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Performance and Exhaust Emissions of a SI Two-stroke Engine with Biolubricants Using Artificial Neural Network

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Abstract

Biolubricants are a new generation of renewable and eco-friendly vegetable-based lubricants which have attracted a lot of attention in recent years. In this research study a back-propagation neural network model has been developed for predicting the effect of different types of biolubricants on the performance and exhaust emissions of a 200 cc two stroke engine. The inputs of the model are lubricant type, lambda and engine speed. Model outputs are: engine brake power, torque, BSFC (brake specific fuel consumption) and exhaust emissions which include CO, CO_2, UHC, O_2 and NO_x emissions. Engine's brake power, torque and brake specific fuel consumption, as well as exhaust emissions have been predicted with the Artificial Neural Network (ANN) model. The relationship between input parameters and engine performance and emissions are determined using the network. The application of ANNs are highly recommended to predict the IC engine parameters under investigation.

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Keywords: Artificial neural network; Biolubricant; Two-stroke engine; Engine oil; Engine performance; emissions.

1. Introduction

Two-stroke engines are an idea specific to simple light weight engines which have been mostly used in portable engines and motorcycles [1,2]. The mixing of fuels and lubricants is one of the main reasons for the increase of emissions of these engines [3]. The lubrication of two-stroke gasoline engines is always done with mixing the lubricant with gasoline in the proper ratio. Conventionally, the lubricant has been

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made up of petroleum based oils, additives of performance enhancers, and one solvent to improve the mixing of gasoline and lubricant [4]. Two major short comings of vegetable oils to be used as biolubricants are the high pour point and low oxidation stability, which are revisable through chemical modification [5]. Natural fatty acid oils such as castor oil, palm oil, rapeseed oil, soybean oil, sunflower oil, and tallow oil have been used in lubricants for years[6-8]. Castor oil has previously been used as a lubricant and can be replaced by petroleum-based lubricants because of the high pour point and low oxidation stability [9,10]. Palm oil is another vegetable oil which is used widely as biolubricants feedstock [11]. Among different methods such as Transesterification, hydrogenation, epoxidation, etc., transesterification with branched polyols like Trimethylolpropane (TMP) is one of the most common methods of chemical modification [12]. Sivasankaran (1988), produced mixtures of two-stroke engine oils based on the vegetable oil jojoba and examined the chemical and physical characteristics, fatigue, wear, and sediments at the engine [13]. Zhou and Ye (1998) tested two types of new two-stroke engine oils on gasoline burning scooters where oxygen additives and catalysts had been used [14]. Singh (2011) produced a 2T engine oil from castor plant oil through epoxidation and found that this engine oil reduces more than 50 percent of smoke compared to petroleum-based two-stroke engine oils [15]. ANNs are good for tasks involving incomplete data sets [16, 17]. In several research papers, the researchers have used the ANN modeling technique on the internal combustion engines [18]. Traver et al. [19] investigate ANN ability to predicting emission parameters of an engine. Dehkiani et al. [20] studied ANN to predict a diesel engine brake power, output torque and exhaust emissions. Rahimi-Ajdadi and Abbaspour-Gilandeh[21] used ANN to estimating fuel consumption. Yuan wang et. al. [22] presented a neural network model that predicts the exhaust emissions from an engine using the total cetane number. In addition, some other researcher used ANN algorithm to evaluating the engine parameters [23-26]. In this study, ANN was proposed to determine the performance and emissions of single cylinder SI engine which lubricated by biolubricants. This will perform by using a group of characteristic engine operating parameters as the ANN inputs.

2. Materials and Methods

2.1 Experimental investigation

In this research, the two-stroke 200 cc SI engine was used under examination (Table 1). To measure the performance parameters of the engine, an eddy current dynamometer with the power of 15kW was applied (Fig. 1a). Two-stroke engine oil produced solely by Pars Oil Company and industrial oil SAE10 (for industrial use) were the petroleum-based lubricants used in the test. Castor oil, waste cooking oil and