ABSTRACT

Compression ignition (CI) engines are widely used in passenger and mass transportation due to higher torque and thermal efficiency compared to spark ignition engines. However, the engines emit higher level of oxides of nitrogen (NOx) and Particulate Matter (PM) / smoke due to combustion with higher degree of heterogeneous diesel-air mixture. As Dimethyl Ether (DME) is a good ignition quality fuel having higher cetane number as well as liquid state while storing at higher pressure in cylinders whereas gaseous state at standard pressure temperature (STP) atmospheric condition, NOx and smoke emissions could be decreased significantly.

A four-stroke automotive diesel engine with rated power output of 5.5 kW at 3600 rpm was used for this study. The engine was modified for operating it under dual fuel mode (DME-Diesel). DME fuel was injected into intake manifold of the diesel engine during suction stroke whereas diesel was directly injected into combustion chamber at nearly end of compression stroke. In first phase, experimental tests were carried out on the engine under dual fuel mode (DME-Diesel) with various speeds (2000, 2200, 2400 and 2800 rpm) and torques. The maximum DME energy shares for all loads are limited in the range of 27% to 30% due to uncontrolled auto-ignition (UAI). Smoke emission decreased with DME. However, CO, HC and NOx emissions increased. In second phase, Exhaust Gas Recirculation technique was adopted to reduce mainly NOx and increase maximum DME shares and further tests with EGR were conducted on the engine with the DME energy share (26.5%). NOx emission decreased significantly with EGR with marginal improvement in extending of maximum DME shares from 26.5% to 30.79%. However, EGR in the engine impacts negatively on brake thermal efficiency. In third phase (final), the experimental tests were conducted on the engine with reduced compression ratio from 19 to 17. The smoke emission

decreased drastically to zero level along with reduction of other emissions (NOx, CO and HC). The maximum DME energy shares improved from 44% to 53%. Three stage heat release with cool flame, premixed combustion phase and diffusion combustion phase were observed with DME.

A notable conclusion emerged from this study is that smoke emission of a compression ignition engine with DME (%) with the reduced compression ratio can drastically be decreased to zero level along with significant reduction of NOx emission (from 4.8 g/kWh to 1.9 g/kWh) compared to base diesel. The maximum energy share of DME with controlled auto-ignition (CAI) is enhanced from 44% with base compression ratio to 53% with the reduced compression ratio. The CI engine can operate with dual fuel (DME-Diesel) in flexi condition to address issues of conventional fuel and environment concern.