EXPERIMENTAL INVESTIGATION OF ENRICHED-HYDROGEN OXY COMBUSTION OF CNG FLAMES STABILIZED OVER A PERFORATED PLATE BURNER

By

Samir Yahia Kamal Youssef

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Mechanical Power Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Under the Supervision of

Prof. Dr. **Tharwat Wazier Abou-Arab**

Professor of Combustion
Mechanical Power Department
Faculty of Engineering
Cairo University

Dr. **Abdelmaged Hafez Ibrahim**

Assistant Professor
Mechanical Power Department
Faculty of Engineering
Cairo University

Dr. **Hatem Omar Haredy**

Assistant Professor
Mechanical Power Department
Faculty of Engineering
Cairo University

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Approved by the
Examining Committee

_____

Prof. Dr. Tharwat Wazier Abou-Arab, Thesis Main Advisor

_____

Prof. Dr. Osama Mohammed Farid Elbahar, Internal Examiner

_____

Prof. Dr. Saad Abdelhameed Elsayed , External Examiner

- Professor of Combustion, Faculty of Engineering, Zagazig University

_____

Dr. Abdelmaged Hafez Ibrahim , Advisor

_____

Dr. Hatem Omar haredy , Advisor

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

Engineer's Name: **Samir Yahia Kamal Youssef**
Date of Birth: **9 / 6 / 1987**
Nationality: **Egyptian**
E-mail: **samiryosef87@gmail.com**
Phone: **01002317075**
Address: **28 Road 10 – Maadi – Cairo - Egypt**
Registration Date: **1 / 10 / 2015**
Awarding Date: **/ /**
Degree: **Master of Science**
Department: **Mechanical Power Engineering**

Supervisors:

Prof. Dr. Tharwat Wazier Abou-Arab
Dr. Abdelmaged Hafez Ibrahim
Dr. Hatem Omar Haredy

Examiners:

Prof. Dr. Tharwat Wazier Abou-Arab (Main Advisor)
Prof. Dr. Osama Mohammed Farid Elbahar (Internal Examiner)
Prof. Dr. Saad Abdelhameed Elsayed (External Examiner)
(Faculty of Engineering, Zagazig University)

Title of Thesis:

Experimental Investigation of Enriched-hydrogen Oxy-combustion of CNG Flames Stabilized Over a Perforated Plate Burner

Key Words:
Flammability Limits, Oxy Combustion, Flashback, Enriched Hydrogen

Summary:

Carbon Dioxide emissions resulting from the combustion of fossil fuels in power generation industries are considered to causing global warming. This study experimentally studies the conditions that must be met when burning a mixture of compressed natural gas and hydrogen gas with an oxidizer mixture made of Oxygen and carbon dioxide gases over a perforated-plate burner. The study succeeded to achieve a stabile flame made of 0% to 30% hydrogen fraction and the flammability limits were determined in different hydrogen fractions. Also, the visual flame appearance (shape, length and color) at different oxygen and hydrogen fractions was recorded.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: **Samir Yahia Kamal Youssef** Date: 12 / 12 / 2019

Signature:

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Finally, I'd like to say to my father, my wife Rehab and my daughter Romaysaa "Allah blesses you all".

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Nomenclature

AFT	Adiabatic Flame Temperature
CNG	Compressed Natural Gas
CCS	Carbon Capture and Sequestration
FGR	Fuel Gas Recirculation
H.F.	Hydrogen Fraction
HRSG	Heat Recovery Steam Generator
IGCC	Integrated Gasification Combined Cycle
LEL	Lower Extinction Limit
LFL	Lower Flammability Limit
L/D	Degree of Premixing (the ratio between the pipe length L to its mean diameter D)
MFMs	Mass flow Meter
$\dot{m}$	Oxidizer Mass Flow Rate
NGCC	Natural Gas Combined Cycle
nH_2	Number of moles of hydrogen divided by number of moles of both of hydrogen and methane.
NIS	National Institute of Standards
O.F.	Oxygen Fraction
Re	Reynolds Number
RFG	Recycled Flue Gases
UFL	Upper Flammability Limit

Greek symbols

Ø: Equivalence ratio

Λ: Excess air factor