

Circular and Elliptical Duct Design and Optimization

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Abstract

The goal is to analyse and compare the computational fluid dynamic analysis of ducts under three different working conditions: at home, in industry, and in a restaurant. A fluent analysis is performed on elliptical and circular cross-section ducts to determine the fluctuation of velocity and pressure magnitude at crucial duct points. Simulations in the ANSYS workbench are used to perform and validate the computational fluid dynamic analysis. The results of the aforementioned research were utilised to optimise the duct used in numerous applications, such as the house, industrial, and restaurant. Geometry is examined for various operating situations and velocity inputs.

Keywords: - Duct, Circular and Elliptical section, HVAC, Different working conditions.

INTRODUCTION

HVAC

HVAC (heating, ventilation, and air conditioning; often known as heating, air flow, and air conditioning) is the process of creating indoor and vehicle environmental comfort. Its goal is to provide first-rate thermal comfort and indoor air quality. HVAC is essential in the construction of medium- to large-scale

industrial and office structures such as skyscrapers, boats, marine habitats, and aquariums.

Ventilation

Ventilation is the process of "changing" or replacing air in any place to provide superior indoor air quality, which includes temperature management, oxygen replenishment, and the removal of

moisture, smells, smoke, warmth, dust, airborne bacteria, and carbon dioxide. Ventilation eliminates unpleasant odours and excessive moisture, introduces outside air, keeps internal building air moving, and prevents indoor air stagnation.

Air Conditioning

An air conditioning system, or a freestanding air conditioner, provides cooling and humidity management for an entire building or a portion of it. Because open windows would operate against the device designed to maintain consistent internal air conditions, air conditioned homes usually feature sealed windows. Outside, fresh air is often pulled into the device via a vent into the interior heat exchanger phase, resulting in positive air pressure.

LITERATURE SURVEY

Santosh Kansal and Krishna Kumar Waghe

A performance study of elliptical cross sectioned bends of HVAC duct for minimal pressure drop was given. A performance analysis of the elliptical cross sectioned bend of HVAC duct was performed in this article. Static pressure loss in HVAC duct systems is of particular significance, and a theoretical study is

performed using computational fluid dynamics (CFD) [1].

Mukesh Didwania, Lokesh Singh, Ashish Malik and Mangal S Sisodiya

A CFD algorithm was used to analyse turbulent flow through a 90° bend of duct in a central AC plant. This test case focuses on the use of approximation models, such as turbulence models, to estimate the physical features of turbulent flow around a 90° bend in a duct. Losses can be reduced by extending the bend length in the duct [2].

Shweta Deshpande and Dr. R. S. Bindu

FEA-based frequency optimization of a duct with variable cross section via structural adjustments to minimise resonance was shown. Different approaches for improving the natural frequency of variable cross-sectioned ducts are briefly described in this work about structural changes for frequency enhancement [4].

METHODOLOGY

Modeling

SOLIDWORKS software was used to create the duct model altogether. First, the sketch command for the solid works is activated. The drawing is then made using 2D instructions.

Transformation of Model

The model is then converted to IGES format, which is most suitable and straightforward to access for any other program. We may import the duct model from SOLIDWORKS to ANSYS using the IGES format.

Mesh The duct is meshed once the entire construction has been modeled. The final step before meshing the model is to configure the meshing controls. With advanced mesh control capabilities, these regions may be avoided. The meshing feature "smart element sizing" generates initial element sizes for free meshing operations.

Loading Internal and exterior velocities are two of the 12 forms of loading that may be used in a computational fluid dynamics study.

DESIGN OF DUCTS

Introduction to Solid Works

Dassault Systems SOLIDWORKS Corp., a subsidiary of Dassault Systems, has been producing Solid Works (formerly Solid Works) solid modelling CAD (computer-aided design) software since 1997.

Tools Used

Create the working directory- First create the working directory to save the all model in one folder File – set working directory – selects the required folder – ok. **Sketch-** This command is used to produce a new sketch, such as a circle, line, rectangle, or ellipse. Select the sketch icon in the "solid works" window and the plane or surface you want to sketch.

Circle- The circle is created with this command. Create a circle by right-clicking the middle mouse button and selecting the centre point and a point on the circle – OK

Ellipse- The ellipse is created with this command. Make an ellipse by selecting a centre point, a minor radius point, and a major radius point. Select the ellipse's center; select the minor radius of the ellipse point and the major radius of the ellipse; click the middle mouse button; OK

Line- The line is created with this command. Make the line by connecting the start and finish points. Select the line symbol from the right tool chest; click the line's start point; click the circle's finish point; enter

Arc- The arc is created using this command. Make the arc by connecting three points.

The three points are the arc's start point, end point, and centre point. Enter by clicking the arc's end point and the arc's midway point. The dimension of the arc may be changed by double clicking on it, and the new dimension will display in the pop-up window.

Create the Hexagon– The hexagon is made by inserting foreign data from the palette into the current object, scrolling down to view the hexagon, then double-clicking it.

Hexagon- Pick a spot for the hexagon on the sketch; using the left mouse button, drag and drop the hexagon's centre at the origin; change the Scale value to the appropriate size; and hit Enter [3].

Rectangle- The rectangle and square are created with this command. Click the rectangle icon in the right Tool Chest; click the rectangle's bottom left point and upper right corner.

Extrude– This command generates the material (to construct a 3D object from a 2D drawing) from the drawn entities. Enter the extrude length and hit the middle mouse button to complete the extrude command. The entities can be a circle, line, or rectangle, for example.

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Sweep Features

The procedure is to first generate a trajectory and then a segment. A trajectory is a route that sweeps a portion along. A sweep feature's trajectory can be sketched or selected, and the section is swept along the sketched or selected trajectory.

SOLIDWORKS DRAWINGS

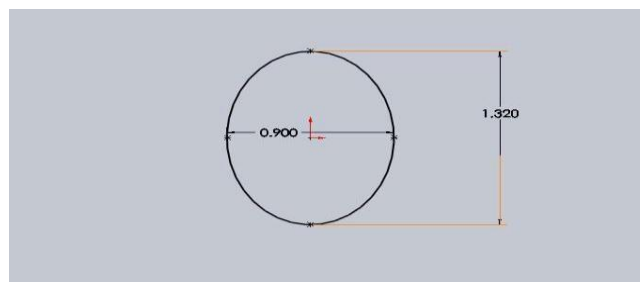


Figure 1 (a): Creating 2d sketch for elliptical duct.

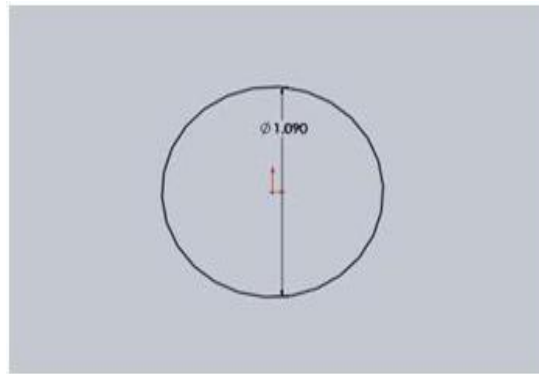


Figure 1 (b): Creating 2d sketch for Circular duct.

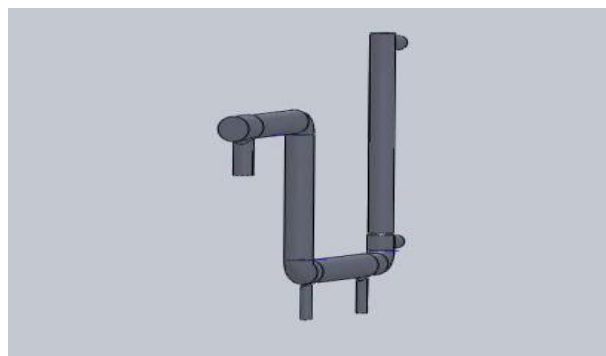


Figure 1 (c): Final view of elliptical duct.



Figure 1 (d): Final view of circular duct.

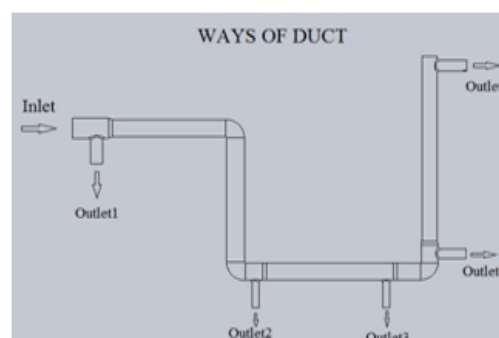


Figure 1 (e): Ways of duct.

SIMULATION

In general, there are two forms of analysis used in industry: 2-D modelling and 3-D modeling. capabilities that may impact the framework's ability to proceed directly or indirectly.

Straight frameworks are less confusing and, in general, do not concern plastic misshaping. Nonlinear frameworks do depict plastic deformation, and many are

also capable of testing a material's right to break [5].

COMPUTATIONAL DYNAMICS

FLUID

SIMULATION DETAILS

Analysis Type- Internal Flow

Boundary Condition

At home - 2m/s At Industry - 6m/s

At Restaurant - 12m/s

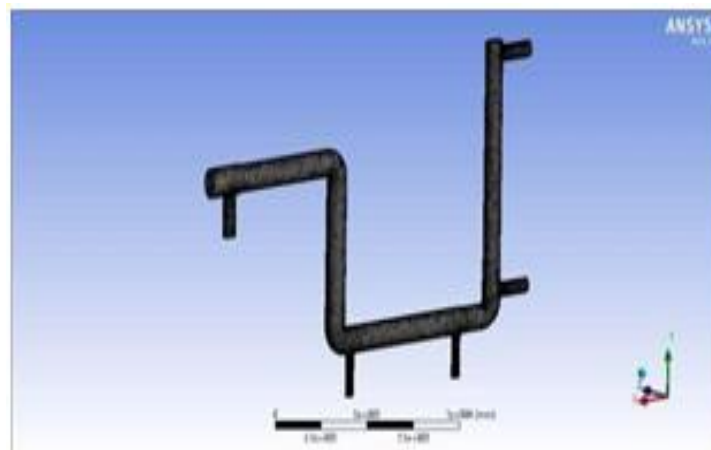


Figure 2 (a): Meshing of elliptical duct.



Figure 2 (b): Meshing of circular duct.

STEP BY STEP PROCEDURE

- The 3D model of the elliptical cross section duct is designed by using SOLIDWORKS software and it is converted as IGES format.
- The IGES (Initial Graphic Exchange Specification) format is suitable to import in the ANSYS Workbench for analyzing.
- Open the ANSYS workbench FLUENT (CFD)
- File – import external geometry file – generate
- • Defaults – physical preference – mechanical
- Advanced – relevance center – fine
- Right click the mesh in tree view – generate mesh
- Project – convert to simulation – yes
- Right click on model – create named selection – inlet, outlet 1,2,3,4 and 5.
- New analysis – FLUENT (CFD)
- Fluent – double click
- Select the inlet surface of the duct – enter value for velocity.
- Double click the result icon in the tree.
- After solve the analysis – take the reading of pressure and velocity for elliptical cross section duct.
- The all results are taken in a picture – and save it to the required folder in the system.

CONCLUSIONS

Table 1: Results for circular and elliptical section ducts

	Home		Industry		Restaurant	
Pressure	3.41	3.42	30.4	30.9	115.3	125
Velocity	4.3	4.3	13.2	13.6	25.8	27.5

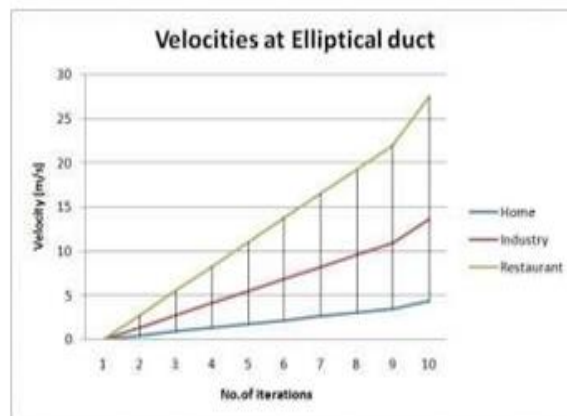


Figure 3: Graph for velocities at elliptical duct.

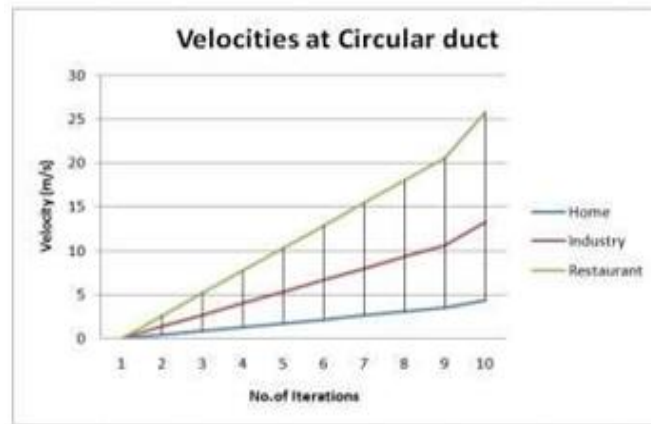


Figure 4: Graph for velocities at circular duct.

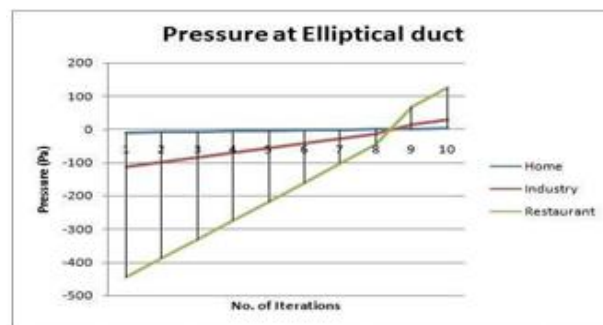


Figure 5: Graph for pressure at elliptical duct.

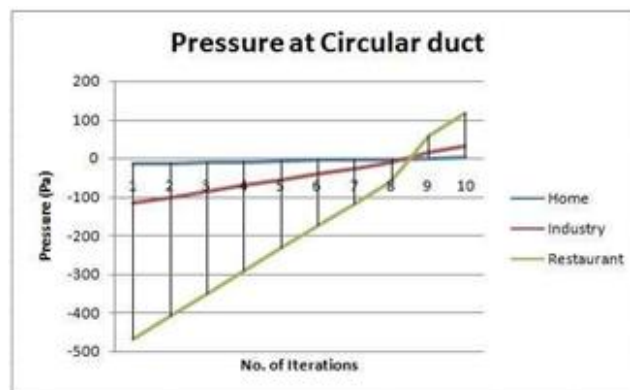


Figure 6: Graph for pressure at circular duct.

In this section, I will provide a quick introduction to ducts and many authors' work that will provide an understanding of duct design and numerous changes. The SOLIDWORKS programme is used to

build an elliptical cross section duct. The analysis will then be performed in ANSYS workbench software. Various section ducts are employed in this project under three different operating conditions: house,

industrial, and restaurant. The duct portions are round and elliptical. According to the graphs, the duct in the restaurant produces greater pressure and velocity. When comparing circular and elliptical ducts, the elliptical duct has a higher velocity and pressure. Industry generates higher pressure and velocity than both home and industry. The peak pressure at the restaurant elliptical duct is 125.2 Pa, and the pressure drop is greater in the circular duct, according to computational fluid data. As a result, elliptical cross sections are suitable for ducts because they provide less pressure drop inside the duct. We are studying 3D modelling software (SOLIDWORKS) and analysis software (ANSYS workbench 14.5) for this project in order to expand our fundamental understanding of industrial design.

REFERENCES

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