AN EXPERIMENTAL APPROACH TO STUDY OF PRESSURE LOSSES IN AIR CONDITIONING DUCT SYSTEM

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ABSTRACT

This paper focuses mainly upon the losses in the flow of the air flowing through air conditioning duct used in household and other application. These losses are mainly pressure and velocity losses and mostly caused due to sudden changes in cross section area and various fitting used for ducting. As we know circular ducts require the least material for a given flow rate and allowable pressure drop, rectangular ducts are generally preferred in practice as they fit easily into the building construction thus occupying less space, and they are also easy to fabricate. Dynamic pressure loss takes place whenever there is a change in either the velocity or direction of airflow due to the use of a variety of bends and fittings in air conditioning ducts. Some of the commonly used fittings are enlargements, contractions, elbows, branches, dampers etc. The major pressure drop as air flows through these fittings is not because of viscous drag (friction) but due to momentum change. As per the Darcy–Weisbach equation, in turbulent flows, the dynamic loss is proportional to square of velocity. In this paper we experimentally approached the direct relation between pressure loss and velocity.

Keyword : *Air conditioning system, duct, pressure drop, cross section and fittings*

1. Introduction

The conditioned air (cooled or heated) from the air conditioning equipment must be properly distributed to rooms or spaces to be conditioned in order to provide comfort conditions. when the conditioned air cannot be supplied directly from the air conditioning equipment to the spaces to be conditioned, then the duct are installed . The duct system convey the conditioned air from the air conditioning equipment to the proper air distribution points or air supply outlets in the room and carry the return air from the room back to the air conditioning equipments for reconditioning and recirculation.

It may be noted that the duct for proper distribution of conditioned air cost nearly 20 to 30% of the total cost of the equipments required and the power required by fans forms the substantial part of the running cost. Thus, it is necessary to design the air duct system in such a way that the capital cost of duct and the cost of running the fans is lowest.

The chief requirements of an air conditioning duct system are:
1. It should convey specified rates of air flow to prescribed locations
2. It should be economical in combined initial cost, fan operating cost and cost of building space
3. It should not transmit or generate objectionable noise

Generally at the time of designing an air conditioning duct system, the required airflow rates are known from load calculations. The location of fans and air outlets are fixed initially. The duct layout is then made taking into account the space available and ease of construction. In principle, required amount of air can be conveyed through the air conditioning ducts by a number of combinations. However, for a given system, only one set results in the optimum design. Hence, it is essential to identify the relevant design parameters and then optimize the design..

1.1 Duct Material

The ducts are usually made from Galvanized Iron sheet metal, aluminum, sheet metal or black steel. The most commonly used duct material in air conditioning is Galvanized sheet metal, because the zinc coating of this metal prevents rusting and avoids the cost of painting. The sheet thickness of Galvanized Iron (G.I) duct from 26 gauge (0.55mm) to 16 gauge (1.6mm). The aluminium is used because of its lighter weight and resistance to moisture. The black sheet metal is always painted unless they withstand high temperature.

Now a day, the use of non-metal ducts has increased. The resin bonded glass fiber ducts are used because they are strong and easy to manufacture according to the desired shape and size. They are used in low velocity applications less than 600m/min and for static pressures below 5mm of water gauge. The cement asbestos ducts may be used for static underground air distribution and for exhausting corrosive materials. The wooden ducts may be used in places where moisture content in air is not very large.

Material	Roughness value
Galvanized Iron (GI)Sheet	0.00015
Concrete	0.0003 to 0.003
Riveted Steel	0.0009 to 0.009
Cast Iron (CI)	0.00026
Commercial Steel	0.00046

Average surface roughness of commonly used duct materials

1.2 Estimation of pressure loss in ducts:

As air flows through a duct its total pressure drops in the direction of flow. The pressure drop is due to:
1. Fluid friction
2. Momentum change due to change of direction and/or velocity

The pressure drop due to friction is known as frictional pressure drop or friction loss, Δpf. The pressure drop due to momentum change is known as momentum pressure drop or dynamic loss, Δpd.
Thus the total pressure drop Δpt is given by:

$$\Delta p_t = \Delta p_f + \Delta p_d$$

Evaluation of frictional pressure drop in duct
The Darcy-Weisbach equation is one of the most commonly used equations for estimating frictional pressure drops in internal flows. This equation is given by:

$$\Delta p_t = f \frac{L}{D} \left(\frac{\rho}{2} V^2\right)$$

2 Experimental Setup

In this experiment several cross section of duct is manufactured by GI sheet of square cross section of 42.5×42.5 cm as per the inlet of evaporative cooler. the straights and elbows section are manufactured and then assemble it in various section like L section, Z section, C section etc. after that we measure the inlet and outlet velocity was measured with the help of help of vane anemometer in m/s. the results obtained for various inlet and corresponding out let velocity for different duct configuratution are tabulated below

Table -1 Observation Table

Sr.no	**Cross Section of Duct**	**Inlet velocity (m/sec)**	**Outlet velocity (m/sec)**	**ΔV (m/sec)**
01	 Trapezoidal Inlet with straight square Cross Section	1.5	0.8	0.7
		3.5	2.1	1.4
		5	3.3	1.7
02	 Trapezoidal Inlet with straight square Cross Section and elbow	1.5	1.7	0.2
		3.5	4.2	0.7
		5	6.4	1.4
03	 Trapezoidal Inlet with two straight square Cross Section & one elbow	1.5	1.4	0.1
		3.5	2.5	1
		5	3.8	1.2
04	 Trapezoidal Inlet with two straight square Cross Section & two elbow	1.5	1.9	0.4
		3.5	4	0.5
		5	5.2	0.2

05	 Trapezoidal inlet with elbow cross section	1.5	1.4	0.1
		3.5	2.2	1.3
		5	4.5	0.5
06	 Trapezoidal inlet with one straight & two elbows	1.5	1.2	0.3
		3.5	2.9	0.6
		5	4.5	0.5
07	 Trapezoidal inlet with two elbows {o/p horizontal}	1.5	1.4	0.1
		3.5	2.9	0.6
		5	4.8	0.2
08	 Trapezoidal inlet with two elbows {o/p vertical}	1.5	0.5	1
		3.5	1.3	2.2
		5	2.2	2.8

09	 Trapezoidal inlet with one elbows {o/p vertical}	1.5	1.7	0.2
		3.5	3.8	0.3
		5	6.6	1.6
10	 Trapezoidal inlet with two elbows {o/p horizontal}	1.5	1	0.5
		3.5	2.3	1.2
		5	3.7	1.3

3. Results And Conclusion

1. From the above results obtained it can be seen that as the inlet velocity increases the outlet velocities changes due to various section attachment in the duct.
2. If the direction of air flow is suddenly changes from horizontal to vertically upward, it affects the output velocity which can be seen in case 8, 9 and 10.

4. CONCLUSIONS

From the observation and result it can be conclude that velocity of air flow changes for various cross section & this velocity changes from fitting to fittings. As we know that change in velocity is the effect of pressure drop, hence this experimental approach prove that pressure drops at various sections in the duct & this effect can be seen as the change in the output air velocity

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