Investigation of natural gas enrichment with high hydrogen participation on knock in dual fuel diesel engine at high loads

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Abstract. With growing worries about the safety of the environment and the lack of supplies of crude oil, a great deal of effort has been made to use alternative fuels in engines. For internal combustion engines, natural gas (NG) is one of the most attractive available fuels. The dual fuel (DF) concept is an effective way for its use. NG has a slow burning velocity and limited lean-burn ability. Enriching NG with hydrogen is an effective way to mitigate such demerits, since H_2 is characterized by a rapid combustion speed, wider combustion limit and low ignition energy. For high engine loads operation, the engine risks to go through a hazardous knocking regime. This study explores experimentally the effect of NG enrichment with high H_2 concentrations (20, 30, 40 and 50 by v %) in DF mode on knock at high engine loads of a compression ignition engine. Results indicated that enriching NG with high H_2 concentrations in DF mode is an interesting technique for improving dual fuel engine up to 80% load without any knock. However, beyond this load (at 90% of full engine load) the knocking phenomenon appears with high intensities and occurs before achieving the maximum output power of the diesel engine (4.5 kW). In the case of pure NG, the engine reach the maximum output power (100% of full engine load) without knocking. An occurrence of knock with H_2 addition might be due to a very low methane number of H_2 that means hydrogen is highly prone to generate the knock than NG, which is mainly composed of methane. Knocking combustion causes major engine damage, reduces the efficiency and requires particular attention. Therefore, it is advisable to operate DF engine with H_2 enrichment at the safe zone (from 20% to 80% engine load) to prevent knock.

Keywords: Natural gas; Hydrogen; Dual fuel; Knock.

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