AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHAINCAL POWER DEPARTMENT

Liquid Fuel Double Swirled Combustion with Gaseous Fuel Injection

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Power Engineering

by

Abd_ALLAH Ezzat Abd El-Khalik

Bachelor of Science in Mechanical Engineering

(Mechanical Power Engineering)

Faculty of Engineering, Ain Shams University, 2012

Supervised by:

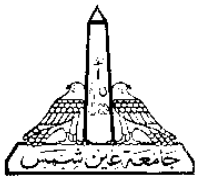
Prof Dr. Mahmoud Mohamed Kamal

Dr. Ahmed Mohamed Taher

Mechanical power Department

Faculty of Engineering- Ain Shams University

Cairo - (2019)



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHAINCAL POWER DEPARTMENT

Liquid Fuel Double Swirled Combustion with Gaseous Fuel Injection

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Power Engineering

by

Abd_ALLAH Ezzat Abd El-Khalik

Bachelor of Science in Mechanical Engineering
(Mechanical Power Engineering)
Faculty of Engineering, Ain Shams University, 2012

Examiners' Committee

Name and Affiliation	Signature
Prof. Dr. Saad El-Din Mohamed Habik Mechanical Power , Port Said University	.....
Prof. Dr. Adel Abd El-Malk El-Ahwany Mechanical Power , Ain shams University	.....
Prof. Dr. Mahmoud Mohamed Kamal Mechanical Power , Ain Shams University	.....
Dr.Ahmed Mohamed Taher Mechanical Power , Ain Shams University	.....

Date: 26/1/2019

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHAINCAL POWER DEPARTMENT

Liquid Fuel Double Swirled Combustion with Gaseous Fuel Injection

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Power Engineering

by

Abd_ALLAH Ezzat Abd El-Khalik

Bachelor of Science in Mechanical Engineering

(Mechanical Power Engineering)

Faculty of Engineering, Ain Shams University, 2012

Supervisors

Name, title and affiliation

Signature

Prof. Dr. Mahmoud Mohamed Kamal .....
Mechanical Power Department,,
Faculty of Engineering- Ain Shams University

Dr.Ahmed Mohamed Taher .....
Mechanical Power Department,,
Faculty of Engineering- Ain Shams University

DISCLAIMER

This thesis is submitted as partial fulfillment of M.Sc. degree in Mechanical Power Engineering, Faculty of Engineering, Ain Shams University.

The work included in this thesis was carried out by the researcher during the Period from 201٦ to 201٨, and no part of it has been submitted for a degree or qualification at any other scientific entity.

The nominee confirms that the work submitted is his own and that adequate credit has been given with reference of the others works.

Abd-ALLAH Ezzat
Abd El-Khalek
Signature

…….

Date: / / 2019

Researcher Data

Name	: Abd-ALLAH Ezzat Abd El-Khalk
Date of Birth	: 1st September,1990
Place of Birth	: Cairo, Egypt
Last Academic Degree	: Bachelor of Science
Field of Specialization	: Mechanical Power Engineering
University issued the degree	: Ain Shams University
Date of issued degree	: June, 2012
Current job	: Gas Turbine Maintenance and Operation Engineer-GUPCO Company

ABSTRACT

The experimental work was proceeded to investigate the effect of the cross flow (opposing jets) as gaseous fuel with merged to the effect of the double swirling on the performance of the diffusion flame. The cross flow was used as opposing jets (as premixed mixture of gaseous fuel and air). And the influence of the double swirler on the flames was stated with swirling modes as (Co or Counter) swirl.

The goal from this experiment was to improve flame stability, but the combustion efficiency kept at high values and also reduced the NO_x emissions values and minimize also the values of the unburned hydrocarbon as well as the carbon monoxide.

The experiment parameters was the ratio of the momentum flux, swirl intensity and the angle of the swirling vanes and also the ratio of the obstruction stream heat input, The strain rate significantly influences the limits of the flame stability, and the flow strain features was addressed by the turbulent kinetic energy. Because the increasing power required a combination with the regulation of the environmental, so the combustor design search for improving the firing technique to increase the power output with extending the limits of the flame stability. A mixture between the passive and reactive control technique is used for achieving these targets.

The test rig which consists of double swirler cylindrical combustor with addition to cross flow as opposing jets, whereas valves used for controlling the air and liquid or gaseous fuel flow rates, also used orifices plates to determine the flow rates. S-type thermocouple was used for measuring the local flame temperature across the combustor and for getting the emissions concentration an electrochemical gas analyzer was used. Flames contours and photos were employed for introduce the flame shape across the combustor.

The results showed that using double swirlers with using the opposing jets, it found that increasing the burning capacities to the diffusion flames because the increasing of the strain rates. The high peak temperature across the combustor leaded to increase in NO_x concentration. The using of the swirler made a re-circulation zone which leaded to more flame stability which reduced the concentration of the unburned hydrocarbon as well as the carbon monoxide but increased the NO_x concentration. The cross flow (opposing jets) was beneficial for the stability of the flame due to the steeping of mixture fraction which was helpful for enhancing the stagnation effects.

Acknowledgement

Thanks to Allah for granting us to compelete this work.

I would like to express my deepest comeliness to my honorable supervisors Prof. Dr. Mahmoud Mohamed Kamal and Dr. Ahmed Mohamed Taher Hussien for their continuous assist and directing over the work of the investigation.

I would like to express my complete thankfulness and gratitude to my great Parents for their continuous support in my whole life.

In the end, my truthful appreciation for my wife for supporting me during the investigation for Eng. Mohamed Mohie for his help and for the technical support.

Table of Contents

List of Figures: