بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

بعض الوثائق الاصلية تالفة

بالرسالة صفحات لم ترد بالاصل

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

DEVELOPMENT OF INJECTION SYSTEMS FOR C.N.G ENGINES USING LEAN MIXTURE

BY

FARID HASSAN ABD EL FATTAH EL BANOUBY

A THESIS

SUBMITTED TO THE UNIVERSITY OF AIN SHAMS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

SUPERVISED BY

PROF.DR.ADEL ABD EL MALEK EL AHWANY
PROF.DR.AHMED HASSAN BAWADY

MECHANICAL POWER DEPT.
FACULTY OF ENGINEERING
AIN SHAMS UNIVERSITY

CAIRO, 2002

Ain Shams University
Faculty of Engineering
Mechanical Power Department

EXAMINERS COMMITTEE

Undersigned certify that they have read and recommended to the faculty of Engineering Ain Shams University for acceptance of the thesis entitled

"DEVELOPMENT OF INJECTION SYSTEMS FOR C.N.G.ENGINES USING LEAN MIXTURE"

Submitted By Eng. **Farid Hassan Abd El Fattah El Ramoby**
in partial fulfillment for the degree of Doctor of Philosophy in Mechanical Engineering (Mechanical Power Department)

Prof. Dr. Mohsen Salem Radwan (M. S. Radwan)
Prof. Dr.Mechanical power Department
El Mataria Faculty of Engineering
Helwan University

Prof. Dr. Samir Mohamed Abd El Ghany (S)
Prof. Dr. Mechanical power Department
Faculty of Engineering
Ain Shams University

Prof. Dr. Adel Abd El Malek El Ahwany (A. E)
Prof. Dr. Mechanical power Department
Faculty of Engineering
Ain Shams University

Prof. Dr. Ahmed Hassan Bawady (A. Bawady)
Prof. Dr. Automotive Engineering Department
Faculty of Engineering
Ain Shams University

ACKNOWLEDGMENT

Thanks to Allah for his permanent support in all work.

The author would like to express his deepest gratitude to Prof. Dr. Adel ABD El Malek El Ahwany for his personal supervision of the project and continuous guidance.

The author would like to express his deepest gratitude to Prof. Dr. Ahmed Hassan Bawady for his supervision, continuous guidance, and encouragement.

The author also wishes to thank Dr. Safwat ABD El Messiah for his help in programming information.

The author also wishes to thank the technician's team of the Mechanical power department in Ain Shams University, Internal Combustion Engine laboratory.

The author also wishes to thank all that who gave him support and help during this work.

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy .

The work included in this thesis with carried out by the author at the laboratory of the Mechanical Power Engineering Department, Ain Shams University.

No part of this thesis has been submitted for a degree qualification at any other University.

Name : Farid Hassan Abd El Fattah El Banouby

Signature :

Date :

ABSTRACT

The aim of this work is to develop the injection system for natural gas engine operated with lean mixture. In this work a proposed gas injector is designed and constructed to operate with the same fuel pump attached to the original Diesel engine. The gas injector is hydraulically operated by the fuel of the Diesel fuel pump during the effective stroke. The hydraulic force opens the gas valve and let the natural gas fuel to pass into the cylinder. The natural gas fuel is introduced into the cylinder either by direct injection or by manifold injection at two different speeds 1500 and 1750 rpm. The gaseous fuel flow rate can be controlled either by varying Diesel pump rack position or by increasing the inlet gas pressure. A control gate at inlet air manifold is used to control the air fuel ratio to different lean limits. A one cylinder four stroke Diesel engine of type USHA 5.5 hp at 1500 rpm was used and prepared in the test rig. The engine is modified to suit the operation with natural gas. The modification of the engine includes the place of the gas injector, decreases the compression ratio from 16.5 to 13, introducing electrical system for spark plug and modification of the injection timing. The engine is tested on the original Diesel engine at 1500-rpm speed and the modified natural gas engine tested at two conditions; the first condition used direct gas injection of natural gas into the cylinder, the second condition used the indirect gas injection into the inlet air manifold. All tests for the modified natural gas engine are run at speeds 1500-rpm and 1750-rpm.

A simulation study to calculate the gaseous fuel injection flow rate is introduced. A mathematical simulation of the gas injector performance has been made to calculate the Diesel oil pressure in the injector, the valve lift and the rate of gas injected during the injection cycle as a part

of the whole injection system and solved by finite difference methods with the aid of computer program.

The experimental tests showed that the engine performance of the manifold gas injection is nearly like the original Diesel results. The experimental results showed that Operating with direct gas injection into the engine would produce the same engine power but with 6% less in thermal efficiency and within the emission pollution limits. In direct gas injection the mixture is operated lean at part load and near stochiometric at full load. The excess air factor in direct gas injection is equal to1.1 at 65% of the engine load and 1500-rpm speed, while in the case of manifold injection λ=1.24 at the same load and speed. The engine performance with the manifold gas injection is better than with direct injection, nearly the same as Diesel engine thermal efficiency and better pollution results than direct gas injection. The pollution results for both direct and manifold injection shows that the CO % is lower in case of manifold gas injection and not more than 0.28% at full load. The NOx emission in manifold injection is higher than direct injection.

A significant comparison between theoretical gas flow rate calculation and the experimental gas flow rate is traced at different Diesel pump rack positions and different inlet gaseous fuel pressure. As expected the rate of gaseous fuel introducing the cylinder is increased by increase the pump rack position of the Diesel pump and by increasing the inlet gaseous fuel pressure.