University of Cincinnati
College of Engineering and Applied Science
Department of Mechanical & Materials Engineering

Course Code : **MECH-5072C**
Course Title : **EXPERIMENTAL METHODS/ME**

Experiment Number : #1
Experiment Title :

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Date Submitted : **Feb 10, 2023**

Group Code : **F-01**
Group Members : **YI, Hongrui: Objective 1 & Objectives 4, 2 hours**
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1. Objectives

At the end of this experiment, the students are expected to:

(1) Determine the velocity and mass flow rate measured by using an orifice plate.
(2) Determine Heat input (at the heating element), Heat loss through conduction, and hence Net Heat Input and Net Heat flux at the test pipe.
(3) Determine the heat transfer coefficient (h) at the test section.
(4) Evaluate local Friction Factor (f).
(5) Establish heat transfer-fluid flow analogy and compare with experimental results. And calculate and compare St from heat transfer-fluid friction analogy by plugging in friction factor and St calculated directly from experimental value of h. Also obtain theoretical values of Nu, St, and f to compare it with experimental values.
(6) Measure temperature and velocity profiles in fully developed region.

2. Theoretical Background

Calculate density of air using ideal gas law:

$$\rho_a = \frac{P_{a,abs}}{R_a T_a} \tag{1}$$

Calculate air velocity using pressure drop across orifice:

$$v_a = C_d \sqrt{\frac{2\Delta P_{ori}}{\rho_a}} \tag{2}$$

Where, C_d is Discharge coefficient.
Calculate mass flow rate of air:

$$\dot{m} = \rho_a v_a A_{or} \tag{3}$$

First, calculate the total energy rate that goes into the heat exchanger.

$$\dot{Q}_{in} = VI \tag{4}$$

The energy loss rate is calculated as follows:

$$\dot{Q}_{loss} = \frac{2\pi k_f L_H (T_w - T_i)}{\ln{(R/r_2)}} \tag{5}$$

Where, k_f is the conductivity of the insulation.
L_H is the length.
T_w is the temperature of the hot wall inside.
T_i is the temperature of the insulation outside.
R is the outside radius.
r_2 is the inside radius of the hollow cylinder.

The net heat input can be calculated using both values calculated above.

$$\dot{Q}_{net} = \dot{Q}_{in} - \dot{Q}_{loss} \tag{6}$$

The heat flux is calculated as follows:

$$q''_{net} = \frac{\dot{Q}_{net}}{A_s} \tag{7}$$

The overall equation of heat transfer coefficient is as follows:

$$h = \frac{q''_{net}}{(T_w - T_b)} \tag{8}$$

Where T_b is the average temperature of the fluid, also known as the bulk mean fluid temperature.

To calculate T_b, T_{b1} and T_{b2} can be found by calculating the plot of the temperature distribution. The slop of the plot is given by:

$$tan\theta = \frac{\Delta T}{L_H} = \frac{\dot{Q}_{net}}{\dot{m}C_p L_H} \tag{9}$$

The friction factor is calculated as:

$$f = (\frac{\Delta P_t}{\rho_h {v_h}^2} - \frac{(T_{b2} - T_{b1})}{4T_{b2}} - \frac{1}{4}\ln(\frac{r_2}{r_1})) \times \frac{2d_i}{L_t} \tag{10}$$

To calculate the Nusselt Number:

$$Nu = \frac{h \cdot d_i}{k} \tag{11}$$

To calculate the Prandtl Number:

$$Pr = \frac{\mu \cdot C_p}{k} \tag{12}$$

To calculate the Reynold Number:

$$Re = \frac{\rho_h \cdot v_h \cdot d_i}{\mu} \tag{13}$$

To calculate the Stanton Number:

$$S = \frac{h}{\rho_h \cdot v_h \cdot C_p} \tag{14}$$

To calculate the St with Reynold Analogy:

$$St_{Re} = \frac{f}{8} \tag{15}$$

To calculate the St with Colburn Analogy:

$$St_{Co} = \frac{f}{8 \cdot (Pr^{\frac{2}{3}})} \tag{16}$$

To calculate the St with Prandtl Analogy:

$$St_{Pr} = \frac{(f/8)}{(1 + 5 \cdot \left(\frac{f}{8}\right)^{0.5} \cdot (Pr - 1))} \tag{17}$$

To calculate the St with Von Karman Analogy:

$$St_{Vo} = \frac{(f/8)}{(1 + 5 \cdot \left(\frac{f}{8}\right)^{0.5} \cdot (Pr - 1) + \ln\left(1 + \left(\frac{5}{6}\right) \cdot (Pr - 1)\right))} \tag{18}$$

To calculate the St with Dittus-Boelter Analogy:

$$St_{Di} = \frac{0.023 \cdot Re^{-0.2}}{Pr^{0.6}} \tag{19}$$

To calculate the St with Sider-Tate Analogy:

$$St_{Si} = \frac{0.027 \cdot Re^{-0.2} \cdot (\frac{\mu}{\mu_w})^{0.14}}{Pr^{\frac{2}{3}}} \tag{20}$$

As for the velocity profiles, velocity could be determined by measuring the difference between static and stagnation pressures at a point:

$$Velocity = C_{pitot}\sqrt{\frac{|2(P_T - P_S|}{\rho}} \tag{21}$$

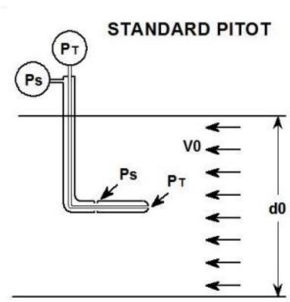

Figure 1. Pitot Tubes

3. Sample Calculation

3.1 Velocity and Mass Flow Rate of Air

Calculate density of air using ideal gas law:

$$R_a = 287\frac{J}{kg\cdot K}$$

$$T_a \ = \ 44°C = 317.15\,K$$

$$P_a = \ 496\,mm\ of\ H2O$$

$$P_{a,abs} = \ 496 \ \times \ 10^{-3}m \times 1000\frac{kg}{m^3}\times 9.8\frac{m}{s^2} + 101325\,Pa = 106185.8\,Pa$$

$$\Delta P_{ori} \ = 126 \ \times \ 10^{-3}m \times 1000\frac{kg}{m^3}\times 9.8\frac{m}{s^2} = 1234.8\,Pa$$

$$\rho_a = \frac{P_{a,abs}}{R_a T_a} = \frac{106185.8}{287\times 317.15} = 1.1666\frac{kg}{m^3}$$

Calculate area of orifice:

Where d=40mm=0.04m

$$A_{or} = \frac{\pi d^2}{4} = 3.1415 \times \frac{0.040^2}{4} = 1.2566\times 10^{-3}\ m^3$$

Calculate air velocity using pressure drop across orifice:

Where Discharge coefficient $C_d = \ 0.613$

$$v_a = C_d\sqrt{\frac{2\Delta P_{ori}}{\rho_a}} = 0.613\sqrt{\frac{2\times 1234.8}{1.1666}} = 46.01\,m/s$$

Calculate mass flow rate of air:

$$\dot{m} = \rho_a v_a A_{or} = 1.1666\times 46.01\times 1.2566\times 10^{-3} = 0.0674\,kg/s$$

3.2 Net Heat Input and Net Heat Flux

Table 1. Thermocouple readings

Thermocouple Number	Temperature (°C)	Thermocouple Number	Temperature (°C)
1	77.7	8	119.3
2	89.4	9	36.5
3	104.0	10	139.4
4	99.6	11	71.4
5	101.7	12	139.9
6	102.9	13	60.5
7	101.1	14	68.1

First, calculate the total energy rate that goes into the heat exchanger.

$$\dot{Q}_{in} = VI = 218V \times 4.2A = 915.6W$$

The energy loss rate is calculated as follows:

$$\dot{Q}_{loss} = \frac{2\pi k_f L_H (T_w - T_i)}{\ln{(R/r_2)}}$$

Where k_f is the conductivity of the insulation. ($k_f = 0.0415\ W/(m \cdot k)$)

L_H is the length. ($L_H = 1.75m$)

T_w is the temperature of the hot wall inside.

T_i is the temperature of the insulation outside.

R is the outside radius. ($R = 0.0365m$)

r_2 is the inside radius of the hollow cylinder. ($r_2 = 0.0175m$)

$$T_w = \frac{T_8 + T_{10} + T_{12}}{3} = \frac{119.3 + 139.4 + 139.9}{3} \text{°C} = 132.87\ \text{°C} = 406.02K$$

$$T_i = \frac{T_9 + T_{11} + T_{13}}{3} = \frac{36.5 + 71.4 + 60.5}{3} \text{°C} = 56.13\ \text{°C} = 329.28K$$

So, the energy loss rate can be calculated.

$$\dot{Q}_{loss} = \frac{2\pi \times 0.0415 \times 1.75(406.02 - 329.28)}{\ln\left(\frac{0.0365}{0.0175}\right)} W = 47.6359\ W$$

The net heat input can be calculated using both values calculated above.

$$\dot{Q}_{net} = \dot{Q}_{in} - \dot{Q}_{loss} = 867.9641\ W$$

The heat flux is calculated as follows:

$$q"_{net} = \frac{\dot{Q}_{net}}{A_s} = \frac{\dot{Q}_{net}}{2\pi r_2 L_H} = 4510.7191\, W/m^2$$

The heat lost as a percentage of total heat input:

$$Heat\ lost = \frac{\dot{Q}_{loss}}{\dot{Q}_{in}} \times 100\% = 5.20\%$$

3.3 Heat Transfer Coefficient

The overall equation of heat transfer coefficient is as follows:

$$h = \frac{q"_{net}}{(T_w - T_b)}$$

Where T_b is the average temperature of the fluid, also known as the bulk mean fluid temperature.

To calculate T_b , $T_{b1}\ and\ T_{b2}$ can be found by calculating the plot of the temperature distribution. The slop of the plot is given by:

$$tan\theta = \frac{\Delta T}{L_H} = \frac{\dot{Q}_{net}}{\dot{m} C_p L_H}$$

Calculating C_p using the mean of T_1 to T_7.

$$C_p = 1010\, J/（kg - K）$$

$$tan\theta = \frac{\dot{Q}_{net}}{\dot{m} C_p L_H} = \frac{867.9641}{0.0401 \times 1010 \times 1.75} = 12.246$$

So the function of the slope can be determined by $y = tan\theta x + y_0$. Bring in data points at T_1 (0.12m,77.7℃) and T_2 (0.4m, 89.4℃) as sample points to calculate the final function $y = 12.246x + 76.23$.

T_{b1} is the value of y when x equals to 0, which $T_{b1} = 76.23$℃. T_{b2} is the value of y when x equals to L_H, which $T_{b2} = 97.66$℃ . So $T_b = 356.35K$

$$h = \frac{q"_{net}}{(T_w - (T_{b1} + T_{b2})/2)} = \frac{4510.7191}{(406.02 - 360.095)} = 90.8153 W/(m^2 \cdot K)$$

3.4 Friction Factor (f)

The friction factor is obtained from the test length pressure drop, ΔP_t

From the measurements:

$\Delta P_t = 115mm\ of\ H_2O = 1000 \frac{kg}{m^3} \times 9.81 \frac{m}{s^2} \times 0.115m = 1128.15Pa$

Since,

$P_1 - P_2 = \Delta P_t$ and $P_2 = 101325Pa$ (room pressure)

$P_1 = \Delta P_t + P_2 = 1128.15 + 101325 = 102453.15Pa$

Then, the mean pressure in the test length P_t is:

$P_t = \frac{P_1+P_2}{2} = \frac{102453.15+101325}{2} = 101889.075Pa$

The density of air in the heated section is:

$\rho_h = \frac{P_t}{R_a T_b} = \frac{101889.075Pa}{287\frac{\mathrm{J}}{\mathrm{kg\cdot K}}\times 356.35\mathrm{K}} = 0.996\,\frac{\mathrm{kg}}{m^3}$

The velocity of air in the heated section:

$v_h = \frac{\dot{\mathrm{m}}}{\rho_h A_i}$

Where,

d_i is the diameter of the heated pipe, $d_i = 2r_1 = 32.6mm$

$A_i = \frac{\pi {d_i}^2}{4} = \frac{\pi\times 0.0326m^2}{4} = 8.347\times 10^{-4}m^2$

Thus,

$v_h = \frac{\dot{\mathrm{m}}}{\rho_h A_i} = \frac{0.0674\frac{kg}{s}}{0.996\frac{\mathrm{kg}}{m^3}\times 8.347\times 10^{-4}m^2} = 81.072\,\frac{m}{s}$

Therefore,

The friction factor is calculated as:

$f = (\frac{\Delta P_t}{\rho_h {v_h}^2} - \frac{(T_{b2}-T_{b1})}{4T_{b2}} - \frac{1}{4}\ln\,(\frac{r_2}{r_1})) \times \frac{2d_i}{L_t}$

$f = \left(\frac{1128.15Pa}{0.996\frac{\mathrm{kg}}{m^3}\times(81.072\frac{m}{s})^2} - \frac{(97.66-76.23)K}{4\times(97.66+273.15)K} - \frac{1}{4}\ln\left(\frac{0.0175m}{0.0163m}\right)\right) \times \frac{2\times 0.0326m}{1.525m} = 0.006$

3.5 Heat Transfer-fluid Flow Analogy

According to the Table 5, by linear interpolation, k is evaluated as:

$$k = 0.0279 + \left(\frac{0.0293-0.0279}{353-333}\right)\cdot(356.35-333) = 0.0295\ W/mK$$

To calculate the Nusselt Number:

$$Nu = \frac{h\cdot d_i}{k} = \frac{90.8153\cdot 32.6\cdot 10^{-3}}{0.0295} = 100.36$$

To calculate the Prandtl Number:
Get μ from the IRC, $\mu = 21\cdot 10^{-6}$, $C_p = 1010$

$$Pr = \frac{\mu\cdot C_p}{k} = \frac{21\cdot 10^{-6}\cdot 1010}{0.0295} = 0.719$$

To calculate the Reynold Number:

$$Re = \frac{\rho_h\cdot v_h\cdot d_i}{\mu} = \frac{0.996\cdot 81.072\cdot 32.6\cdot 10^{-3}}{21\cdot 10^{-6}} = 125351.21$$

To calculate the Stanton Number:

$$St = \frac{h}{\rho_h\cdot v_h\cdot C_p} = \frac{90.8153}{0.996\cdot 81.072\cdot 1010} = 0.00111$$

To calculate the St with Reynold Analogy:

$$St_{Re} = \frac{f}{8} = \frac{0.006}{8} = 0.00075$$

To calculate the St with Colburn Analogy:

$$St_{Co} = \frac{f}{8 \cdot (Pr^{\frac{2}{3}})} = \frac{0.006}{8 \cdot (0.719^{\frac{2}{3}})} = 0.000934$$

To calculate the St with Prandtl Analogy:

$$St_{Pr} = \frac{(f/8)}{(1 + 5 \cdot \left(\frac{f}{8}\right)^{0.5} \cdot (Pr - 1))} = 0.00078$$

To calculate the St with Von Karman Analogy:

$$St_{Vo} = \frac{(f/8)}{(1 + 5 \cdot \left(\frac{f}{8}\right)^{0.5} \cdot (Pr - 1) + \ln\left(1 + \left(\frac{5}{6}\right) \cdot (Pr - 1)\right))} = 0.00108$$

To calculate the St with Dittus-Boelter Analogy:

$$St_{Di} = \frac{0.023 \cdot Re^{-0.2}}{Pr^{0.6}} = 0.00268$$

To calculate the St with Sider-Tate Analogy:
Get μ_w from the IRC, $\mu_w = 21.1 \cdot 10^{-6}$

$$St_{Si} = \frac{0.027 \cdot Re^{-0.2} \cdot (\frac{\mu}{\mu_w})^{0.14}}{Pr^{\frac{2}{3}}} = 0.00274$$

To calculate the theoretical values of f, Nu and St:
$Nu_{th} = 0.023 \cdot Re^{0.8} \cdot Pr^{0.4} = 241.503$, $St_{th} = \frac{Nu_{th}}{Re \cdot Pr} = 0.000825 f_{th} = 0.316 \cdot Re^{-0.25} = 0.0168$

Then, measure the difference between the analogies.
Reynold Analogy: $Error_{Re} = \frac{|St_{Re} - St|}{St} = 32.4\%$
Colburn Analogy: $Error_{Co} = \frac{|St_{co} - St|}{St} = 15.86\%$
Prandtl Analogy: $Error_{Pr} = \frac{|St_{Pr} - St|}{St} = 29.73\%$
Von Karman Analogy: $Error_{Vo} = \frac{|St_{Vo} - St|}{St} = 2.7\%$
Dittus-Boelter Analogy: $Error_{Di} = \frac{|St_{Di} - St|}{St} = 141.44\%$
Sider-Tate Analogy: $Error_{Si} = \frac{|St_{Si} - St|}{St} = 146.85\%$
Accordingly, $Error_{Vo} < Error_{Co} < Error_{Pr} < Error_{Re} < Error_{Di} < Error_{Si}$

3.6 Temperature and Velocity Profiles

Table 2. Velocity and Temperature Profiles

Dial Reading(mm)	Temperature(°C)	Manometer(mm H_2O)
0	68.6	38
3	61.2	54

6	58.5	65
9	57.4	74
12	56.1	81
15	56.4	85
18	56.3	82
21	57.7	75
24	60.4	66
27	64.8	53
29.5	71.2	44

The velocity could be determined by using equation (21) with the density determined in objective 1.

4. Result

4.1 Velocity and Mass Flow Rate of Air

The result of velocity and mass Flow Rate shown in the Table 3:

Table 3. Velocity and mass flow rate of air results

Parameter	Result
$\rho_a\ (kg/m^3)$	1.1666
$v_a\ (m/s)$	46.01
$\dot{m}\ (kg/s)$	0.0674

4.2 Net Heat Input and Net Heat Flux

Table 4. Results for Net Heat Input and Net Heat Flux

Parameters	Value
$\dot{Q}_{in}$	$915.6W$
$\dot{Q}_{loss}$	$47.6359\ W$ (5.2% of $\dot{Q}_{in}$)
$\dot{Q}_{net}$	$867.9641\ W$
q''_{net}	$4510.7191\ W/m^2$

4.3 Heat Transfer Coefficient

Table 5. Results of Heat Transfer Coefficient

Parameters	Value

h	$90.8153 W/(m^2 \cdot K)$

4.4 Friction Factor (f)

Table 6. Results of Experimental Friction Factor

PARAMETER	VALUE
P_t	101889.075 Pa
ρ_h	0.996 kg/m^3
v_h	81.072 m/s
f	0.006

4.5 Heat Transfer-fluid Flow Analogy

Table 7. Results of Establish the Heat Transfer Fluid Mechanics Analogy

PARAMETER	Experimental Value	Theoretical Value
f	0.006	0.019
Nu	100.36	160.42
St	0.00111	0.0014
HTFM analogies	/	/
Reynolds analogy St	0.00075	/
Colburn analogy St	0.000934	/
Prandtl analogy St	0.00078	/
Von-Karman analogy St	0.00108	/
Dittus-Boetter analogy St	0.00268	/
Sider-Tate analogy St	0.00274	/

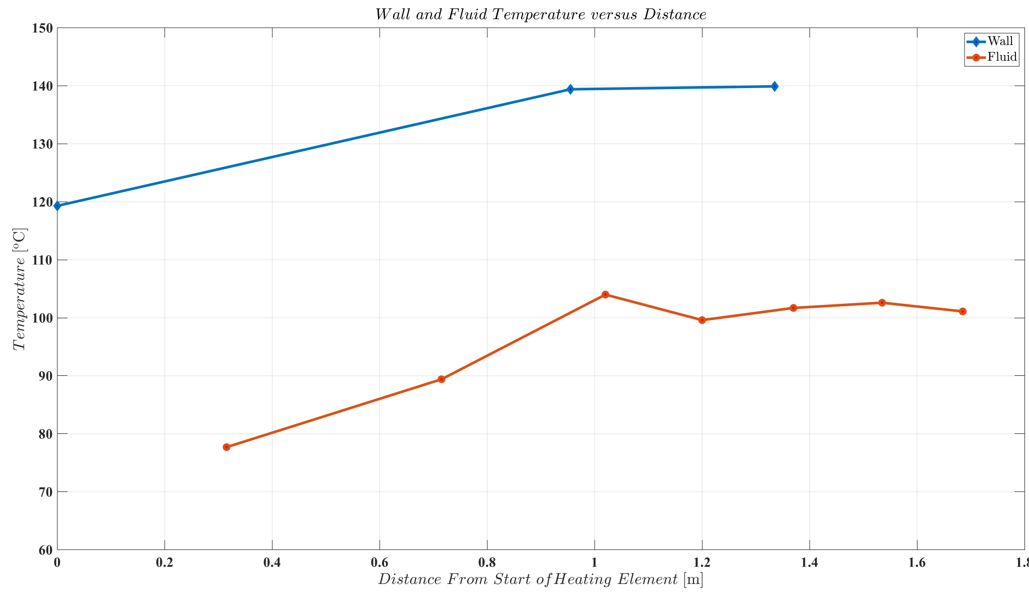

Figure 2. Wall and Fluid Temperature Versus Distance

4.6 Temperature and Velocity Profiles

With matlab the temperature and velocity profiles shown in the figure below:

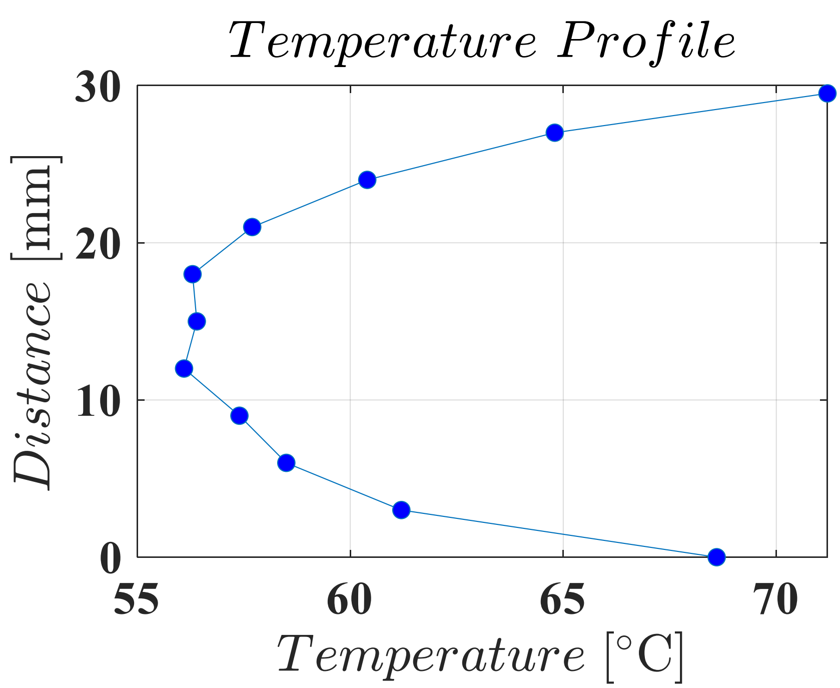

Figure 3. Temperature Profiles

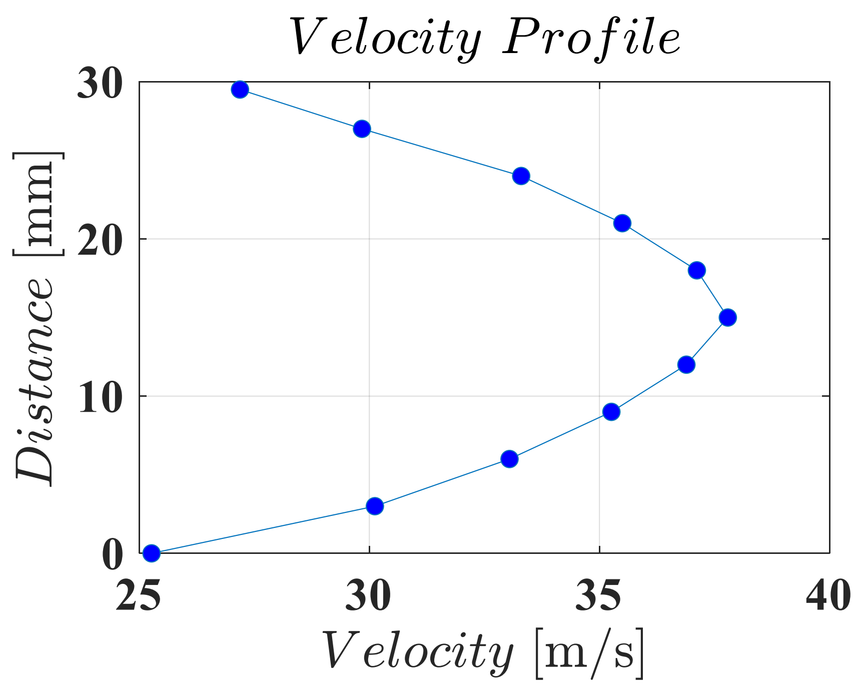

Figure 4. Velocity Profiles

5. Discussion and Conclusions

(1) Explain why the air velocity changes in the heated section of the pipe, with respect to the conservation of mass principle.

Based on the conservation of mass principle, the mass flow rate remains the same in control volume all the time. As for the heated section of the pipe, the density of the air as well as the cross-section area decreases. Since mass flow rate is the product of density, velocity and cross-section area, the velocity of the air increases while the other two factors decrease.

(2) What is the total heat input from the heater in watts? How much is lost via conduction through the insulation?

According to the calculation, the total heat input from the heater is 915.6W. The heat lost via conduction through the insulation is 5.20%.

The possible reasons for the errors are as follows:

Random error:

The reading fluctuates rapidly, experimenters were not able to read a steady measurement.

When the experimenters walk around the experiment table, the air will be accelerated and cause unexpected errors on convection.

(3) What is the value of the heat transfer coefficient h? What is the order of magnitude? What would be order of magnitude for h still air or slow moving air?

The value of the heat transfer coefficient is 90.8153 $W/(m^2 \cdot K)$. The order of magnitude is 1 to 2 (nearly two). For still air or slow moving air, the heat transfer coefficient will be smaller. The order would be 1.

(4) What is the value of the experimental friction factor f? What is the value of Nusselt number Nu and Stanton number St obtained using h? Which analogy gives the closest value of St to that of St obtained directly from h? What is the main purpose of these analogies? Which is easier to determine in an experiment - h or f?

The value of the experimental friction factor is 0.006.

The Nusselt number is 100.36 , the Stanton number is 0.00111.

According to the calculation, the closest value of St is obtained by the Von Karman Analogy.

The main purpose of these analogies is to obtain Stanton number under different conditions.

According to the experiment and the calculation analysis, the f is much easier to determine. Because the experiment uses the friction factor f, associated with fluid flow, to get the heat transfer coefficient h.

(5) Discuss the velocity and temperature profiles Discuss the velocity and temperature profiles - what is the physical reason for this shape? [Hint: For the velocity profile, explain in terms of viscous force near the wall. For the temperature profile, explain in terms of which mode of heat transfer dominates: convection in the axial direction or conduction in the radial direction?]

For the velocity profile, the highest speed occurs at the middle of the pipeline. That is due to the viscous force, as the air flow through the pipe, which is the resistance to the movement of flow generated by the wall. As it closes to the wall, the viscous force would be larger. Therefore, the velocity at the edge will be the lowest, while highest in the middle of the pipeline.

For the temperature profile, the lowest temperature occurs at the middle of the pipeline in general. The air is mainly heated by the conduction and convection of heated pipe. As the convection is most effective at the center line of maximum velocity of flow, the lowest temperature occurs at the middle of the pipeline. Since convention would be lower as it closes to the wall, the temperature would be the highest when at the edge.

APPENDICES

A – MATLAB Code (or Excel, other computational software, etc)

```
%% LAB 1
%% Code
close all
clear all
clc
set(0,'DefaultAxesFontName', 'Times New Roman')
set(0,'DefaultAxesFontSize', 22)
set(0,'defaultlinelinewidth',0.5)
set(0,'DefaultLineMarkerSize', 8)
set(0,'defaultAxesFontWeight','bold')
%% Objective 6
Pa = 496*9.8+101325;
Ta = 44+273.15;
Ra = 287;
p = Pa/(Ra*Ta);
d = 0:3:30;
d(end) = d(end)-0.5;
T = [68.6 61.2 58.5 57.4 56.1 56.4 56.3 57.7 60.4 64.8 71.2];
dP = [38 54 65 74 81 85 82 75 66 53 44]*9.8;

v = sqrt(2*dP/p);

figure
plot(T,d,'o-','MarkerFaceColor','b')
ylabel(['$ Distance\;\mathrm{[mm]} $'],'interpreter','latex')
xlabel(['$ Temperature\;\mathrm{[^\circ C]} $'],'interpreter','latex')
title(['$ Temperature\ Profile $'],'interpreter','latex')
grid on

figure
plot(v,d,'o-','MarkerFaceColor','b')
ylabel(['$ Distance\;\mathrm{[mm]} $'],'interpreter','latex')
xlabel(['$ Velocity\;\mathrm{[m/s]} $'],'interpreter','latex')
title(['$ Velocity\ Profile $'],'interpreter','latex')
grid on

%% ob 5
Ta=[77.7 89.4 104 99.6 101.7 102.6 101.1 119.3 36.5 139.4 71.4 139.9 60.5
68.1];

d_wall=[195 760 380].*0.001;
d_fluid=[195 120 400 305 180 170 165 150].*0.001;
Tak=Ta+273.15;

T_wall=Tak(8:2:12);
T_fluid=Tak(1:7);
p_wall=[0, sum(d_wall(1:2)),sum(d_wall(1:3))];
p_fluid=[sum(d_fluid(1:2)),sum(d_fluid(1:3)),sum(d_fluid(1:4)),sum(d_fluid(1:
5)),sum(d_fluid(1:6)),sum(d_fluid(1:7)),sum(d_fluid)];
```

```
figure
plot(p_wall,T_wall-273.15,'d-
','MarkerFaceColor','b','LineWidth',4,'MarkerSize',8)
hold on
plot(p_fluid,T_fluid-273.15,'o-
','MarkerFaceColor','r','LineWidth',4,'MarkerSize',8)
ylim([60 150])
ylabel(['$ Temperature\;\mathrm{[^oC]} $'],'interpreter','latex')
xlabel(['$ Distance\ From\ Start\ of Heating\ Element\;\mathrm{[m]}
$'],'interpreter','latex')
title(['$ Wall\ and\ Fluid\ Temperature\ versus\ Distance
$'],'interpreter','latex')
legend('Wall','Fluid')
legend(['Wall'],['Fluid'],'interpreter','latex')
grid on
```

B – Scanned Lab Notes

Data Sheet

Data sheet

Fan pressure difference, $p - p_b$ = 496 [mm water];

Orifice pressure drop, Δp_{or} = 126 [mm water]; Ta= 44 [°C]

Test length pressure drop, $d p_t$ = 115 [mm water]; Voltage=218V; Current = 4.19A
4.2

Thermocouple Readings

Thermocouple Number	Temperature [°C]	Thermocouple Number	Temperature [°C]
1	77.7	w 8	119.3
2	89.4	i 9 ·	36.5
3	104.0	w 10	139.4
4	99.6	i 11 ·	71.4
5	101.7	w 12	139.9
6	102.9	i 13 .	60.5
7	101.1	14	68.1

each division 0.1 mm
10 divs = 1 mm

Velocity and Temperature Profiles [Pitot tube readings]

Dial reading (mm)	Temperature	Manometer	Dial reading	Temperature	Manometer
0	68.6	38	18	56.3	82
3	61.2	54	21	57.7	75
6	58.5	65	24	60.4	66
9	57.4	74	27	64.8	53
12	56.1	81	29.5	71.2	44
15	56.4	85			