AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

A STUDY OF THE EFFECT OF INTERACTION BETWEEN A LIQUID FUEL SPRAY AND THE SURROUNDING AIR ON COMBUSTION CHARACTERISTICS

BY

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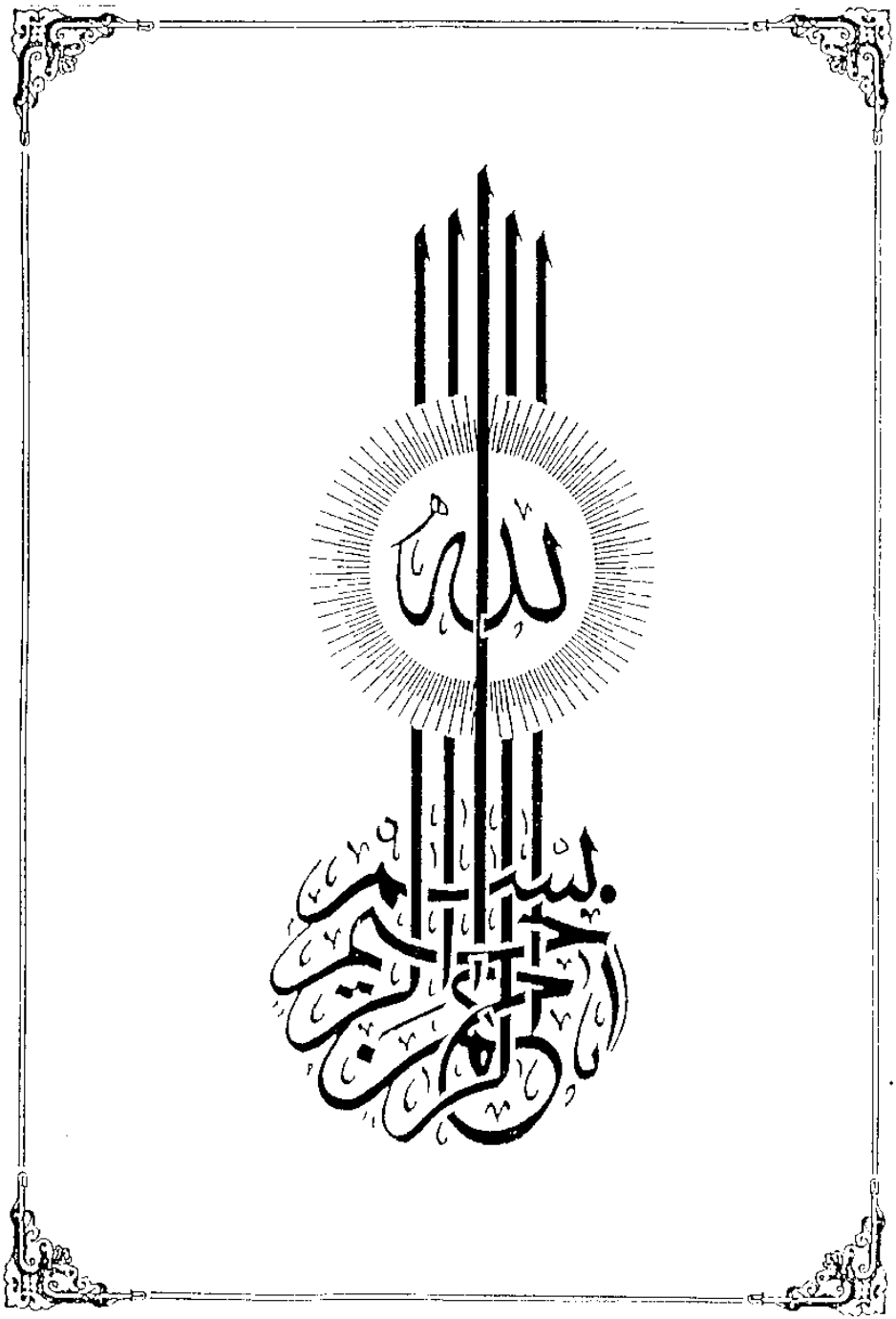

PREFACE

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Mechanical Engineering.

The work included in this thesis was carried out by the author in the Energy and Automotive Department ,Faculty of Engineering , Ain Shams University from December 1981 to September 1988.

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

ABSTRACT

In the present work , measurements of local flame properties are performed within disc / swirl stabilized kerosene spray flame in a cylindrical water cooled combustion chamber of 0.21 m internal diameter . The flames corresponded to different values of air swirl (10° , 35°) and stabilizer disc diameter (0.07 , 0.08 and 0.09 m) . The six flames operated under lean mixture conditions with an input equivalence ratio of 0.68 .

The results indicated that , for both high and low swirl , the increase of disc diameter from 0.07 to 0.09 m causes an improvement in the fuel spray and turbulent mixing of the fuel and air with a resulting higher tendency for flame stabilization. This is coupled with a higher rate of chemical reactions and energy release rate at downstream regions of the flames . The increase of disc diameter , for both high and low swirl , decreases the values of heat flux to the combustor wall at first then increases the values of heat flux , with larger values , for the largest disc diameter .

The increase in the degree of combustion air swirl produced similar effect on the flame properties as those observed with the increase in stabilized disc diameter . However , the extent of these effects is much larger with the

increase in air swirl . The increase of air swirl increases the amount of fuel vapour and CO within the central region of the flame and this caused an increase in the flame length. Also the increase of air swirl increases the measured values of heat flux to the combustor wall.

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NOMENCLATURE

A	Area	m^2
c_w	Specific heat	KJ/Kg°
D	Disc diameter	m
D_p	Droplet diameter	um
d	Combustion chamber internal diameter	m
d_w	Wire diameter	um
FN	Flow number	
ID	Inner diameter	mm
l	Axial distance of the segment	m
$\dot{m}$	Air flow rate	Kg/sec
m_w	Water flow rate	Kg/sec
N	Viscosity	c.stokes
N_p	Number of droplet	
OD	Outer diameter	mm
P	Inlet air pressure	atm
p	Pressure differential across the nozzle	Ib/sq.inch
Q	Heat flux	Kw
q	Fuel volume flow rate	Imperial gallon /hı
q_a	Air flow rate	m^3/sec
R_o	Combustion chamber internal radius (d / 2)	m
r	Radial distance	
S	Swirl number	
s	Swirl angle	
SMD	Sauter mean droplet diameter	um
T	Gas temperature	^{o}C
T_o	Inlet air temperature	^{o}K
T_w	Water temperature rise	^{o}C