Abstract

With increasingly stricter emission legislations worldwide and shrinking reserves of fossil fuels, biodiesel has emerged out as one of the most promising alternative fuel for diesel engines. However, one major drawback of biodiesel is that it produces higher NOx emissions than mineral diesel although the soot emissions are comparatively lower due to its different combustion characteristics. Therefore it is very important to develop fundamental understanding about the spatial changes in combustion characteristics inside the engine combustion chamber in order to optimize the combustion, which can potentially make it an efficient alternative for mineral diesel.

Endoscopic visualization technique is one of the possible solutions to experimentally investigate the variation in spatial combustion characteristics inside the engine combustion chamber under firing conditions. In the present study, engine endoscopy technique is implemented in a single cylinder diesel engine. Major engine modification for undertaking endoscopy include (1) modifying the engine components like cylinder head, piston to accommodate the endoscope window (2) developing camera control system and designing endoscopic protection components etc. Experiments were conducted for mineral diesel, biodiesel and their blends (B20, B50) at different engine load conditions. Combustion images were captured after every 0.5 crank angle degrees and these were further analyzed using image processing methods/ programs to determine various combustion related parameters such as start of combustion, spatial distribution of soot and spatial flame temperature distribution. It was found that soot particles largely disappear towards the late combustion phase due to their oxidation/re-burning in the combustion chamber. Luminous flames appear earlier in biodiesel as compared to diesel, which indicates shorter ignition delay for biodiesel. It was also found that results obtained from endoscopic technique matches well with the results obtained from conventional techniques for comparing the start of combustion, soot concentration and flame temperature. It was also observed that luminosity of flame in combustion images decrease as the oxygen content in the fuel increases (i.e. increasing biodiesel content). However the variation in combustion duration, spatial soot distribution, and spatial temperature distribution with varying engine load does not match with the results obtained from that of the conventional techniques, possibly because of the thermophoresis carbon deposition on the endoscope window and restricted field of view.

In summary, endoscopy is a great technique to fundamentally understand the combustion in the engine combustion chamber and the effect of changing fuel composition on the combustion.