ABSTRACT

This investigation deals with the details of the development of a mathematical combustion model for a dual fuel combustion system for a compression ignition engine operating on the principle of carburetion and the details of the experimental investigations carried out to correlate the findings of the analytical data.

While adequate data on mathematical modelling has been reported in literature pertaining to straight diesel operations, very little information is available about dual fuel combustion modelling. The combustion model developed and reported in this work relates to the closed period of the engine cycle. Watson's two part burning, namely premixed and diffused combustion approach, developed for straight diesel simulation has been modified suitably and adapted. A single zone model in which the cylinder contents behave as an uniform heat source form the basis of computer simulation.

As dual fuel combustion results in a lower overall gas temperature, factors like dissociation and radiant heat losses are ignored. Combustion of both the fuels are divided into two parts, namely premixed and diffusion types and for convenience, these two phenomena are assumed to begin at the ignition point and proceed concurrently. The apparent mass
burning rates of ethanol and diesel under these assumptions determine the rate of heat release individually and collectively. In the absence of any information pertaining to the formation of ignition nuclei of ethanol, the cause of ignition and combustion of ethanol vapour is attributed to the combustion of diesel. It is further assumed that the normalized premixed and diffusion mass burning rates of ethanol are equal to that of diesel.

The determination of the mass burning rate of fuel facilitates the prediction of the cylinder pressure development. The effects of the contained water in proof ethanol on the development of compression pressure, temperature and the combustion rates have also been analysed.

An experimental programme to validate the analytical findings using a well instrumented single cylinder 3.7 kW - 1500 rpm diesel engine has been carried out. The data obtained from several experimental runs have been found to correlate well with the analytical findings.

The analytical and experimental investigations have enabled the development of a mathematical correlation for the delay period, an important parameter in the combustion study, as given below through a curve fitting technique:

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DELAY (MS) = 2.5 \times 10^{-2} \left(\frac{1800}{T}\right) / P^{1.02}
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where $P$ and $T$ are the pressure and temperature of the charge respectively at the point of injection of diesel fuel.

It is believed that the data generated will help in understanding the complex combustion phenomena of dual fuel combustion occurring in compression ignition engines and developing a combustion system for such prime movers.