Computational fluid dynamics investigation of air-gas pre mixing controller mixer designed for CNG-diesel dual-fuel engines

ABSTRACT

CNG-air mixer is a device like carburetor that used to convert the diesel engine to dual fuel engine without more engine modifications. The main purpose of this mixer is to supply the engine by homogeneous CNG-air mixture simultaneously with suitable airfuel ratios (AFRs) as required by the engine. The best mixing of gas and air is hardly achieved due to stationary parts of existing types of mixer. Therefore, this paper carried out a computational fluid dynamics (CFD) study to investigate the performance of new commercial mixer. This mixer is a secondary fuel pre mixing controller designed for a 3.168 liter dual fuel-diesel engine and positioned at the air inlet manifold. The mixing process of CNG and air is controlled by the interior design of the mixer and the movement of controller valve. Preliminary analysis was conducted when the maximum engine speed (3600 rpm) and at a fully open secondary fuel inlet pipe. With this case, atmospheric pressure was used at the gas inlet to see if the gas could be sucked or need to be supplied with pressure higher than atmospheric pressure. The second step of investigation was done when the valve moved to last position and mass flow rate was used at the mixer outlet and gas inlet according to required air fuel ratio (AFR) to find the pressure at the gas inlet besides examine the homogeneity of CNG-air mixture. The mixer had been tested with various AFRs starting with (10) for rich, (17.2) for stoichiometric, and (20, 30, 40) for lean combustion. Uniformity index (UI) and color contours of methane mass fraction (MCh4) were used to evaluate the mixing quality of CNG and air. The results of testing showed that the gas should be supplied with pressure higher than atmospheric pressure to obtain the AFR close to stoichiometric ratio. This pressure was very high which not allowed in the pressure regulator that available in the market. This problem caused by the design of control valve shaft. Furthermore, the study showed that the mixer is unable to provide a homogeneous mixture of CNG and air. Therefore, the mixer needs to be optimized in terms of controlling AFR and CNG-air mixture homogeneity.

Keyword: CNG-air mixer; Computational fluid dynamics; Dual-fuel systems