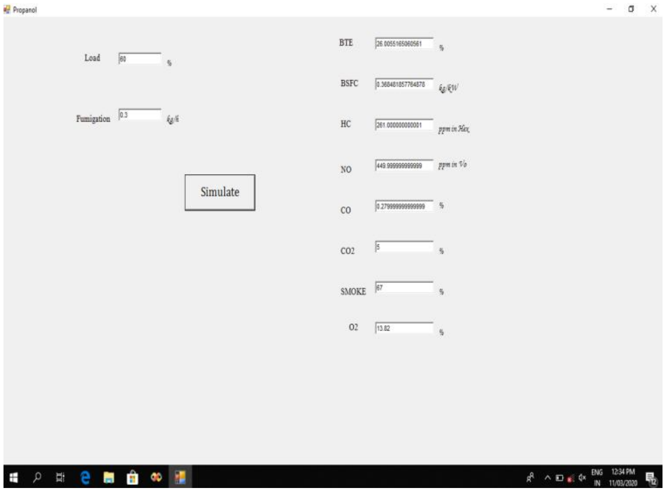

Figure 5: Visual Basic Simulation page for 60% load and 0.3kg/s mass

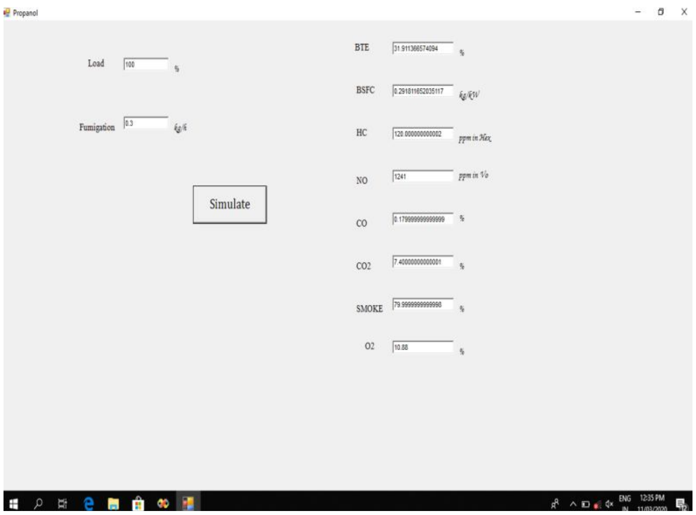

Figure 6: Visual Basic Simulation page for 100% load and 0.3kg/s mass

.

5. RESULTS

Important performance parameter brake thermal efficiency and nitrous oxide and smokes are major pollutants diesel engines consider for results and discussion. Figures 7 depict the comparative analysis of experimental results with the mathematical results with respect to the load. It is evidently seen from figure 7 that the experimental results and the mathematical results hold a close agreement with the divergence in the range of -1% to 2.2%. This divergence might be due to the investigational error including equipment error and the environmental impact during testing.

Figure 8 depicts the comparative analysis of experimental results with that of the theoretical results of 1-propanol nitrous oxide with respect to load. It is clearly seen from figures 8 that the experimental results and the theoretical results hold a very close agreement with the deviation in the range of 0.5% to -1.1%. This deviation might be due to the experimental error including instrument error and the environmental impact during testing.

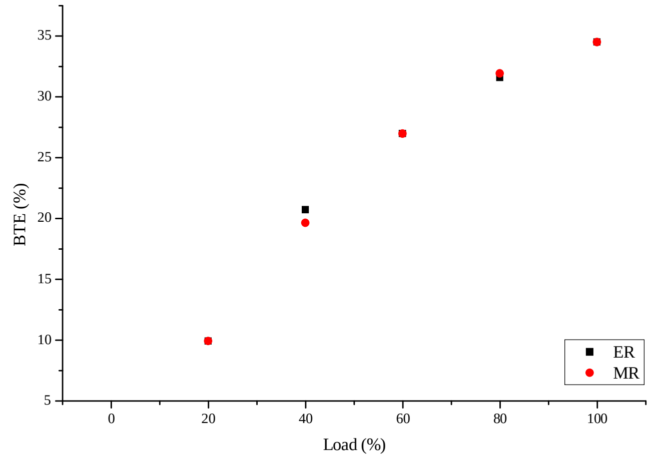

Figure 7: Comparison of mathematical results with the experimental results of 1-Propanol smoke.

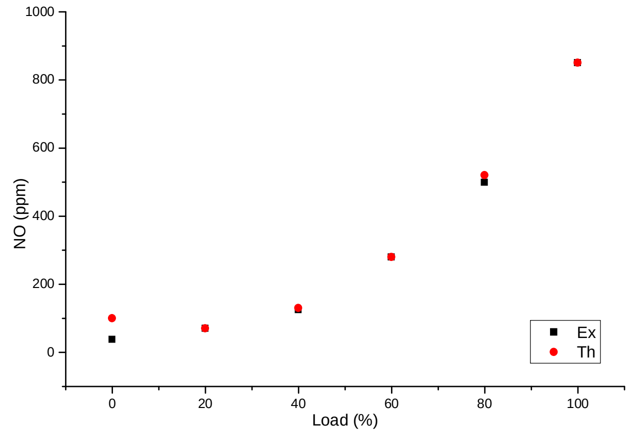

Figure 8: Comparison of mathematical results with the experimental results of 1-Propanol smoke.

Figure 8 depicts the comparative analysis of experimental results with that of the theoretical results of 1-propanol smoke with respect to load. It is clearly seen from figure 9 that the experimental results and the theoretical results hold a very close agreement with the deviation in the range of 1.8% to -0.8%. This deviation might be due to the experimental error including instrument error and the environmental impact during testing.

.

6. CONCLUSION

In this present work, analysis of performance using IDE framework more effective to predict the performance and emission values. The following conclusions can be drawn from the present work,

- Easy to predict the engine performance for different load and different fuel injection
- Easy to find out the optimum value of the engine and easy to compare with other values

- Single page display entire engine exhaust emission with respect load and mass of the fuel, it is very easy to identify the which point initiate the maximum emission.

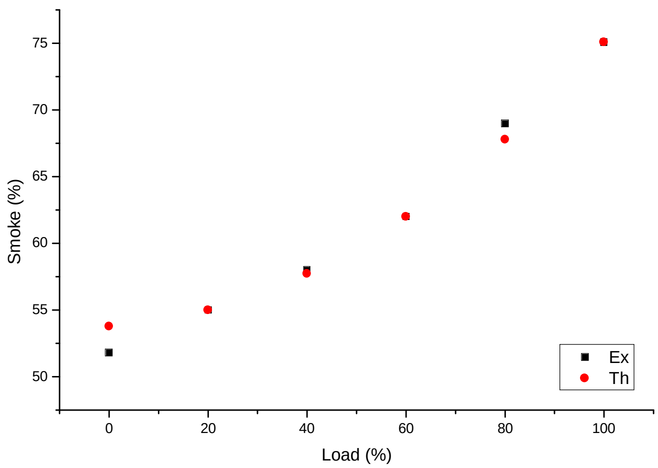

Figure 9: Comparison of mathematical results with the experimental results of 1-Propanol smoke.

- This tool easy to find out the manual error and instruments error because of the actual values deviation rightly pointed out the errors
- Finally this software save the human time and money

In this work provide evidence that IDE works more efficient to produce the performance and emission values with load and different fuel injection condition. This results shows that further research required on combustion parameters to predict with a square equation or some other methods.

REFERENCES

1. M.M Rashed, M.A Kalam, H.H Masjuki, M.Mofijur, M.G Rasul, N.W.M Zulkifli. **Performance and emission characteristics of a diesel engine fueled with palm, jatropha, and moringa oil methyl ester**, *Ind Crops Prod*, Vol. 79, pp. 70–6, 2016.
2. H.K Rashedul, H.H Masjuki, M.A Kalam, A.M Ashraful. **Performance and emission of a CI engine using antioxidant treated biodiesel,** *J Clean Energy Technol*, vol. 5, pp. 6–10, 2017. https://doi.org/10.18178/JOCET.2017.5.1.335
3. K.K. Radha, S.N. Sarada, K. Rajagopal, E.L. Nagesh. **Performance and emission characteristics of C.I. engine operated on vegetable oils as alternative fuels,** *International Journal of Automotive and Mechanical Engineering*, Vol. 4, pp. 414-427, 2011.
4. Othman, MF, Adam, A, Najafi, G, Mamat, R. **Green fuel as alternative fuel for diesel engine: a review'**, *Renew Sustain Energy Rev*, vol. 80, pp. 694–709, 2017. https://doi.org/10.1016/j.rser.2017.05.140
5. López, I, Pinzi, S, Leiva-candia, D, Dorado, P 2015, '**Multiple response optimizations to reduce exhaust emissions and fuel consumption of a diesel engine fuelled with olive pomace oil methyl ester/diesel fuel blends'**, *Energy*, pp. 1–7, 2015.
6. Wan Nor Maawa, WG, Rizalman, M, Masjuki, HH & Najafi, G, **Effects of biodiesel from different feedstocks on engine performance and emissions: a review',** *Renew Sustain Energy Rev*, vol. 51, pp. 585–602, 2015.
7. Verma, P, Sharma, MP & Dwivedi, G. **Evaluation and enhancement of cold flow properties of palm oil and its biodiesel',** *Energy* Rep, vol. 2, pp. 8–13, 2016.
8. Tan, KT, Gui, MM, Lee, KT & Mohammed, AR. **An optimized study of methanol and ethanol in supercritical alcohol technology for biodiesel production',** *The Journal of Supercritical Fluids*, vol. 53, no. 1-3, pp. 82-87, 2010. https://doi.org/10.1016/j.supflu.2009.12.017
9. Stoecker, WF. **Design of thermal systems, BOOK.** McGraw Hill Book Company, 2011.
10. Beraud, G. **Mathematical models and vaccination strategies.** *Vaccine*, vol. 36, no. 36, pp. 5366-5372, 2011.
11. Vasan, A, Mercy, Gopalakrishnan, V, Prasanna, N & Vivekanandan, M. **Predicting Tool for Cyclone Separator with Simple Mathematical Model using RSM',** *Asian Journal of Research in Social Sciences and Humanities*, vol. 6, no. 10, pp, 601., 2016.
12. Kumar, PCM, Vijayakumar, M & Prasanna, N. **'Mathematical Investigation on Emission of Bio-Diesel in Internal Combustion Engine',** *International Journal for Scientific Research & Development*, vol. 3, no. 10, pp. 274-277, 2015.
13. Satishchandra Salam and Tikendra Nath Verma, **Analysis of significance of variables in IC engine operation: an empirical methodology'**, *Energy Conversion and Management*, Volume 207, 1 March 2020. https://doi.org/10.1016/j.enconman.2020.112520
14. Mahendra P.Verma. **Steam tables for pure water as an ActiveX component in Visual Basic 6.0**, *Computers & Geosciences*, Volume 29, Issue 9, p.p 1155-1163, 2003.
15. Mohammed Moanes and AliSameer K. Salih. **A Visual Basic-Based Tool for Design of Stand-alone Solar Power Systems ,** *Energy Procedia*, volume 36 1255 – 1264, 2013. https://doi.org/10.1016/j.egypro.2013.07.142
16. C.Balakrishnan, RM.Vidhyavathi, K.Kavitha, J.Joseph Sahayarayan, S.Santhosh Kumar. **Mathematical Model-Based Speech Signals Processing Effects on Human Stress**, *International Journal of Emerging Trends in Engineering Research*, Vol 8,no 2, pp 361-364 Feb 2020. https://doi.org/10.30534/ijeter/2020/20822020
17. Manish Bhandari. **Numerical Solutions for Transverse Loading on Plate made of Functionally Graded Material**, *International Journal of Emerging Trends in Engineering Research*, Vol 8,no 4, pp 969-974 Apr 2020. https://doi.org/10.30534/ijeter/2020/05842020

18. AshokKumar, V.K.Tewari, ChanchalGupta, NaveenKumar. **A visual basic program and instrumentation system for power and energy mapping of tractor implement', Engineering in Agriculture,** *Environment and Food,* Volume 10, Issue 2, p.p 121-132, 2017.
19. NaveenKumarK. And P.Pandey. **A visual basic program for predicting optimum gear and throttle position for best fuel economy for 32 kW tractor',** *Computers and Electronics in Agriculture,* Vol. 119, p.p 217-227, 2015.
https://doi.org/10.30534/ijeter/2020/05842020