AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
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EFFECT OF HYDROGEN ENRICHMENT ON PERFORMANCE OF SPARK IGNITION ENGINES OPERATED WITH NATURAL GAS

A Thesis Submitted in Partial Fulfillment of the Requirements for the M.Sc. Degree in Mechanical Engineering (Automotive**)**

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Practical Study of the Effect of Hydrogen Enrichment on Automotive Spark Ignition Engine Fuelled by Natural Gas

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Statement

This thesis is submitted to Ain Shams University for degree of Master of Science in Mechanical Engineering (Automotive).

The work included in this thesis was carried by the author from 2009 to 2014.

No part of this thesis has been submitted for the degree or a qualification at any other university or institute.

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AC	Alternating current
BTE	Brake thermal efficiency
BSFC	Brake specific fuel consumption
BSHC	Brake specific unburned hydrocarbon
BSCO	Brake specific carbon monoxide
BSNOx	Brake specific nitric oxides
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CNG	Compressed natural gas
EAR	Excess air ratio
ECU	Electronic control unit
H_2	Hydrogen
HC	Hydrocarbon
HCNG	Hydrogen enriched compressed natural gas
ICE	Internal combustion engine
LPG	Liquefied petroleum gas
LNG	Liquefied natural gas
MBT	Minimum advance for best torque
NDIR	Non dispersive infrared
NG	Natural gas
NO_X	Nitrogen oxides
PPM	Part Per Million
SI	Spark ignition
WOT	Wide throttle open

SUMMARY

The limited crude oil reserves together with the increasing concern about environmental protection, pushed scientists to research in alternative fuels for internal combustion engines as CNG, LBG, HCNG, H_2 etc. With the aim of reducing fuel consumption and increasing engines efficiencies, hydrogen is often thought of as the ideal alternative fuel for internal combustion engines as it has clean burning characteristics and doesn't produce toxic products because its main product is water. Hydrogen is the most abundant element on earth but its current use is as a fuel additive to improve the combustion of HC fuels like CNG due to its high burning velocity. Studying the impact of hydrogen enriching of CNG fuel on performance and emissions parameters of automotive engine is the object of this research. For this purpose a test rig has been constructed consisting of a1.5 Liter Hyundai carburetor engine coupled with a water dynamometer to measure power, torque, BSFC, BTE parameters and exhaust gas emissions using measuring facilities consisting an orifice plate equipped with U-tube manometer to measure induced air volume flow rate, calibrated digital load cell to measure mass flow rate of consumed fuel and AGS -688 5-gases gas analyzer to measure emissions parameters and engine speed. The engine was fitted to operate on gasoline, CNG, (10%H_2 /90%CNG), (20%H_2/ 80%CNG) and (30%H_2/ 70%CNG) by volume mixtures and was tested in two different modes of operation such as steady state condition with WOT and variable speed range from 1500 rpm to 4500 rpm and at the constant speed of 2000 rpm with variable load of 25% to 75% of engine full load. It was found that:

-Adding hydrogen to compressed natural gas fuel improves power, torque, BSFC, BTE of around 21.8%, 10%, 15.1%, 11% respectively and emissions except NOx emissions for full load test relative to those of pure CNG fuelled engine.