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Simulation Model of Hydrogen Fueled SI Engine

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Abstract- Limited reserves of fossil fuels and strict pollution norms have forced research towards searching alternate fuels. Hydrogen has great potential as an alternative fuel for Internal Combustion Engine. Understanding behavior of hydrogen fueled spark ignition engine and parameters controlling the performance is important. Simulation is an affordable solution as it saves time and money. In this paper, a mathematical model has been developed. The results acquired from the model and experimental results from literature have shown reasonable agreement. This model was used as a simulation tool for predicting performance of hydrogen fueled SI Engine under variable operating parameters. Finally, engine performances under variable compression ratio have presented.

Index Terms- Compression ratio, mathematical model, turbulent flame speed, laminar flame speed, hydrogen fueled internal combustion engine,quasi dimensional two zone model, brake power.

I. INTRODUCTION

There are limited fossil fuel reserves on the earth. However, consumption of fossil fuels, leads to severe air pollution. Therefore, developing Internal Combustion engines with improved efficiency and reduction in emission levels is the need of hour. So search for alternative fuel has become a prime important research task now days. Hydrogen is almost carbon free and light gaseous alternative fuel [1]. The use of hydrogen as an alternate fuel fulfills base norms as: High energy content, Availability, less pollution, safety, storage and transport. Hydrogen has justified its utility as compared to number of fuels in these norms.

Wide range of flammability ensures combustion of hydrogen in an IC engine over a broad range of air fuel mixtures [2]. Low ignition energy promotes combustion of lean mixture and assures prompt ignition. High auto ignition energy allows use of larger compression ratios in a hydrogen fueled engine than in a hydro-carbon engine. Hydrogen has peak flame speed at stoichiometric ratios. Under these conditions, the hydrogen flame speed is maximum (faster) as compared to gasoline. Hydrogen engine can match its performance with ideal engine cycle more closely. Fame velocity reduces considerably at leaner mixtures.

Diffusivity of hydrogen gas is very fast. This ability to spread in air is greater than gasoline and is useful because of two main reasons. First, it promotes the formation of a homogeneous mixture of air and fuel. Second, if any hydrogen leakage occurs, the hydrogen scatters fast, resulting in safer conditions. Review of hydrogen engine have shown that hydrogen operated IC engines are more effective, clean and cheaper in comparison with the fuel cells [3].

Computer simulation is an important tool in the development of internal combustion engines. It reduces time and cost in the engine development. Simulation extracts more data in comparison to data that can be got from experiments. The study of complex processes in the combustion chamber can be performed in a better manner. Few researchers have worked on simulation of hydrogen fueled SI engine.

Maher et al. [4] used two zone quasi-dimensional models to simulate the performance of a spark ignition engine fueled with a mixture of various fuels (ethanol, gasoline, hydrogen). The results gained from the study have shown the ability of the model to predict satisfactorily the performance and emissions, including the incidence of pre-ignition at various engine operating conditions. K.Subbarao et al. [5] compared the Eddy current entrainment model over the Reynolds parameter model in describing the combustion process in S.I engine fueled with hydrogen gas. They reported that Eddy Current Entrainment model was useful compared to the Reynolds Parameter model