CFD Modelling of Combustion of CNG and Hydrogen-rich Syngas Under a Dual Fueling Strategy

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ABSTRACT:
The dependence on fossil based liquid fuels for the transport sector has resulted in severe punishment on the environment. On the other hand, natural reserve of liquid petroleum is depleting at an alarming rate. even though there are efforts to move from combustion-based engines to electric vehicles, the transition needs time and resource. Countries have adopted natural gas as an alternative fuel particularly for the public transport such as buses and taxi. However, the combustion process of CNG is associated to instability and lower performance at low-load and low-speed and higher temperature that can damage engine hardware at highload and high-speed applications. Researchers have used inline steam reformers of CNG for the generation of hydrogen in Fuel cell vehicles. However, the requirement of complex separation process and issues related to production cost, the technologies could not be widely commercialized. On the other hand, the syngas production is simple and cheaper as compared to hydrogen production and it uses an existing engine in dual fueling mode with little modification. The objective of this work is to model the combustion of CNG and syngas in dual fueling strategy for the combustion stability and performance enhancement of a CNG engine. A single-cylinder, four-stroke spark ignition engine with a compression ratio of 14:1 is used in the current work. The engine is operated at 1200 rpm at idle condition (no load). The fuel injection timing for syngas is considered at 300o BTDC while 120o BTDC for CNG. The ignition timing is considered at 32o BTDC. The modeling work include a cold flow, combustion and comparison of the combustion parameters of base-line CNG data with that of CNG-Syngas dual fuel. A dual fuel strategy is modeled as its geometry. The CFD model was validated by using an experimental result from the engine at 1200 rpm with no load condition fueled with CNG. Addition of syngas into CNG fuel has increased the burning temperature there by the peak pressure. The thermal efficiency of the engine is improved. Syngas is inducted to the air induction system for enrichment in CNG-syngas dual fueling operation in the current CFD modelling work. Syngas-enrichment in CNG-fueling has improved combustion stability and the combustion efficiency. This is attributed to the higher laminar speed of hydrogen in the syngas.

KEYWORDS : *CNG; syngas, dual fueling; combustion; performance; emissions*