NUMERICAL STUDY OF THE EFFECT OF DROP SHAPED DIMENSIONS ON HEAT EXCHANGER PERFORMANCE

by

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B.Sc Mechanical Engineering 2009

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Thesis submitted to the Sudan University of science and Technology partial fulfillment of the requirementsfor the degree of M.Sc. in power engineering

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October 2014

Abstract

This research presents the results of numerical study of heat transfer and pressure drop behavior in a compact heat exchanger (CHE) designed with drop-shaped pin fins. The heat exchanger used for thisresearch consists of a rectangular duct fitted with different drop-shaped pin fins dimensions with the same heat transfer wetted surface area.A three dimensional finite volume based numerical model using ANSYS FLUENT 14.5 has been conducted to select the optimum pin fin dimension considering maximum heattransfer and minimum pressure drop across the heat exchanger. The total four cases that tested having pin tails length to drop diameter *L/D* of 1.75, 1.5, 1.25 and 1.

The numerical results indicated that the case which had the ratio *L/D* of 1.75 achieved the best performance of pressure drop for the same heat transfer coefficient.

التجريدة

يوضح هذا البحث نتائج محاكاة لانتقال الحرارة وفقودات الضغط في مبادل حراري مدمج صمم بزعانف مسمارية علي شكل قطرة. المبادل الحراري المستخدم لهذا البحث يتكون من قناة مستطيلة الشكل مثبته فيه زعانف مسمارية مختلفة من ناحية الابعاد ولكن لها نفس مساحة انتقال الحرارة. تم اجراء المحاكاة في نموزج ثلاثي الابعاد باستخدام برنامج ANSYS Fluent 14.5 لاختيار الابعاد المثالية التي تعطي اعلي انتقال حرارة واقل فقودات ضغط للمبادل الحراري. أجريت الدراسة علي اربع نمازج لها نسبة *L/D=1.7, 1.5, 1.25,1*.

نتائج المحاكاة اثبتت ان النموزج الذي له نسبة *L/D=1.75* حقق افضل اداء بالنسبة لفقودات الضغط لنفس معامل انتقال الحرارة مقارنة مع النمازج الاخري.

Acknowledgments

First I would like to express my deep appreciation and gratitude to Dr.ObaiYounisTaha for his constant support and exceptionally helpful guidance throughout this study. Working under his supervision greatly contributed to improving the quality of the thesis.

Also I would like to thank my parents. “You have offered unconditional tolerance and support throughout not only my graduate work, but throughout my entire life”.

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Nomenclature

A_{wf} Flow wetted surface area (mm^2).

A_{wh} Heat transfer wetted surface area (mm^2).

V_{op} Total fluid volume inside the heat exchanger (mm^3).

D_h Hydraulic Diameter (mm).

A_{ave} The average flow area (mm^2).

D Pin diameter (mm).

H Pin height (mm).

L Total test section length, Pin tail length (mm).

$\dot{Q}$ Heat transfer rate (W).

Nu Nusselt number.

Re Reynold number.

$\bar{h}$ Average heat transfer coefficient ($\frac{W}{m^2K}$).

f Friction coefficient.

T_{in} Air inlet temperature (K)

T_{out} Air outlet temperature (K).

T_{wall} Wall temperature (K).

ΔT_{lm} The log mean difference temperature (K).

ΔP_{ave} The average pressure difference (Pa).

K Thermal conductivity ($\frac{W}{m\ K}$).

k Turbulent kinetic energy.

l Turbulent length scale.

I_i Conductive and diffusing flux.

Greek

μ Dynamic viscosity ($\frac{Kg}{m.s}$).

μ_t Eddy viscosity or turbulent viscosity ($\frac{Kg}{m.s}$).

θ Pin fin angle.

ρ Density ($\frac{Kg}{m^3}$).

ε Turbulence dissipation rate ($\frac{m^2}{s^3}$).

Subscripts

e East face of control volume.

w West face ofcontrol volume.

E East node ofcontrol volume.

W West node ofcontrol volume.

P Node of control volume.

EE East of the east node ofcontrol volume.

WW West of the west node of control volume.

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