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Exhaust gas analysis of an eight cylinder gasoline engine based on engine speed

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Abstract

In this experimental work, exhaust gas analysis of an eight cylinder and v-type gasoline engine, namely, a Chevrolet 5.7, is experimentally performed in terms of engine speed at laboratory conditions by using of an exhaust gas analyzer and the special software called "NetDyn" and "WinDyn". The engine test setup includes a dynamometer to determine the engine torque and data acquisition system. At the experimental works, the engine speed ranges from 2500 rpm to 5250 rpm and step time for successive speeds is held constant as 10 s. A throttle position of 60 is selected for the engine operation. Exhaust gas emissions such as O_2, CO, NO_x and SO_2, are measured in terms of engine speed. Exhaust gas temperature and excess air coefficient are also measured as a function of the engine speed during the experiments.

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Keywords: gasoline engine; engine speed; emission characteristics; NO_x; CO; O_2; SO_2.

1. Introduction

Analyses of energy producing systems with respect to the energy and exergy are not enough itself. The systems should be also analyzed from the environmental aspects. As the gasoline or diesel engines are taken into consideration, the level of exhaust gas emissions from these engines is very important. There are limited studies

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aiming to investigate the exhaust gas emissions of gasoline engines as a function of engine speed in the literature. Some of them are as follows;

The influence of compression ratio on the engine characteristics such as engine torque, maximum brake torque, ignition timing, break specific fuel consumption and exhaust gas emissions (HC and CO) for different ratios of ethanol (E0, E10, E20, E40 and E60) was experimentally carried out by means of a single cylinder gasoline engine. The effect of engine speed on the exhaust gas temperature and emissions, namely HC and CO was also experimentally investigated. The maximum amount of decrease in exhaust gas emissions was observed by using E40 and E60 fuels at 2000 rpm engine speed. HC emission was decreased more when it was compared to CO emission [1]. In order to compare the emissions of diesel and gasoline engines, different blends of diesel and gasoline fueled automobiles were tested at various idle engine speeds in simulated city traffic intersection situations. The tests were carried out for HC, NOx and CO emissions, PAHs (particle-bound poly-aromatic hydro-carbons), particle number and size distribution at engine speeds between 1500 and 3000 rpm with 500 rpm intervals. It was observed that HC, NOx and CO emissions raised as the engine speed raised for all diesel and gasoline engines cars. The amount of NOx emissions for gasoline engines was lower than that of diesel engines [2]. The engine characteristics including engine power and torque, brake mean effective pressure, brake specific fuel consumption and exhaust gas emissions such as CO and brake specific NOx were experimentally tested for different fuels, namely methane, gasoline, methanol, propane, ethanol and hydrogen. The experimental results were validated by means of a simulated computer code. It resulted that CO emission generally raised for all fuels in the study at engine speeds ranging from 1500 to 6000 rpm. The maximum CO emission was determined by using gasoline fuel [3]. The influence of mixture of ethanol and diethyl ether on homogenous charge compression ignition (HCCI) combustion was experimentally carried out by means of a single cylinder, port injection HCCI engine. During the experiments, various ratios of the mixture including 30% ethanol–70% diethyl ether (E30/D70), (E40/D60), (E50/D50) and one hundred percent diethyl ether were tested in the experiments. The experiments were performed at an engine speed of 1200 rpm and various proportions of air-fuel equivalence ratios. The engine characteristics, namely cylinder pressure, heat transfer from the cylinder, indicated mean effective pressure (IMEP), combustion parameters, and thermal efficiency were observed as a function of different ratios of fuels under the study in the experiments. The exhaust gas emissions including CO, HC and NOx were also observed [4]. By means of a numerical model improved, NOx emission and efficiency of a gasoline engine were compared for various fuels such as the natural gas and natural gas-hydrogen gas mixtures [5].

As it is seen from the literature survey summarized above, there are not many studies concerning with the emission characteristics of gasoline engines in terms of engine speed. Our purpose is to make contribution to the researchers conducting research in this area. In this experimental work, NO_x, SO_2, CO and O_2 emissions of a Chevrolet 5.7, v-type, eight cylinder gasoline engine are measured at the speeds ranging from 2133 rpm to 5132 rpm. The principal diversity of this study from the literature is the investigation of the exhaust gas average temperature and excess air coefficient in terms of engine speed function of engine speed and discussed.

Nomenclature

AFR	Air-fuel ratio	
N	Engine speed	rpm
T_{eg}	Exhaust gas temperature	ºC
η_c	Combustion efficiency	
λ	Excess air coefficient	

2. Experimental Work

The experimental works were performed at the Mechanical Engineering Laboratory of Central Michigan University-USA. The engine test apparatus used in the experiments is depicted in Figure 1.