Ain Shams University
Faculty of Engineering

A STUDY OF THE PROCESS OF HEATING A SOLID SURFACE BY IMPINGEMENT OF HOT JETS

A THESIS
BY

MOHAMED SAAD EL-DINE EL-MORSI
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SUPERVISED BY

Prof. Dr. S. M. Abd El-Ghany
Ain Shams University

Ass. Prof. Dr. M. A. Noseir
Ain Shams University

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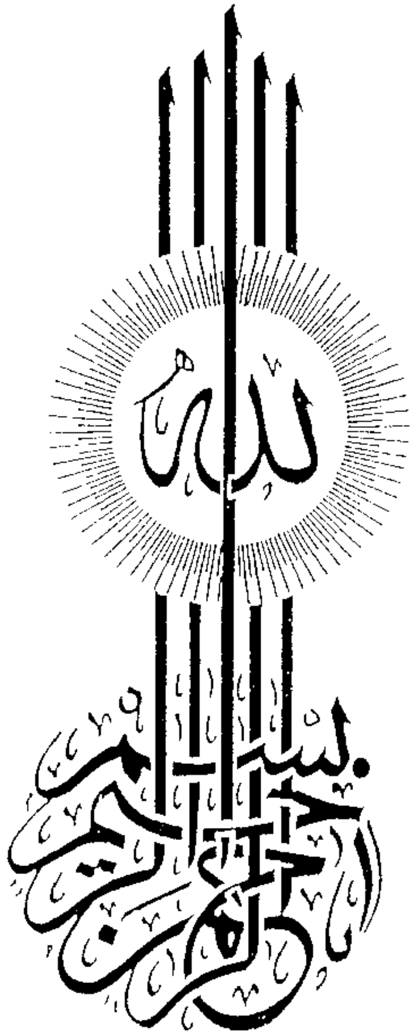
بسم الله الرحمن الرحيم

PREFACE

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

The work included in this thesis was carried out by the author at the laboratories of the department of Mechanical Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at any other University.

Signature: M. ElMorsi

Name: Mohamed El-Morsi

Examiners committee

The undersigned certify that they have read and recommend to the Faculty of Engineering, Ain Shams University for acceptance a thesis entitled " A Study of the Process of Heating A Solid Surface by Impingement of Hot Jets", submitted by Mohamed Saad El-Din El-Morsi, in partial fulfilment of the requirements for the degree of Master of Science in Mechanical Engineering.

Signature

1. Prof. Dr. **SALAMA ABD EL-HADY MOHAMED**
   Professor of Mechanical Engineering
   Aswan Institute of Technology.

2. Prof. Dr. **ADEL ABD EL MALAK EL-AHWANY**
   Professor of Mechanical Engineering
   Faculty of Engineering, Ain Shams University.

3. Prof. Dr. **SAMIR MOHAMED ABD EL-GHANY**
   Professor of Mechanical Engineering
   Faculty of Engineering, Ain Shams University.

4. Ass. Prof. Dr. **MAHMOUD ABD EL-RASHID NOSEIR**
   Assistant Professor of Mechanical Engineering
   Faculty of Engineering, Ain Shams University.

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Summary

Impinging jets are an established technique for obtaining high local transfer coefficients between a fluid and a surface. They are employed in different ranges of heat and/or mass transfer applications including; heating or cooling of large surface area products, drying of paper and textiles, cooling of gas turbine blades and annealing of metals and plastic sheets.

A significant amount of research has been conducted on the problem of cooling a uniform heat flux surface, with gas or liquid jets. However, there have been very few attempts to study the problem of heating a flat plate normal to the jet axis. The only experimental research, up to my knowledge, that studies heating an inclined flat plate using hot air jets has been carried out in 1952. Nevertheless this research has been criticised by other researchers.

In the present study an experimental investigation is conducted on the local heat transfer coefficients for a round jet of hot air, issuing from a 27 mm diameter tube, striking an oblique solid surface. The problem parameters investigated are the plate inclination, the nozzle-to-plate spacing and the jet Reynolds number. It is found that the point of maximum heat transfer is displaced uphill from the geometric impingement point and the magnitude of this displacement increases as the plate inclination increases. The local coefficients on the uphill side of the point of maximum heat transfer tend to drop off more rapidly, unlike those on the downhill side. Thus, on comparing oblique impingement to normal impingement, there is an unsymmetric distribution in the local heat transfer coefficients about the stagnation

point, this asymmetry increases as the plate inclination increases. Moreover, inclined jets provide higher heat transfer coefficients on the downhill side and lower heat transfer coefficients on the uphill side, leading to imbalance in the heating capabilities on the two sides. It is also observed that the stagnation point Nusselt number decreases as the plate inclination increases. An empirical correlation of the experimental data along the plane of the plate inclination is developed.

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