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Comparison of Rectangular and Circular AC ducts by means of Velocity, Pressure and Temperature Change.

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Abstract

AC ducts are consist of two types of cross sections, rectangular and circular. Their performance also vary with the type of duct used. In most of the cases sharp turnings are avoided so as to avoid direct contact with duct inner surface. At some places the conditioned air flow also regulated with the help of duct wings. These types of conditions affect the performance of the duct. In this paper the overall performance of both types of duct is compared on the basis of velocity, pressure and temperature change at the inlet, middle section and at the outlet. This is done with the help of CFD tool. Also the FVM method is used in background of this CFD Tool to get more accurate results. The conclusion is given on the basis of values obtained by CFD tool.

Keywords: *AC Duct, CFD Tool, FVM Method*

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1. INTRODUCTION TO AC DUCTS:

Ducts are conduits or passages used in heating, ventilation, and air conditioning to deliver and remove air. The needed airflows include, for example, supply air, return air, and exhaust air. Ducts commonly also deliver ventilation air as part of the supply air. As such, air ducts are one method of ensuring acceptable indoor air quality as well as thermal comfort.

1.1 Types of AC Ducts according to cross section.

There are only two types of AC ducts mostly used as per the cross sectional area. These are commonly used duct types in industry and home.

1) Rectangular Duct.
2) Circular Duct.

Both are having their own advantages. We can choose these ducts as per our requirement and the specification.

Rectangular Duct:

Figure 1.1: Rectangular duct used for AC.

➢ **The Advantages of Rectangular Air Ducts**

Rectangular ducts are necessary whenever we have got a tight space that won't allow for the height of round ducts.

- Takes up less height
- Easily connects fan coil to main duct
- Better for low pressure systems

➢ **The Disadvantages of Square Ductwork**

- They allow for more noise to escape from the duct. Rectangular ducts also cost more to install initially.
- Higher noise pollution
- Costs more for initial installation

Circular Duct:

Round ducts are easy to build and come in predetermined sizes and metal thicknesses. If the space is available it is the cheapest way to go because it can be mass produced and cut to size in the field. All the conceivable transitions are available off the shelf. So overall if the biggest concern is cost, and it always is, the round duct is a cheaper choice where possible. They are much stronger in high static and low pressure conditions thus reducing the fear of collapse as discussed in the previous paragraph.

➢ **The Advantages of Round Air Ducts**

There are many advantages to round ducts, from increased airflow, quick installation, and lower costs.

- Less friction
- Better, more efficient airflow
- Easy to join pieces together

- Faster installation
- Better for medium to high pressure systems
- Costs less for initial installation
- Less noise pollution

➢ **The Disadvantages of Round Ductwork**

- Takes up more space (taller)
- Not efficient for low pressure systems
- Difficult to connect fan coil to main duct

There are some common specification of AC duct which is given in following table:

Table 1.1: Common specifications of AC Duct.

Duct Wall Thicknesses	30 mm
Mean Air Velocity (Max.)	25.4 m/s
Design Pressure (Max.)	1000 Pa Positive 750 Pa Negative
Operating Temperature Limits	-20°C to +80°C

2. CAD MODEL PREPARATION OF RECTANGULAR/CIRCULAR AC DUCT:

Pro-Engineering is the CAD tool used for the development of AC duct model. The dimensions are obtained from actual duct mounted in a building. Figure 2.1 shows the detailed diagram from which the dimensions are taken.

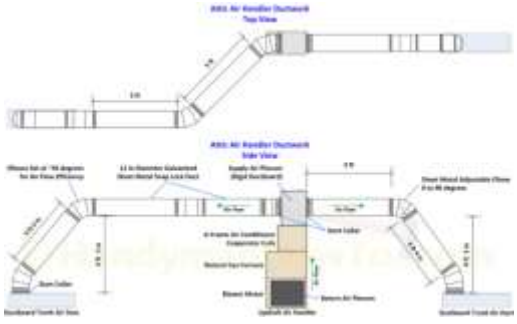

Figure 2.1: Detailed AC duct layout for dimensions.

Several Commands are used for CAD model preparation like extrude, revolve, remove material, sweep etc. The CAD model prepared is shown in figure 2.2.

Figure 2.2: CAD model for circular duct.

Same model is prepared for rectangular duct which is further imported in ANSYS software.

3. CFD ANALYSIS OF AC DUCT:

To perform CFD Analysis of AC duct, we have used the ANSYS Fluent software. Fluent is the module of ANSYS which deals with fluid flow problems.

ANSYS software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements, and electromagnetic properties

3.1 Required Material Properties

Following are the properties required for the CFD analysis.

Table 3.1: Properties of Air for Vibration Analysis

Property	Value
Inlet Velocity	15 m/s
Temperature	288 K
Pressure	1 Bar

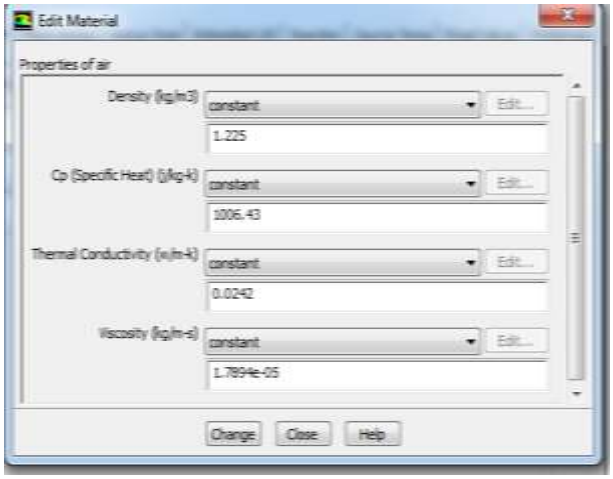

Figure 3.1: Properties of Air.

3.2 Meshing:

Figure 3.2: Meshed view with number of nodes and elements.

3.3 Results from CFD Analysis

Following are the results which are obtained from ANSYS Fluent CFD tool.

- **For Circular AC Duct:**

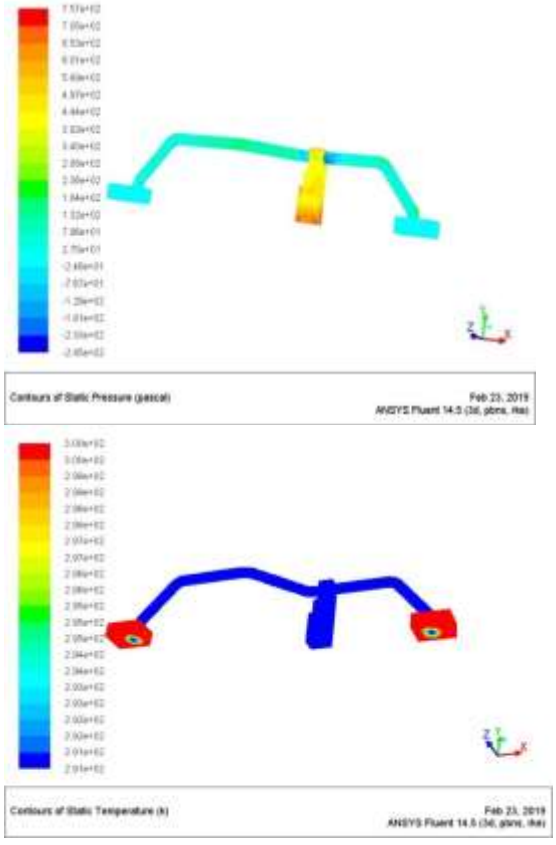

Figure 3.3: Pressure and Temperature counter obtained through CFD Analysis.

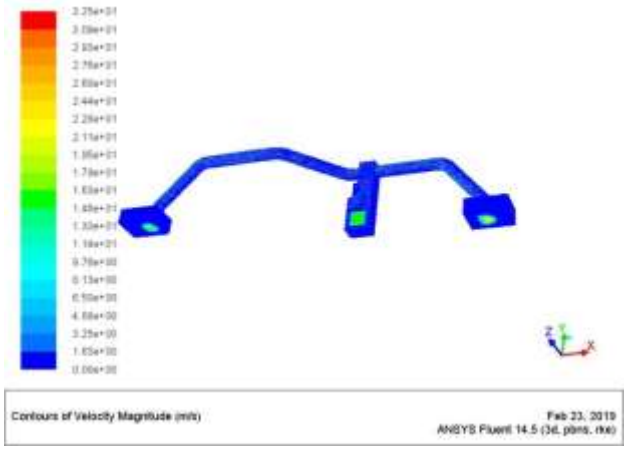

Figure 3.4: Velocity Counters obtained through CFD Analysis.

- **For Rectangular AC Duct:**

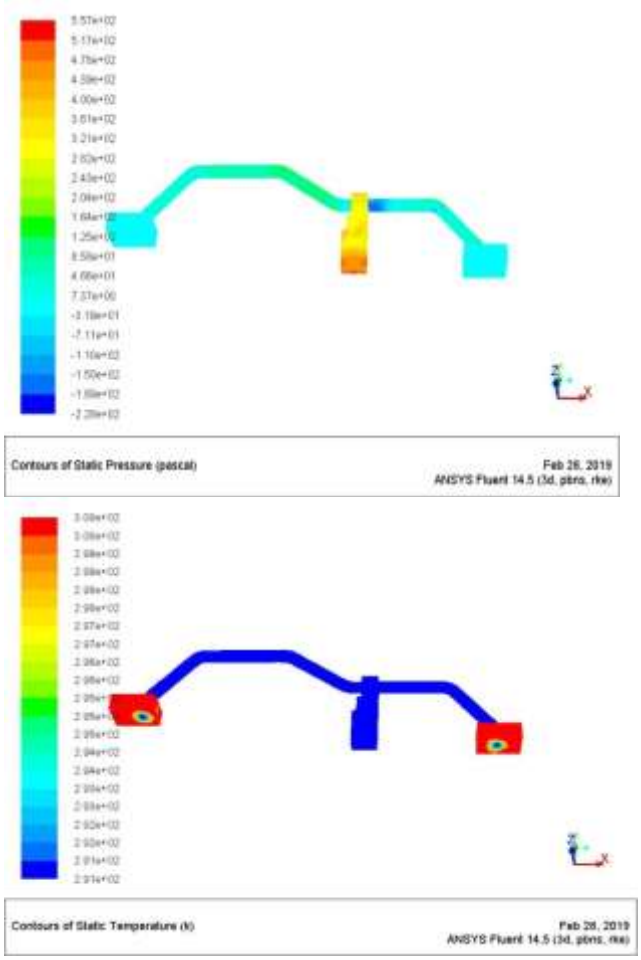

Figure 3.4: Pressure and Temperature counter obtained through CFD Analysis.

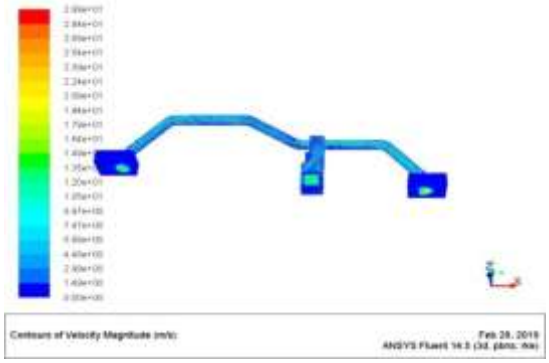

Figure 3.5: Velocity Counters obtained through CFD Analysis.

4. RESULT COMPARISON:

Table 4.1: Results from CFD Tool at the inlet Duct

Sr. No.	Parameter	Value for Circular Duct	Value for Rectangular Duct
1	Number of Nodes	21847	22935
2	Number of Elements	104023	143954
3	Maximum Velocity	5 m/s	5
4	Maximum Pressure	1000 Pascal	1000 Pascal
5	Maximum Density	1kg/m^3	1kg/m^3
6	Maximum Temperature	288 k	288 k

Table 4.2: Results from CFD Tool at the Middle of Duct

Sr. No.	Parameter	Value for Circular Duct	Value for Rectangular Duct
1	Maximum Velocity	17.4 m/s	15 m/s
2	Maximum Pressure	10457 Pascal	10200 Pascal
3	Maximum Density	1.23 kg/m^3	1.2 kg/m^3
4	Maximum Temperature	295 K	298 K

Table 4.3: Results from CFD Tool at the End of Right side Duct

Sr. No.	Parameter	Value for Circular Duct	Value for Rectangular Duct
1	Maximum Velocity	32.5 m/s	28 m/s
2	Maximum Pressure	7570 Pascal	6054 Pascal
3	Maximum Density	1.23 kg/m^3	1.2 kg/m^3
4	Maximum Temperature	300 k	303 K

5. CONCLUSION:

By observing results and values we can state that the Circular duct is more efficient than the rectangular duct. All the values we got are more superior than the rectangular duct. Also the other advantages of Circular duct provides better ease for installation and performance.

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