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Experimental Investigation of the Effect of Gasoline Fuel on Engine Performance, NOx reduction, and Engine Wear of a 38.8L Military Heavy Duty CIDI Diesel Engine Applying EGR

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Abstract

Rapidly depleting oil reserves and strict pollution regulations have made it necessary to find a substitute for diesel fuel. In the context of the multi-fuel strategy program, gasoline has improved the fuel availability for both combat and commercial highway vehicles with diesel engines. This study examines the effect of gasoline fuel on the engine wear, performance, and emission of a military, heavy-duty, supercharged diesel engine. In a CIDI diesel engine, the use of Gasoline has been considered to be significantly sustainable with engine performance and reduced pollutants. For this research a military heavy-duty, 38.8 L, 585kW, diesel engine, the EGR technique was used for gasoline and diesel fuels.

Furthermore, the impact of nanoparticles on NOx emissions was also explored. NOx emission reduces in diesel engines by using the EGR technique. Two test fuels were tested in their trials for a total of 100 hours of engine endurance assessment. After every 20 hours of engine operation, 100 mL of lube oil was extracted from the oil sump and tested for elemental analysis. Ferrography and atomic absorption spectroscopy have been used to measure the composition of metal wear debris. It was used to evaluate the metal wear on the exposed cylinder liner. A new engine part was used to perform durability tests for test fuels. For gasoline-powered engines, metal wear was estimated to be 10 to 12 percent higher than for diesel-powered engines. Gasoline fuel’s engine performance was 4.5% lower than diesel fuel. When the engine was running on Gasoline, NOx emissions were reduced by 28%, and nanoparticle emissions were also reduced.

Introduction

Diesel engines are mainly encountered in frontline combat operations and heavy-duty highway vehicles. A diesel engine with a supercharger improves power, reduces fuel consumption, and improves engine durability. Roughly 85% and 5-15% of vehicles rely on diesel and Gasoline fuel respectively. Whereas, approximately 27% and 33% of petroleum diesel and Gasoline fuel respectively, are extracted from crude oil refinery processes [29]. Therefore, surplus Gasoline fuel is available as an alternative fuel for diesel [30].

A multi-fuel strategies initiative has been initiated in response to the rapid reduction of petroleum oil deposits. Due to an abundance of Gasoline fuel, all combat ground and heavy-duty highway vehicles can be operated with Gasoline fuel without considerably sacrificing the diesel engine’s performance and exhaust emissions. This alternate approach promotes logistical optimization and homogeneity, and also improves the economics. Table 1 summarizes the diesel and gasoline fuel qualities.

Gasoline diesel engines can be utilized in military combat vehicles and heavy-duty highway vehicles. The heating value of Gasoline is less. As a result, employing Gasoline fuel could result in a performance penalty [1,2,4,32]. Consequently, for optimal performance with dual fuel diesel/Gasoline, the fuel injection pump must be tuned to balance the quantity of fuel per cycle by increasing the volume of Gasoline [3,4,5,7].

In selecting suitable alternative fuel, engine wear is one of the most critical performances due to the non-lubricating quality of Gasoline fuel and fuel dilution with lubricating oil [26]. Diesel engine components that are most likely to wear are cylinder liner, piston rings, piston pin, crankshaft, camshaft, engine valves, and all engine bearings. All metallic slight penalty of power, specific fuel consumption, and engine wear.

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Definitions/Abbreviations

Symbol - Description, Units
cst - Centi stokes
^{o}C - Degree centigrade
kW - Kilo watt
MJ - Mega joule
Vol - Volume
wt - Weight

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