ABSTRACT

The objective of this research was to investigate the performance, emission, and combustion characteristics of oxygen enriched hydrogen gas as a fuel for direct injection diesel engines. The research signified that oxygen enriched hydrogen is a suitable fuel for direct injection diesel engines. In this research oxygen enriched hydrogen gas was used as a dual fuel along with petroleum diesel in the engine operation. In the present research, hydrogen was produced along with oxygen by electrochemical reaction of water. This gas mixture was coined as oxygen enriched hydrogen (OEH) gas. This gas mixture was aspirated along with intake air of the test engine.

The test engine used for this research was Kirloskar make single cylinder, water-cooled, four stroke, vertical cylinder, naturally aspirated, stationary, direct injection diesel engine, developing a rated power of 5.9 kW at a rated speed of 1800 rpm and having a compression ratio of 17.5:1. Standard instruments were used to measure the performance and engine-out emissions such as carbon monoxide (CO), carbon dioxide (CO_2), unburned hydrocarbon (UBHC), oxides of nitrogen (NO_X), smoke and excess oxygen in the exhaust (O_2). All the measurements were repeated thrice and the average value was taken for analysis.

Initially the engine was tested with petroleum diesel at standard engine specifications i.e., injection timing of diesel fuel as 23º BTDC, injection pressure as 200 bar, compression ratio as 17.5:1, and speed as 1800 rpm. This served as a base line operation to compare the results of other experiments.

In the first of phase of experiment, the engine was tested for the best flow rate of OEH gas by considering the facts of higher thermal efficiency and

reduced engine-out emissions. For this, the OEH gas of 1.2 litre per minute (lpm), 2.4 lpm, 3.7 lpm, 4.6 lpm, and 5.5 lpm produced by electrochemical reaction of water were aspirated into the cylinder along with the intake air at standard engine specification.

Then for the best flow rate of OEH gas, six operating parameters of the engine were varied and tested for their impact on performance, emission, and combustion characteristics of the engine. The six operating parameters varied were injection time of diesel fuel, injection pressure of diesel fuel, temperature of diesel fuel, inlet air temperature, cooling water flow rate, and combination of injection pressure and injection time of diesel fuel.

From the results of the tests conducted to find the best flow rate of OEH gas by considering increase in brake thermal efficiency and reduction in all engine-out emissions except NO_X emission, the various flow rates of OEH gas can be ordered as

5.5 lpm > 4.6 lpm > 3.7 lpm > 2.4 lpm > 1.2 lpm

From the results, it is distinguished that when 4.6 lpm and 5.5 lpm of OEH gas addition in diesel combustion process were compared, the variations in performance parameter like BTE and emission parameters like CO, UBHC, and Smoke were small. But in the case of NO_X emission, the 4.6 lpm emitted only 16.9% whereas 5.5 lpm emitted 22.62%. It very clearly shows that the best flow rate of OEH gas is 4.6 lpm.

Based on the present research work, it is concluded that the DI diesel engine can be effectively operated with the OEH gas of 4.6 lpm, with diesel fuel injection pressure of 220 bar and retarded injection timing of 19^{o} BTDC.