شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

جامعة عين شمس

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نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
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EXPERIMENTAL INVESTIGATION OF TURBULENT PLANAR INHOMOGENEOUS JET FLAMES USING RAYLEIGH SCATTERING TECHNIQUE

By

Bassem Mohamed Akoush Abdelmohsen

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
2020

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Title of Thesis:
Experimental investigation of turbulent planar inhomogeneous jet flames using Rayleigh scattering technique

Key Words:
Inhomogeneous; Mixing field; Stability; Regime diagram; Rayleigh scattering

Summary:

The objective of this work is to study the mixing field of inhomogeneous jets flames using highly resolved measurements of non-reacting free jets of air and fuel in a concentric flow slot burner, CFSB, using Rayleigh scattering technique. The impact of the mixing length, equivalence ratio, Reynolds number, velocity ratio between the air and the fuel and the fuel type on the mixing field were investigated. The data are then analyzed statistically and classified using the regime diagram of partially premixed flames. The stability characteristics of inhomogeneous jet flames are studied experimentally at different velocities of co-flow air. The aim is to study the correlation between the mixing field structure and flames stability. This work provides a massive dataset with high quality for the mixing field of inhomogeneous jet flames which can be used in numerical modeling of these flames in the future.

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.

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Signature:

Acknowledgement

First and foremost, I would like to express my deep gratitude to my thesis advisors Prof. Mohy Mansour, Prof. Abdelhafez Hassanein and Dr. Mohamed Fayed for their support, guidance inspiring remarks and wise suggestions. Without their assistance and encouragement, I could not have done this research work or written my M.Sc. thesis. I really appreciate all their contributions of time and ideas to gain a fruitful and productive research experience.

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Nomenclature

Latin

Symbol	Description
$\mathbf{A}$	Cross-section area of flow
$\mathbf{D}$	Hydraulic Diameter
$\mathbf{dZ/dl}$	Two-dimensional gradients of the mixture fraction
$\mathbf{fl}$	Focal length
$\mathbf{(F/A)_{st}}$	Stoichiometric fuel to air ratio
$\mathbf{F/A}$	Actual fuel to air ratio
$\mathbf{I_{Laser}}$	Laser energy
$\mathbf{(L/D)_{max}}$	Maximum limit of L/D for stable flames
$\mathbf{(L/D)_{min}}$	Minimum limit of L/D for stable flames
$\mathbf{L}$	Mixing length
$\mathbf{m}$	Number of carbon atoms
$\dot{\mathbf{m}}$	Mass flow rate
$\mathbf{MW}$	Molecular weight
$\mathbf{n}$	Number of hydrogen atoms
$\mathbf{Re}$	Reynolds number
$\mathbf{U}$	Stream velocity of fluid
$\mathbf{Z}$	Mass Mixture Fraction
$\mathbf{N}$	Total molecular number density
$\mathbf{R_{\Delta}}$	The normalized range of mixture fraction, the ratio between ΔZ and ΔZ_{LR}
$\mathbf{R_{Z}}$	The normalized mean of mixture fraction, the ratio between Z_{mm} and Z_{LR}
$\mathbf{S_{Rayleigh}}$	Rayleigh scattering intensity
$\mathbf{V_{cF}}$	Velocity of co-flow
$\mathbf{Z_{L}}$	Mixture fraction at lean flammability limit
$\mathbf{Z_{LR}}$	Arithmetic mean of the flammability limits mixture fraction
$\mathbf{Z_{R}}$	Mixture fraction at rich flammability limit
$\mathbf{Z_{max}}$	Maximum mixture fraction
$\mathbf{Z_{min}}$	Minimum mixture fraction
$\mathbf{Z_{mm}}$	Arithmetic mean of the min and max mixture fraction