ABSTRACT

The transport sector is in the transient stage transforming from conventional fuel to decarbonized fuel. The Dimethyl ether (DME) as fuel gets more attention for compression ignition engines as it has lower carbon content fuel (DME: 0.337, Diesel: 0.516) and higher cetane number (DME: 58, Diesel: 51) compared to conventional diesel. The fuel could be stored in a liquid state at high pressure (above 5 bar) in cylinders and converted into a gaseous state at atmospheric (standard temperature pressure) conditions. A DME fuelled compression ignition engine could operate with low levels of NO_x and particulate/smoke emissions.

A four-stroke common rail direct injection (CRDI) single cylinder automotive compression ignition (CI) engine with a rated power output of 8.2 kW at 3000 rpm was used for this study. The engine's hardware was modified for operating under dual fuel mode (DME-diesel). The DME fuel was injected into the intake manifold of the CRDI CI engine, whereas diesel fuel was injected directly into the combustion chamber near the end of the compression stroke. The maximum DME energy share (DME ES) at optimum injection timing (15°BTDC) for all loads is limited in the range of 52% to 63% due to knock occurrence and uncontrolled auto-ignition (UAI). Further, the combined strategy of retarded injection timing (12°BTDC), split injection (25°BTDC) and exhaust gas recirculation (EGR) extended the maximum DME ES from 52% to 72% by mitigating the knocking tendency. Smoke emission decreased drastically to zero level at higher DME ES. However, NO_x, CO and HC emissions increased. Hence, the engine was further modified to operate under homogeneous charge compression ignition (HCCI) mode fuelled with neat DME (100%). Zero smoke and ultra-low NO_x emissions were observed under DME HCCI mode. However, reduction in load due to knock and increased CO and HC emissions were observed under DME HCCI mode. Further, the maximum load of the engine with the EGR under HCCI mode is extended with controlled auto-ignition (CAI). Further, the experimental tests were conducted on the engine with hydrogen addition under DME HCCI mode. A compression ignition engine fuelled with DME under HCCI mode could operate with enhanced hydrogen energy share (HES),

improved energy efficiency and zero smoke emission with ultra-low CO, HC, NO_x, and CO_2 emissions.

A notable conclusion that emerged from this study is that the compression ignition engine fuelled with DME under HCCI mode with the EGR and hydrogen could reduce the smoke emission to zero level with ultra-low levels of other emissions (NO_x, CO, HC and CO_2) along with energy efficiency improvement and extended the maximum load limit by mitigating the knock tendency.