ABSTRACT

Energy is a vital factor in economic development of any country and one of the basic parameters that define the quality of life. Major percentages of global electric energy requirement are met through the use of fossil fuels. Considering the developing nation India, the electric energy requirements are met to a major extent by fossil fuels and to a small extent by hydel, nuclear and renewable sources. Fossil resources are finite and inhomogeneously distributed, and their exploitation normally produces emissions which are liable for global climate changes. Hence, it has to be used prudently. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible. The various renewable energy sources are solar energy, wind energy, ocean energy, tidal energy, energy from biomass, fuel cell, hydrogen gas and geothermal energy. Among these resources, solar energy and wind energy contribute to some extent. But as solar energy is available only during day time and the installation cost is high, it is unable to meet the required demand for a developing nation like India. Wind energy is seasonal, and its availability with the minimum wind speed requirement for energy conversion is quite less. Other renewable sources could meet a part of the electric energy demand despite their limitations. Also, these resources could not supply reliable energy to the entire rural population which is out of reach of electric energy.

To overcome the problems posed by fossil fuels and other renewable sources, a globally responsible alternative fuel is required. India's energy security would remain vulnerable until alternative fuels to substitute/supplement petro-based fuels are developed based on indigenously produced renewable feedstocks. The main objective of this research work is to

find a solution for the existing energy crisis through a renewable and eco-friendly source, and develop a model to assess the performance of the diesel power generator run by using biofuel. Biofuels are environment friendly fuels and their utilization would address global concerns about suppression of carbon emissions. Biofuels are derived from renewable bio-mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the electric energy needs of India's vast rural population. Biofuels can increasingly satisfy the electric energy needs in an environmentally benign and cost effective manner while reducing the dependence on import of fossil fuels and thereby providing a higher degree of National Energy Security.

Bio-diesel is a biofuel obtained from vegetable oils, animal fats and waste cooking oils. Use of non-edible oils in biodiesel preparation is advantageous as their usage is quite less. In particular, jatropha, pongamia, mahua, castor, linseed, kusum, karanja and neem are preferred feedstocks for biodiesel production. Moreover, soyabean, rapeseed, sunflower and palm oils add their value to promote the energy requirement of a nation. Biodiesel is a tenable and self reliant fuel. It reduces carbon and sulphur emissions. The properties of biodiesel are similar to that of petroleum diesel. It can be used as a fuel to produce electricity. The biodiesel is produced by the simplest process called transesterification. Many studies have been carried out to assess the performance of the diesel engine using various biodiesel feedstocks. The commonly used oils by the researchers for engine performance analysis were jatropha, pongamia, neem, soyabean, palm and waste cooking oils. Various ANN prediction models were developed using the above stated oils for assessing the diesel engine performance.

In this research work, biodiesel is viewed as a source of electric energy. Biodiesel was produced from neem oil by transesterification. Mixture of 25% biodiesel and 75% diesel is called B25. An I.C engine coupled to a three phase alternator thereafter stated as diesel power generator, was fueled with different neem biodiesel-diesel blends (B_{75}, B_{50}, and B_{25}), pure biodiesel (B_{100}) and pure diesel to study its electric power generation potential. The same biodiesel aged for 930 days at room temperature were used to run the diesel power generator and its performance was investigated. The dissertation also proposes the following artificial intelligent models to predict the power generating potential of the diesel power generator.

- Fuzzy system models are developed in LabVIEW for transesterification and prediction of the performance of the diesel power generator
- Back propagation neural network model is developed in MATLAB to predict the performance of the diesel power generator by estimating output voltage, frequency and power

The diesel power generator is tested using the fresh biodiesel and the results are used as data base for training and testing the developed neural network model. The experimental results of B_{25} using fresh biodiesel blends and aged biodiesel blends have shown that B_{25} produces better output power and efficiency. The training performance of the back propagation neural network model is assessed using root mean square error. The estimated output voltage, frequency and electric power are assessed with regression analysis between the experimental values and the ANN output data. The regression is found to be 0.999. The back propagation neural network model results are very close to experimental results.