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FACULTY OF ENGINEERING

MECHANICAL ENGINEERING DEPARTMENT

A STUDY IN VALVELESS PULSED COMBUSTOR AND GAS DYNAMIC COUPLING OF TWIN COMBUSTORS

bY

SAMIR GAMAL EL-DIN AHMED

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SUPERVISED BY

Prof. Dr. A.I. ABDEL FATTAH

Prof. Dr. E.S. MARZOUK

Dr. F. EL-ERIAN

Prof. Dr. Abdel Fattah I. Abdel Fattah

Professor, Mechanical Engineering Department

Alexandria University

Prof. Dr. Salah H. Al-Emam

Professor , Mechanical Engineering Department,

Mansoura University.

Prof. Dr. Hassan A. Wardah

Professor , Mechanical Engineering Department

Alexandria University

Prof. Dr. El Sayed M. Marzouk

Assistant Professor, Mechanical Engineering Department

Alexandria University

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ABSTRACT

A self aspirating valveless pulsed combustor is a cyclic operating combustor, without moving parts, in which the basic feature is the utilization of inertia effects associated with the non steady motion of combustion products for the purpose of scavenging the combustion space and drawing in fresh charge, precompressing it before ignition in each cycle. The products of combustion are expelled with high velocity permitting work extraction from the machine.

Potential applications and advantages of pulsating combustion are presented. The present study, however, aims at employing the phenomena for use in gas turbine to benefit from the gain in stagnation pressure across the combustion chamber instead of the customary loss associated with the use of conventional steady flow combustion chambers.

For this purpose, a highly rated, propane fueled, valveless pulsed combustor was constructed based on SNECMA/Lockwood design with 10 % increase in linear dimensions so that the combustion chamber diameter was 80 mm. Historical review have-been-presented which suggested

that improving the air breathing capacity of the unit and improving the fuel distribution in the air charge for its full utilization, are of discrete importance to realize full potential performance from a combustor. So, an experimental test programe was carried out to optimize the combustor for maximum specific thrust and minimum specific fuel consumption. Different fuel injection nozzles, aerodynamic inlet forms, tail pipe lengths and throat areas were tested. The developed optimized configuration resulted in improved performance compared to that of SNECMA with 6% increase in maximum total specific thrust and 12% reduction in specific fuel consumption.

A second objective was to develop a gas dynamic coupling system for twin combustors at their exits.
A simplified wave analysis presented suggested how the correct coupling configuration proposed would result in some degree of precompression and in antiphase operation which aid in suppressing noise. The analysis also provided the lengths required for inlet air pipe to plenum and non steady flow ejectors needed.

The non steady ejectors were experimentally tested in ambient air (without plenum chamber) for maximum thrust augmentation. The optimum configuration resulted in 65% increase in thrust produced from combustor tail end at same fuel flow rate.

The coupling system successfully achieved antiphase locked operation of the twin combustors. The fundamental frequency in the plenum chamber doupled to 360 Hz leading to good measure of noise suppression. This would also improve the effectiveness of accoustic absorbant media for the complete combustor when used for engine integration. However, the thrust produced at the exit end was reduced by about 60% at the same fuel flow rate. This is propably due to the low pressure resulted in the exhaust plenum because of the pumping effect required to suck air inflow to the plenum and the high augmentation ratio of the two ejectors. This effect would be overcome on the complete combustion chamber coupled with rectified forward thrust from combustors inlets.

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