شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

شبكة المعلومــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

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 %

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بعض الوثائق

الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصـــــل

B1.9.0

TANTA UNIVERSITY
FACULTY OF ENGINEERING

Effect Of Rotation on the Flow Resistance and Heat Transfer in Circular Tubes Rotating About a Parallel Axis

A thesis submitted to the Department of Mechanical Power Engineering
For the fulfillment of the Degree
Master of Science
In Mechanical power Engineering

By

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We certify that we have read his thesis and that in our opinion It is fully adequate in the scope and quality as a dissertation for the degree of Master of Science in Mechanical Engineering.

2002

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Degree : Master of Science In Mechanical power Engineering

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2002

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Abstract

Many engineering installations and equipment include rotating elements, which work under severe operating conditions and different temperature levels, such as turbines, generators, engines, rotating heat exchangers, etc. The severe operating conditions along with the high temperatures extremely affect the crystal structure and increase rate of mechanical wear, and therefore reduce their lifetime. For these reasons, many studies have been done to achieve a good cooling process for such rotating elements. For example, rotating heat exchangers and cooling of turbine blades (gas or steam turbines) which may operate at temperatures up to 1800 °C.

The rate of cooling process is significantly affected by the rotation speed. Therefore, many researchers have to study the effects of rotation on the heat transfer process e.g. do great efforts.

A survey of literature is made to clear all studies made in this subject during the last few decades. It shows that there is a lack of experimental studies that investigate the effect of rotating on flow characteristics and heat transfer in a tube rotating around a parallel axis and the effect of the various parameters of this construction. The present study focuses on this point. A test rig is designed to study the effect of the following parameters on both flow and heat transfer characteristics;

- The distance between the tube and the axis of rotation.
- Variation of the rotational speed of tube.

The test rig includes a mechanism for power supply fixed on the rotating tube and also for the thermocouples led out from the rotating tube to the measuring device. Water is used as a heat transfer fluid and sealing between the rotating tube and the fixed ends of the test rig is provided.

The results show a considerable increase in both the heat transfer and friction coefficients with the increase of the rotational speed, and the distance between the tube and its axis of rotation (radius of rotation). General correlations for the friction factor and the Nusselt number are proposed as

functions of the flow and rotation parameters. These correlations, which are applicable to a wide range of varieties, are found to be representative to the experimental data with a good accuracy. The proposed friction correlation can describe all the experimental results within ±5.8 %, while the proposed heat transfer correlations can describe all the test data within ±4.4%. Nomograms are constructed to permit quick estimations of the friction factor and Nusselt number under different operating conditions.

Comparisons between the experimental results and Nakayama correlations [4] are made. Maximum deviations of about 9.7 % for the friction coefficient and about 11 % for the Nusselt number are obtained.

CONTENTS

NOMENCLATURE

A	area, cm^2.
$A_{C.S.}$	cross section area, cm^2.
$A_{H.T}$	heat transfer area, cm^2.
C_p	specific heat at constant pressure, J/kg K.
d	tube diameter, cm.
E	error
f	friction coefficient, $(\Delta h*a*2g)/l*v^2$.
Gr	Grashof number, $g\beta\ (t_s - t)*d^3/v^2$.
Gr^*	Rotational Grashof number, $H\,\omega^2\,\beta\,(\tau\, a)\,d^3/v^2$.
g	gravitational acceleration, m/s^2.
H	radius of rotation (amplitude),cm.
h	local heat transfer coefficient, $W/m^2\ K$.
h^*	average heat transfer coefficient, $W/m^2\ K$.
k	thermal conductivity, W/m K .
l	tube length, cm.
$\dot{m}$	rate of mass flow, kg/s
N	rotation speed, rpm.
Nu	Nusselt number, $h\,d/k$.
Nu_{av}	average Nusselt number, $h^*\,d/k$.
P	pressure, N/m^2 .
Pr	Prandtl number ,$\mu\, C_p/k$.
Q	heat transfer, W.
$\dot{q}_c$	heat flux, W/m^2.
Re	Reynolds number , Ud/ν .
Ri	Richardson number , Gr/Re^2 .
Ro	rotation number, $N*d^2/\nu$.
t	bulk fluid temperature, $(t_o+t_i)/2$, K .
t_i	inlet fluid temperature , K .
t_o	outlet fluid temperature , K .
t_s	tube surface temperature , K .
U	radial velocity, m/s.
U_{in}	inlet velocity , m/s .

u	dimensionless radial velocity .
V	volume,cm^3.
$\dot{V}$	volume flow rate, cm^3/sec.
x	body force, $(1+6.4\,9\,\delta\Gamma^2)^{1/2} - 2.55/\Gamma$

GREEK SYMBOLS

α	thermal diffusivity , m^2/s .
β	coefficient of volumetric thermal expansion , K^{-1} .
ρ	density , kg/m^3.
ρ_∞	ambient density , kg/m^3.
Δ	difference
δ	thickness of the boundary layer
μ	dynamic viscosity , kg/ms.
ν	kinematic viscosity , m^2/s.
τ	time,sec.
Γ	(inertia force) / (Coriolis force), $\left[\dfrac{Re^{2m+1}}{(Gr^{*}Pr^{1-k})^{m+1}}\right]^{(\frac{2}{2m+3})}$
ω	angular velocity of the pipe, rad/s.
θ	circumferential angle

SUBSCRIPTS

b	Bulk
m	Mean
s	Surface
i	inner
o	outer

Chapter 1
Introduction