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Investigating the engine vibration in MF285 tractor effected by different blends of biodiesel fuel using statistical methods and ANFIS

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Introduction

Vibrations include a wide range of engineering sciences and discuss from different aspects. One of the aspects is related to various types of engines vibrations, which are often used as power sources in agriculture. The created vibrations can cause lack of comfort and reduce effective work and have bad influence on the health and safety. One of the important parameters of the diesel engine that has the ability to create vibration and knocking is the type of fuel. In this study, the effects of different blends of biodiesel, bioethanol and diesel on the engine vibration were investigated. As a result, a blend of fuels such as synthetic fuel that creates less vibration engine can be identified and introduced.

Materials and Methods

In this study, canola oil and methanol alcohol with purity of 99.99% and the molar ratio of 6:1 and sodium hydroxide catalyst with 1% by weight of oil were used for biodiesel production. Reactor configurations include: maintaining the temperature at 50 ° C, the reaction time of 5 minutes and the intensity of mixing (8000 rpm), and pump flow, 0.83 liters per minute. A Massey Ferguson (MF) 285 tractor with single differential (2WD), built in 2012 at Tractor factory of Iran was used for the experiment. To measure the engine vibration signals, an oscillator with model of VM120 British MONITRAN was used. Vibration signals were measured at three levels of engine speed (2000, 1600, 1000 rpm) in three directions (X, Y, Z). The analysis performed by two methods in this study: statistical data analysis and data analysis using Adaptive neuro-fuzzy inference system (ANFIS).

Statistical analysis of data: a factorial experiment of 10×3 based on completely randomized design with three replications was used in each direction of X, Y and Z that conducted separately. Data were compiled and analyzed by SPSS 19 software. Ten levels of fuel were including of biodiesel (5, 15 and 25%) and bioethanol (2, 4 and 6%), and diesel fuel.

Data analysis by ANFIS: ANFIS is the combination of fuzzy systems and artificial neural network so that it has both benefits. This system is useful to solve the complex non-linear problems in agricultural engineering applications such as systems involved in the soil, plant and air. ANFIS by linguistic concepts can establish and inference non-linear relationship between inputs and outputs. In this research, modeling was generally performed by Toolbox of ANFIS and coding in MATLAB too. Five important and effective factors in modeling were optimized until the best ANFIS model is obtained. The five factors were: type of input fuzzy sets, the number of input fuzzy sets, fuzzy set of output, methods of optimization and the number of epochs.

Results and Discussion

Based on the total vibration acceleration values for different fuels in different rpm, pure diesel ($B_5E_4D_{91}$) had the highest vibration and the lowest vibration was seen in the mixed fuel of $B_{25}E_4D_{71}$. Based on the results, two combined fuel of (B25E2D73, B25E4D71) have the lowest vibration and highest amount of biodiesel fuel (25%). After them, three combined fuels of (B5E2D83, B5E4D81, and B5E6D79) have created more vibration and the lowest amount of biodiesel fuel in this study (5%) has created the greatest amount of vibration. With increasing engine speed, the number of combustion courses and piston shock per unit of time increases. As a result, the engine body vibration increases. The results are consistent with results from other researchers.

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Conclusions

In this study, motor vibration of MF285 tractors, by replacing a portion of diesel fuel with biodiesel produced from canola oil and bioethanol, was investigated. In the beginning, necessary biodiesel fuel was produced by research reactor in biodiesel workshop, and then different percentages of diesel and bio-ethanol were mixed to biodiesel and ten combined fuels were created. Finally the effect of different fuel combinations and different engine rotational speeds on the tractor engine vibrations was studied based on a factorial randomized complete block design and then analyzed and modeled by ANFIS. The results showed that the vibration of pure diesel fuel had the highest vibration. Also, with increasing biodiesel fuel blends, the amount of vibration reduced significantly. Increase in engine speed had direct effect on increasing the amount of vibration. Also by increasing the percent of bioethanol from 0 to 4%, the amount of vibration was reduced then vibration value increased by raising the percent of bioethanol. After modeling and analyzing, our results showed that the best fuel in terms of having the lowest vibration motor was $B_{25}E_4D_{71}$.

Keywords: Bio–ethanol, Bio–fuel, Diesel, Oscillato, Vibration