بسم الله الرحمن الرحيم

شبكة المعلومـــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

﴿ قـــسـم ﴾

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد اعدت دون آية تغيرات

يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of
15 – 25c and relative humidity 20-40 %

بعض الوثائق الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصـــل

Mansoura University
Faculty of Engineering
Mech. Power Engg. Dept.

Thesis in

A Theoretical Study of Heat and Fluid Flow in Porous Media

Submitted for the Degree of Master of Science in Mechanical Power Engineering

By

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2007

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ACKNOWLEDGEMENT

Praise is to **ALLAH**, the most merciful and the owner of the whole world, and prays and peace on Prophet **MOHAMED**.

I would like to express my great respect to Prof. Dr. **Mahmoud M. Awad**, Mechanical Power Department, Faculty of Engineering, Mansoura University, for his care, valuable supervision, and scientific support. In fact, without his efforts, this research would not have been within hands.

Deep appreciation and gratitude go to Assoc. Prof. **Gamal M. Attia**, Basic Sciences Department, Faculty of Engineering, Mansoura University, for his encouragement and valuable suggestions, especially in the numerical algorithm design and adaptation. His assistance, precious advices, support, and cooperation are most appreciated.

My grateful and thanks go also to Dr. **Housam Abou Bakr El-Seddiek**, Mechanical Power Department, Faculty of Engineering, Mansoura University, for his continuous encouragement, valuable scientific support and cooperation. Therefore, he deserves my gratitude and respect.

I am very thankful to Dr. **Khalil A. EL-Salam**, Mechanical Power Department, 10th of Ramadan Higher Technological Institute, that he did not save any effort to support and advice me only, for the face of **ALLAH**. Therefore, I am so grateful to his scientific and religious honesties.

Finally, my great gratitude and respect to my mother and to the soul of my late father.

ABSTRACT

This work documents a theoretical study of hydrodynamic and thermal behavior in a porous media. This porous medium was modeled as bundles of parallel square rods arranged in a regular pattern inline and stagger arrangements with infinite length in the direction perpendicular to the flow direction. The flow was assumed laminar, incompressible, and two-dimensional. The hydrodynamic and thermal behaviors were studied numerically due to impulsive start of flow and it's propagation with time assuming that the square rods have constant wall temperature.

The study was applied in two parts:-

In the first one, the flow was assumed to be fully developed.

In the second one, the entrance region effect was taken into consideration.

Moreover, the numerical investigation was carried out at the following ranges:-

- Darcian Reynolds number range $0.01 \leq Re_D \leq 100$ for inline arrangement and $0.01 \leq Re_D \leq 25$ for stagger arrangement.
- The fluid phase is water and the range of the Prandtl number is $1.78 \leq Pr \leq 13.44$.

- The macroscopic flow angle "Θ" was varied as 0^{o}, 15^{o}, 30^{o} and 45^{o}
- The media porosity, $8\% \leq \varepsilon \leq 84\%$ for inline arrangement and, $60\% \leq \varepsilon \leq 84\%$ for stagger arrangement.

A detailed numerical algorithm was established and a Delphi computer program was designed in this work to solve the governing equations and give values of the dimensionless variables (stream Ψ^{*}, vorticity ω^{*} and temperature Θ), until the steady state condition is reached. The results were transformed to contour plots to indicate the corresponding distributions inside the calculation domain.

The effect of changing the macroscopic flow angle "Θ", Darcian Reynolds number "Re_D" and system porosity "ε" on the dimensionless pressure drop was investigated. Empirical equations, relating the media porosity "ε" with the media permeability "K" for both inline and stagger arrangements were extracted.

The empirical equation resulted from this work for the inline arrangement was compared with the existing equation obtained and proved good agreement.

The average Nusselt number was calculated in case of macroscopic flow angle $\Theta = 0^{o}$ and media porosity $\varepsilon = 60\%$ over each individual cell of the porous

array until thermal equilibrium reached. Consequently, the row average Nusselt number $\overline{Nu}$ was calculated at different values of Darcian Reynolds numbers "Re_D". In addition, the thermal behavior of the square rods was compared with that if the rods were assumed to have circular cross-section having the same hydraulic diameter and cell height.

An empirical exponential formula, relating the average Nusselt number $\overline{Nu}$ with the Reynolds number based on the hydraulic diameter and average velocity over the minimum cross-section, ($Re_{D_H,Max}$) was extracted for both inline and stagger arrangements.

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