THRUST CONTROL USING COMBINED VANES AND PLUG ARRANGEMENTS

by

Walid Aniss Mahmoud Aissa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

in

AEROSPACE ENGINEERING

Under the Supervision of

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Faculty of Engineering , Cairo University
GIZA , EGYPT
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ABSTRACT

Thrust vector control can be used to augment or replace aerodynamic control forces and moments generated by airframe control surfaces. Moreover, it is the only key to post-stall maneuverability. A static test is made to investigate the internal performance of axisymmetric convergent sonic nozzles under the effect of vectoring two externally mounted vanes. The internal performance is also investigated when a central plug ; fixed or floating of conical or contoured profile is moved along the nozzle axis relative to the nozzle exit for a range of nozzle pressure ratios and vane deflection angles. It is found that configurations of larger nozzle throat area have higher vane pressure distribution , greater vane hinge moment than those of smaller nozzle throat area. They also have upstream center of pressure location and greatest aerodynamically heated region toward the vane leading edge than those of smaller nozzle throat area. Plug nozzles have relatively higher pressure distribution, more forward vane center of pressure location compared to plugless nozzle of the same throat area.. In addition, they have larger nozzle discharge coefficient, axial force, side force and hinge moment compared to plugless nozzle of the same throat area. Moreover, plug nozzles have closer effective vane angle to geometric vane angle and side force effectiveness to the ideal value. Contouring the plug further enhances the nozzle performance. Full model side force and hinge moment can be estimated from the corresponding scale model values. Empirical formulas are estimated for nozzle discharge coefficient, side force generation effectiveness, and hinge moment coefficient for the tested configurations. Flow visualization studies indicate reversed flow for the lower vane of plugless nozzle which is not observed for configurations having the same throat area but utilizing plug arrangement.

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TABLE OF CONTENTS

LIST OF TABLES