

Faculty of engineering

Mechanical engineering department

Fluid mechanics Laboratory

ENME312

Section NO.1

Experiment NO.9

**" Pressure losses in ductwork "**

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Date of Performing: 24/7/2018

Date of Submission: 29/7/2018

**Abstract:**

When a fluid flows through a pipe, there is a loss of energy (or pressure) in the fluid. This is because energy is dissipated to overcome the viscous (frictional) forces exerted by the walls of the pipe as well as the moving fluid layers itself. In addition to the energy lost due to frictional forces, the flow also loses pressure as it goes through fittings, such as valves, elbows, contractions and expansions. The pressure loss in pipe flows is commonly referred to as head loss. The frictional losses are referred to as major losses while losses through fittings etc, are called minor losses. Together they make up the total head losses. When the fluid flow in pipe the pressure will be different from point to another because friction and other factors like change in diameter and shape of the pipe .The aim of this experiment is to calculate the pressure loss in ductwork in two state ,the first state when the fan is slow ,the other one when the fan is fast .The Darcy friction factor(f)is not a constant and depends on the parameters of the pipe and the velocity of the fluid flow. It may be evaluated for given conditions by the use of various empirical or theoretical relations, or it may be obtained from Moody diagrams .

**Objectives:**

1. To calculate the total pressure loss through the system.

2. To specify the elements this caused the maximum and minimum pressure losses.

3. To calculate the velocity of the flow.

4. Comparing between the effect of the slow and high velocity of the flow on the friction loss factor.

5. Calculate the equivalent length of the system depending on the total pressure loss.

6. To be familiarize with the duct flow instrument

**Sample Calculations:**

**For the slow fan:**

ho = 5.1 mb

Qo=123.7\*=279.35 m3/hr

hv = 2.9 mb

Qv= 163.3\*=278.09 m3/hr

D = 0.0984 m

A = = 0.0076 m2

V1 = = 10.21 m/s

V2 = = 10.16 m/s

Vavg=  =10.19 m/s

For = ­­­­­39.24 ­­­­­­­­­pa

Ks = = 0.0756

kstotal = = 1.815

Leq = = = 7.14 m

**For the fast fan:**

ho = 20.8 mb

Qo=123.7\*=564.15 m3/hr

hv = 12.2 mb

Qv= 163.3\* = 570.38 m3/hr

D = 0.0984 m

A = = 0.0076 m2

V1 = = 20.62 m/s

V2 = = 20.85 m/s

Vavg = =20.73 m/s

For = 156.96 ­­­­­­­­­pa

Kf = = 0.073

kftotal = = 1.734

Leq = = = 6.83 m

**Where:**

|  |  |
| --- | --- |
|  |  |
| ho | Head read from orifice (mm) |
| Qo | Flow rate using orifice (m^3/s) |
| hv | Head read from venturi (mm) |
| Qv | Flow rate using venture (m^3/s) |
| D | Diameter =0.0984 m |
| A | Area (m^2) |
| V1 | Velocity calculated from venture (m/s) |
| V2 | Velocity calculated from orifice (m/s) |
| Vavg | Average of V1 and V2 (m/s) |
| K | Friction loss factor |
|  | Pressure lost at each fitting (pa) |
| Ρ | Fluid(air density) (kg/m^3) |

f Darcy friction factor = 0.025

**Results:**

Table (1): Shows the static pressure losses and the friction loss factors for all of the fittings for slow.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **fan (slow)** |  |  |  |  |  |  |  |  | **fan (fast)** |  |  |
|  | **P loss (m H2O)** | **P(Pa)** | **Ks** |  |  |  |  |  |  | **p loss (m H2O)** | **P(Pa)** | **Kf** |
| **1 to 2** | 0.046 | 451.26 | 0.869689 |  |  |  |  |  | **1 to 2** | 0.165 | 1618.65 | 0.753111 |
| **2 to 3** | 0 | 0 | 0 |  |  |  |  |  | **2 to 3** | 0 | 0 | 0 |
| **3 to 5** | 0.025 | 245.25 | 0.472657 |  |  |  |  |  | **3 to 5** | 0.105 | 1030.05 | 0.479252 |
| **5 to 6** | 0.0025 | 24.525 | 0.047266 |  |  |  |  |  | **5 to 6** | 0.009 | 88.29 | 0.041079 |
| **6 to 7** | 0.001 | 9.81 | 0.018906 |  |  |  |  |  | **6 to 7** | 0.002 | 19.62 | 0.009129 |
| **7 to 10** | 0.0045 | 44.145 | 0.085078 |  |  |  |  |  | **7 to 10** | 0.016 | 156.96 | 0.073029 |
| **10 to 11** | 0.0025 | 24.525 | 0.047266 |  |  |  |  |  | **10 to 11** | 0.008 | 78.48 | 0.036514 |
| **11 to 12** | 0.004 | 39.24 | 0.075625 |  |  |  |  |  | **11 to 12** | 0.021 | 206.01 | 0.09585 |
| **12 to 13** | 0.001 | 9.81 | 0.018906 |  |  |  |  |  | **12 to 13** | 0.0055 | 53.955 | 0.025104 |
| **13 to 14** | 0.0025 | 24.525 | 0.047266 |  |  |  |  |  | **13 to 14** | 0.009 | 88.29 | 0.041079 |
| **14 to 15** | 0.0025 | 24.525 | 0.047266 |  |  |  |  |  | **14 to 15** | 0.021 | 206.01 | 0.09585 |
| **15 to 16** | 0.0065 | 63.765 | 0.122891 |  |  |  |  |  | **15 to 16** | 0.022 | 215.82 | 0.100415 |
| **16 to 18** | 0.0035 | 34.335 | 0.066172 |  |  |  |  |  | **16 to 18** | 0.016 | 156.96 | 0.073029 |
| **1 to 18** | 0.096 | 941.76 | 1.815004 |  |  |  |  |  | **1 to 18** | 0.38 | 3727.8 | 1.734436 |

Table (2): Shows the static pressure losses and the friction loss factors for all of the fittings for fast.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **fan (fast)** |  |  |
|  | **p loss (m H2O)** | **P(Pa)** | **Kf** |
| **1 to 2** | 0.165 | 1618.65 | 0.753111 |
| **2 to 3** | 0 | 0 | 0 |
| **3 to 5** | 0.105 | 1030.05 | 0.479252 |
| **5 to 6** | 0.009 | 88.29 | 0.041079 |
| **6 to 7** | 0.002 | 19.62 | 0.009129 |
| **7 to 10** | 0.016 | 156.96 | 0.073029 |
| **10 to 11** | 0.008 | 78.48 | 0.036514 |
| **11 to 12** | 0.021 | 206.01 | 0.09585 |
| **12 to 13** | 0.0055 | 53.955 | 0.025104 |
| **13 to 14** | 0.009 | 88.29 | 0.041079 |
| **14 to 15** | 0.021 | 206.01 | 0.09585 |
| **15 to 16** | 0.022 | 215.82 | 0.100415 |
| **16 to 18** | 0.016 | 156.96 | 0.073029 |
| **1 to 18** | 0.38 | 3727.8 | 1.734436 |

**Leq for slow= 7.14m**

**Leq for fast= 6.83m**

\*Maximum pressure loss occurred in Screen section.

\*Minimum pressure loss occurred in Straight ducts.

\*Orifice meter is the flow measuring device with the most pressure loss.

**Discussion of Results:**

It’s obvious that the static pressure loss and the speed of the fluid are directly proportional. This can be explained since at a higher velocity, the fluid is less stable and so more likely to lose pressure as it moves.

The values of “K” also vary depending on which fitting the fluid is moving through. In other word, higher static pressure loss will yield large constant “K”.

It also can be noticed that the total friction loss factor “K” equals the sum of each friction loss factor at each fitting and section of the air path. A useful value can be determined. Given the constant “K” and “f” an equivalent length of fitting can be found. This has two advantages, it dramatically decreases the amount of information that is required and it also removes the problem of the units to measure lengths and diameters since the ratio Le/D is dimensionless.

Since the equivalent length of fittings is less than the real length (7.42 m), and since the pressure drop almost zero in the straight pipes, one can deduce that if the equivalent length of fittings is less than the real length of pipes, it will be efficient to use that number of fittings for same flow, else greater losses for the same length will result.

However, few errors occurred during the experiment. One can mention the defects of the machine operated and misreading the pressure gages in some turns.

**Conclusion:**

This experiment had shown the necessary calculations that go into the making or purchasing of a duct or tutor. For that to happen, taking all losses must be considered. These losses, in addition to the friction losses factor “K” can help in making the right decision to save money when buying a duct because they help determine how much loss needs to be overcome and so the right fittings to be used.

**Appendices:**

* **Data Sheet:**

Data sheet is attached at the end of the report.

* **References:**

1. Fluid Mechanics Lab Manual.
2. Currie, I.G., 2012. Fundamental Mechanics of Fluids, 4th Edition. Boca Raton, FL: CRC Press