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Design and Cfd Analysis of Orifice Plate at Different Velocity Ratios

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ABSTRACT

Flow measurement is measurement of the quantity of the fluid that passes through the pipe, duct or an open channel. Flow may be measured by measuring the velocity of fluid over a known area. Differential pressure measuring devices such as orifice plates and nozzles are extensively applied in several industries to estimate the mass flow rate running through a channel by correlating the measured pressure loss.

In this thesis, an orifice plates with different geometry were designed and compared on the basis of their coefficient of discharge. This was done with the help of simulations done with k-ε and model on CFD as a solver. Simulations were carried out on a single hole, perforated (6 holes, 8 holes, 12 holes and 14 holes) at different Reynolds numbers (8000, 10000 and 12000).

In this thesis the CFD analyses to determine the pressure drop turbulence intensity, mass flow rate, and velocity.

3D modeled in parametric software Pro-Engineer and analysis done in ANSYS.

INTRODUCTION

An passage plate could be a device used for measure rate of flow, for reducing pressure or for proscribing flow (in the latter 2 cases it's usually referred to as a restriction plate). Either a volumetrical or mass rate of flow could also be determined, reckoning on the calculation related to the passage plate. It uses an equivalent principle as a Venturi nozzle, particularly Bernoulli's principle that states that there's a relationship between the pressure of the fluid and also the rate of the fluid. once the speed will increase, the pressure decreases and the other way around.

Once the orifice plate is designed and installed, the flow rate can often be indicated with an acceptably low uncertainty simply by taking the square root of the differential pressure across the orifice's pressure tappings and applying an appropriate constant. Even compressible flows of gases that vary in pressure and temperature may be measured with acceptable uncertainty by merely taking the square roots of the absolute pressure and/or temperature, depending on the purpose of the measurement and the costs of ancillary instrumentation. Orifice plates are also used to reduce pressure or restrict flow, in which case they are often called restriction plates.

DIFFERENT TYPES OF PASSAGE PLATES AND THEIR APPLICATIONS

Paddle sort passage Plate

Concentric beveled bore

Application:

This most typical Bore employed in The Industries. this is often the sole sort typically Accepted to be used In

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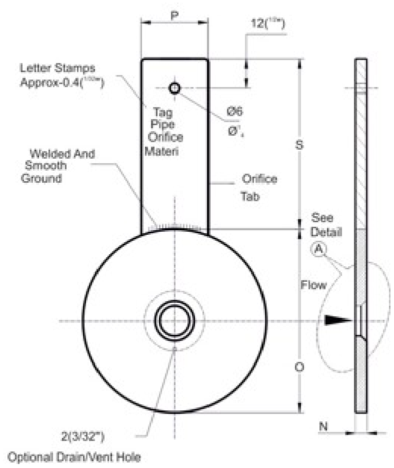
Custody Transfer mensuration, Since Adequate information isn't obtainable For alternative Bores. Used Primarily For Clean uniform Liquids, Gases, Non Viscous Fluids. The Bevel Is Matched At 45° Angle To the specified Throat Thickness



LITERATURE SURVEY

1. CFD Analysis and Comparison of Fluid Flow through A Single Hole And Multi Hole Orifice Plate.

2. Numerical analysis of the performance characteristics of conical entrance orifice meter

3. Flow characteristics of fluid and its effectiveness on orifice plate using pneumatic proportional control

4. Prediction of Performance Characteristics of Orifice Plate Assembly for Non-Standard Conditions Using CFD

INTRODUCTION TO CAD

Throughout the history of our industrial society, many inventions have been patented and Whole new technologies have evolved. Perhaps the single development that has impacted Manufacturing more quickly and significantly than any previous technology is the digital computer.

Computers are being used increasingly for both design and detailing of engineering components in the drawing office.

Computer-aided design (CAD) is defined as the application of computers and graphics Software to aid or enhance the product design from conceptualization to documentation. CAD is most commonly associated with the use of an interactive computer graphics system, referred to As a CAD system. Computer-aided design systems are powerful tools and in the mechanical Design and geometric modeling of products and components.

INTRODUCTION TO PRO/ENGINEER

Pro/ENGINEER, PTC's parametric, integrated **3D CAD/CAM/CAE solution**, is used by discrete manufacturers for mechanical engineering, design and manufacturing.

Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes.

3D MODEL OF ORIFICE PLATE

Single hole

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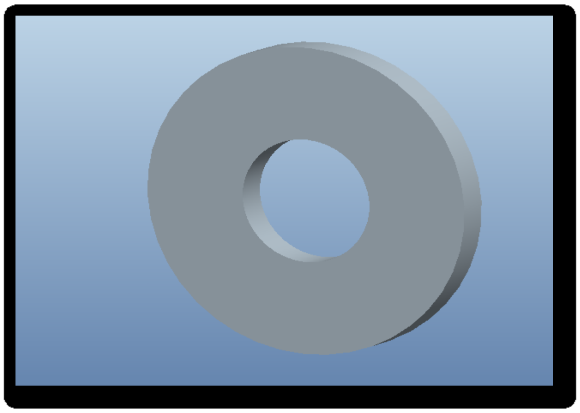
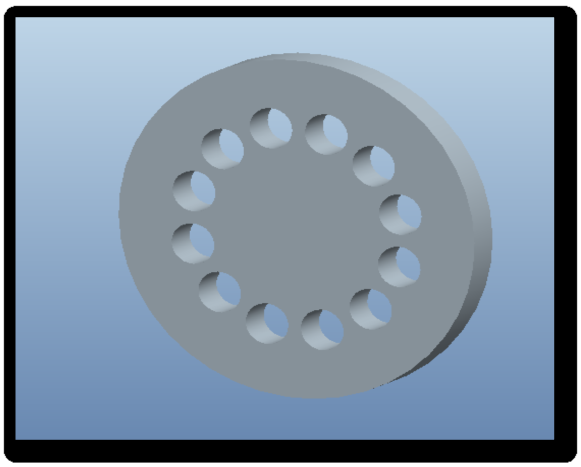
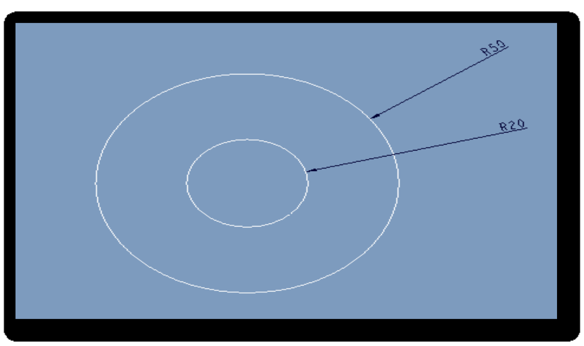


12 holes

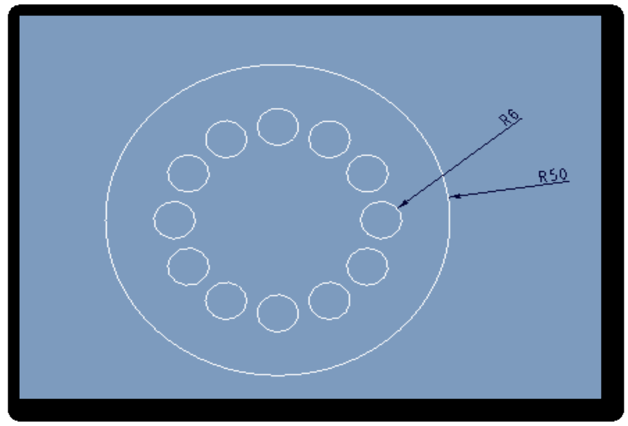


2D MODEL OF ORIFICE PLATE

Single hole



12 holes



INTRODUCTION TO FEA

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Top established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

By the early 70's, FEA was limited to expensive mainframe computers generally owned by the aeronautics, automotive, defense, and nuclear industries. Since the rapid decline in the cost of computers and the phenomenal increase in computing power, FEA has been developed to an incredible precision. Present day supercomputers are now able to produce accurate results for all kinds of parameters.

INTRODUCTION TO ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The

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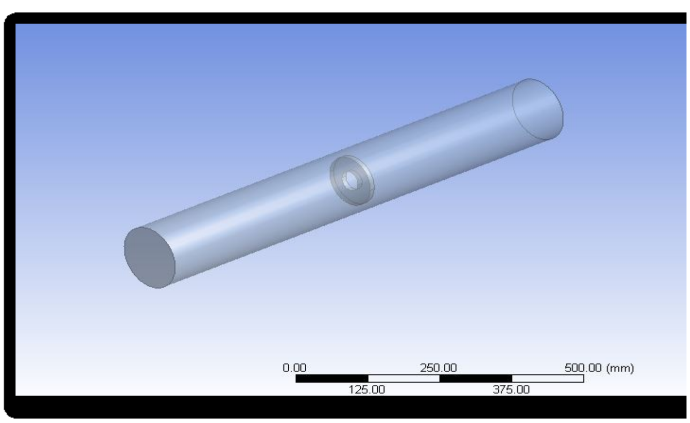
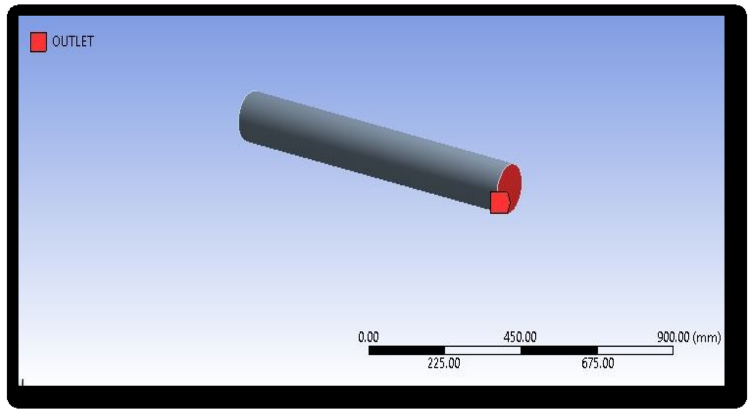
software implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

INTRODUCTION TO CFD

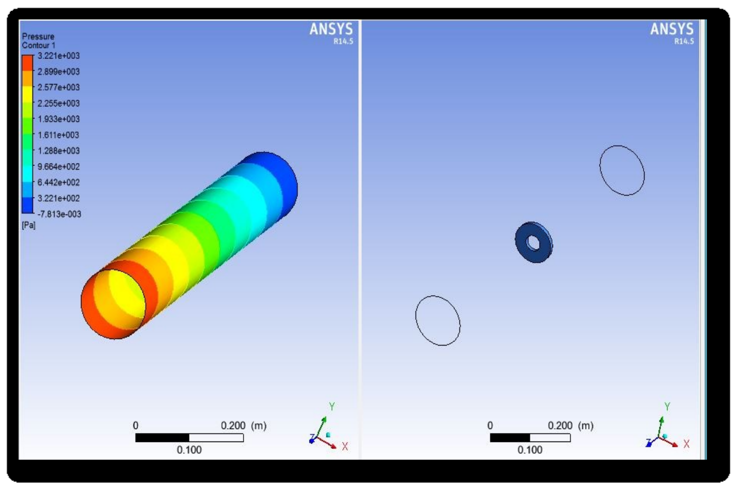
Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing, e.g. flight tests.

CFD ANALYSIS OF ORIFICE PLATE

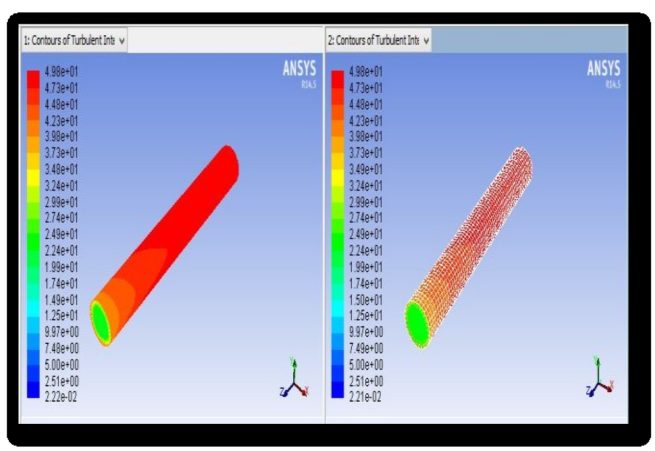




STATIC PRESSURE



TURBULENCE INTENSITY



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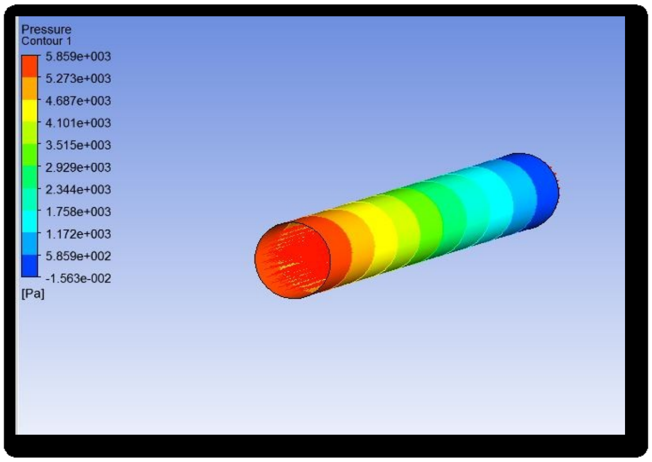
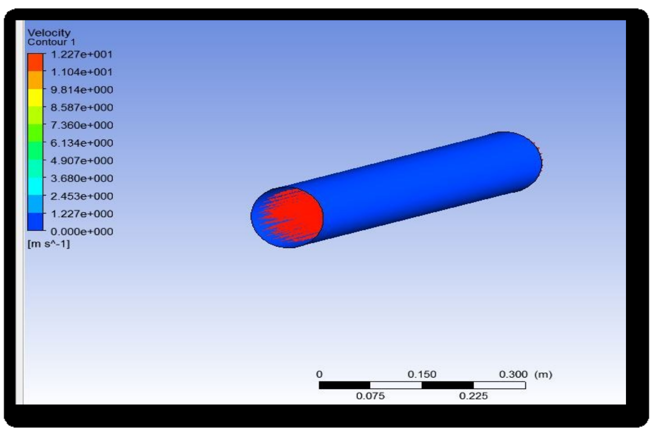
AT REYNOLDS NUMBER-10000 STATIC PRESSURE



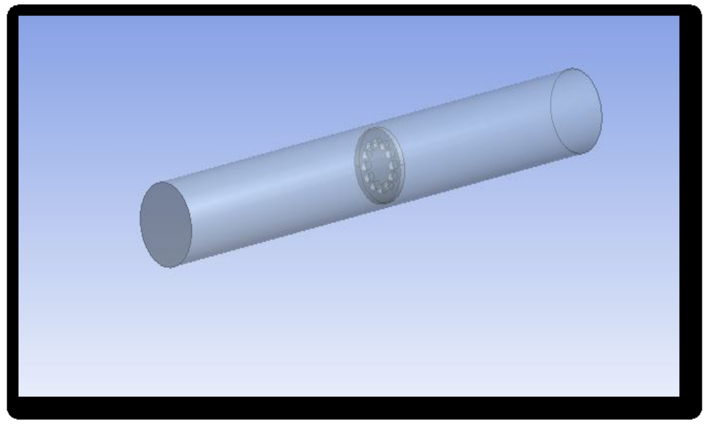
VELOCITY MAGNITUDE



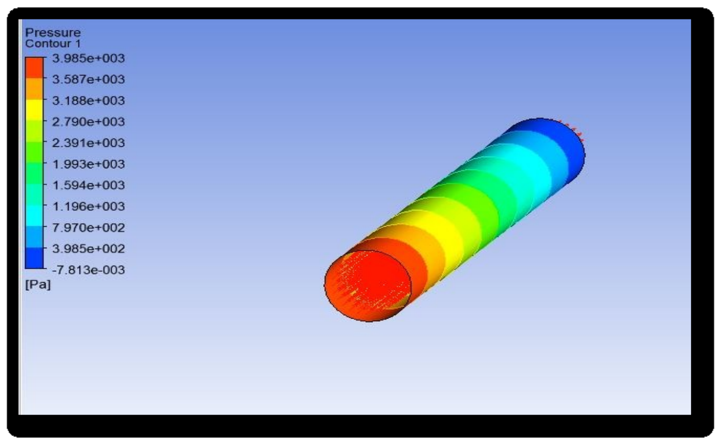
TWELEVE HOLES

AT REYNOLDS NUMBER-8000

IMPORTED MODEL



STATIC PRESSURE



CONCLUSION

In this thesis, an orifice plates with different geometry were designed and compared on the basis of their coefficient of discharge. This was done with the help of simulations done with k-ε and model on CFD as a solver. Simulations were carried out on a single hole, perforated (6 holes, 8 holes, 12 holes and 14 holes) at different Reynolds's numbers (8000, 10000 and 12000).

By observing the CFD analysis results, the pressure and turbulent intensity increases by increasing the orifice plate holes and Reynolds numbers. Mass flow rate value more for single hole of the orifice plate.

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