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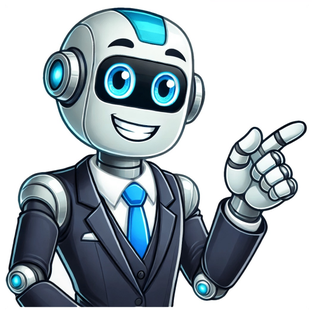

An Orifice Meter is basically a type offlow meter which isused to measure the rate of flow fluids (mainly Liquids or Gases), using the Differential Pressure Measurement principle.There is basically an Orifice Plate installed in the orifice meter which provides obstruction to the fluid flow. Here, the streamline contracts because of the area contraction due to orifice which is placed between the pipe by the flange.There is a vena -contacta considered as a minimum area -cross-section.Differential pressure is developed across the Orifice Plate which is directly proportional to the flow-rate of the liquid or gas.See also: Use Of Venturimeter for Flow Measurement and its AdvantagesPrinciple of Orifice meter :When a liquid/gas, whose flow-rate is to be determined, is passed through an Orifice Meter, there is a drop in the pressure between the Inlet section and Outlet Section of Orifice Meter. This drop in pressure can be measured using a differential pressure measuring instrument.Since this differential pressure is in direct proportion to the flow-rate as per Bernoullis Equation hence the differential pressure instrument can be configured to display flow-rate instead of showing differential pressure. orifice meterWorking of Orifice Meter :The working principle of Orifice Meter is the same, like that of Venturi meter The orifice plate is being fixed at a section of the pipe, creates an obstruction to the flow by providing an opening in the form of an orifice to the flow passage.Orifice meters are built in different forms depending upon the application-specific requirement, The shape, size, and location of holes on the Orifice Plate describe the Orifice Meter Specifications as per the following:Concentric Orifice PlateEccentric Orifice PlateSegment Orifice PlateQuadrant Edge Orifice PlateThe fluid flows inside the Inlet section of the Orifice meter having a pressure P1.As the fluid proceeds further into the Converging section, its pressure reduces gradually and it finally reaches a value of P2 at the end of the Converging section and enters the Cylindrical section.Thedifferential pressure sensorconnected between the Inlet and the and the Cylindrical Throat section of the Orifice meter displays the difference in pressure (P1-P2). This difference in pressure is in direct proportion to the flow rate of the liquid flowing through the Orifice meter.Further, the fluid passed through the Diverging recovery cone section and the velocity reduces thereby it regains its pressures. Designing a lesser angle of the Diverging recovery section helps more in regaining the kinetic energy of the liquid.Line Size: 6 mm to 800 mmAccuracy: +/-0.5% to +/-3.0%.Operating Temperature (Max.): Up to 800 degCOperating Pressure (Max.): Up to 400 barNatural GasWater Treatment PlantsOil Filtration PlantsPetrochemicals and RefineriesThe Orifice meter is very cheap as compared to other types of flow meters.Less space is required to Install and hence ideal for space-constrained applicationsThe operational response can be designed with perfection.Installation direction possibilities: Vertical / Horizontal / Inclined.Easily gets clogged due to impurities in gas or in unclear liquids.The minimum pressure that can be achieved for reading the flow is sometimes difficult to achieve due to limitations in the vena-contracta length for an Orifice Plate.Unlike Venturi meter, downstream pressure cannot be recovered in Orifice Meters. Overall head loss is around 40% to 90% of the differential pressure.Flow straighteners are required at the inlet and the outlet to attain streamline flow thereby increasing the cost and space for installation.Orifice Plate can get easily corroded with time thereby entails an error.The discharge Co-efficient obtained is low.Some Questions and Answers :What is an Orifice Plate?An orifice plate: It is a thin plate with a hole in it, which is usually placed in a pipe. When a fluid (whether liquid or gaseous) passes through the orifice, its pressure builds up slightly upstream of the orifice but as the fluid is forced to converge to pass through the hole, the velocity increases, and the fluid pressure decreases. A little downstream of the orifice the flow reaches its point of maximum convergence, the vena contracta where the velocity reaches its maximum and the pressure reaches its minimum. Beyond that, the flow expands, the velocity falls and the pressure increases.2. Explain the term vena-contracta with neat sketch vena contracta diagramThe figure shows a sharp-edged orifice in one side of a reservoir containing water. The water will emerge from the orifice as a free jet, that is, a jet discharged in the atmosphere and will, therefore, be under the influence of gravity only. The section C-C of the jet, at which the streamlines are straight and parallel to each other and perpendicular to the plane of the orifice, and the jet has the minimum cross-sectional area, is known as vena contracta. The pressure at section C-C is uniform and it is equal to the pressure of surrounding the jet. The velocity of flow of water at this section will be maximum by the principle of continuity. Beyond the section C-C the jet may, however, diverge again and it undergoes a downward deflection due to gravity. The area of jet i.e. at vena contracta may be related to the area of the orifice by following expression a2=Cc.a0 Cc=Coefficient of contraction3. Define all hydraulic coefficients.There are four hydraulic coefficients-1. Coefficient of contraction (Cc): It is the ratio of the area of the jet at vena contracta to the area of Orifice is known as Coefficient of contraction.2. Coefficient of velocity(Cv): It is the ratio of actual velocity of jet at vena contracta to the theoretical velocity of the jet is known as the Coefficient of velocity3. Coefficient of discharge (Cd): It is the ratio of actual discharge through an orifice to the theoretical discharge is known as the Coefficient of discharge.4. Coefficient of Resistance (Cr): It is the ratio of loss of head in the orifice to the head of water available at the exit of the orifice is known as the Coefficient of resistance. link to Top Branches of Mechanical Engineering link to Shree Ram Ayodhya Murti, idol - Vector , Wallart An orifice meter is a widely used device for measuring the flow rate of fluids in a pipeline. It operates based on Bernoullis principle, which describes the inverse relationship between the pressure and velocity of a fluid. When fluid flows through the orifice plate, a pressure drop occurs, and by measuring this pressure drop, the flow rate can be accurately determined. Orifice meters are valued for their simplicity, cost-effectiveness, and minimal maintenance requirements, making them popular in various industrial applications. An orifice meter consists of several key components, each playing a crucial role in its operation: Orifice Plate A thin metal plate with a precise hole in the center. This plate is inserted between two flanges in the pipeline. The hole creates a restriction, causing a drop in pressure and an increase in velocity as the fluid passes through it. Inlet Section The section where the fluid enters the orifice meter. The inlet is designed to ensure smooth and stable fluid flow into the orifice plate. Overflow Pipe Prevents fluid overflow, ensuring that the meter operates within its design limits. Flow Dissipator This component, which houses the orifice plate, helps in stabilizing the fluid flow and contains taps for measuring pressure changes. Outlet Section The section where the fluid exits the orifice meter after passing through the orifice plate. Pitot Tube Used to measure the fluids pressure drop across the orifice plate. It is an essential component for accurate flow rate measurement. Manometer Attached to the pitot tube, it displays the pressure readings, allowing for the calculation of the flow rate. Working Principle of an Orifice Meter The operation of an orifice meter is straightforward and relies on the following steps: Fluid Entry Fluid enters the orifice meter through the inlet section, moving towards the orifice plate. Flow Through Orifice Plate As the fluid passes through the small hole in the orifice plate, its velocity increases, and its pressure decreases. This is due to the constriction created by the orifice plate, which accelerates the fluid. Vena Contracta Formation Just downstream of the orifice plate, the fluid streamlines converge to form the vena contracta, where the fluid velocity is at its peak and pressure at its minimum. Pressure Recovery Beyond the vena contracta, the fluid begins to decelerate, causing a partial recovery of pressure, though it does not return to the initial pressure level upstream of the orifice plate. Measurement The pressure difference between the upstream section (before the orifice plate) and the downstream section (after the vena contracta) is measured using differential pressure measuring instruments. This pressure drop is directly related to the flow rate of the fluid. Types of Orifice Plates / Meters Orifice meters come in various designs, each suited to different types of fluids and applications: Concentric Square Edged Used for clean liquids, gasses, and low-velocity vapors. Features a sharp, square-edged hole bored in a flat thin plate. Provides high accuracy when installed correctly. Commonly used in applications where precise flow measurement is required. Segmental Orifice Meter Ideal for fluids with substantial entrained water or air, and suspensions. Prevents build-up in front of the orifice plate. Suitable for measuring slurries and extremely dirty gasses. Often used in wastewater treatment and similar applications. Eccentric Orifice Meter Has an off-center flow opening. Suitable for fluids containing small amounts of non-abrasive solids. Commonly used in chemical industries for measuring flows with slight contamination. Helps in preventing sedimentation and clogging. Quadrant Edge Orifice Designed for high-viscosity fluids. Features an inlet with a quarter-circle edge and a plate thickness equal to the radius of the inlet. Often used in industries dealing with thick, viscous liquids like oils and syrups. Click here for Orifice Plate Flow and Pressure Drop Calculation Excel Tool Advantages of Orifice Meters Orifice meters offer several benefits that make them a popular choice in various industrial applications: Low Cost: Simple design and construction make them cost-effective compared to other flow measurement devices. Easy Installation: Can be easily installed in existing pipeline systems without requiring extensive modifications. Minimal Maintenance: Require little to no regular maintenance, reducing operational costs. Easy Replacement: Components, particularly the orifice plate, can be easily replaced if damaged or worn out. No Moving Parts: Reduces the risk of mechanical failure and increases reliability. High Accuracy: Capable of providing accurate flow measurements for a wide range of gasses and liquids. Versatile Sizes: Available in various sizes to fit different pipeline diameters. Compact Design: Occupies minimal space, making it suitable for installations where space is limited. Wide Range of Applications: Can measure both high and low flow rates, making it versatile. Disadvantages of Orifice Meters Despite their advantages, orifice meters have some limitations: Not Suitable for Dirty Fluids: Ineffective for measuring dirty fluids, slurries, and wet steam as they can clog the orifice. Impulse Line Issues: Susceptible to freezing and plugging, affecting accuracy and reliability. Sensitivity to Conditions: Accuracy can be affected by changes in fluid temperature, viscosity, and density. Pressure Loss: Causes a significant drop in pressure, which may not be fully recovered downstream. Risk of Corrosion: Orifice plates can corrode, leading to measurement inaccuracies. Limited Measuring Range: The measuring range is constrained by fluid viscosity, making it less suitable for very thick or very thin fluids. Applications of Orifice Meters Orifice meters are used in a wide range of industrial applications due to their versatility and reliability: Fluid Flow Measurement: Used in pipelines to measure the flow rates of various fluids. Natural Gas Plants: Widely used to measure the flow of natural gas. Water Treatment Plants: Measures flow rates of water and treatment chemicals. Petrochemical Plants and Refineries: Used in processes involving the measurement of crude oil, refined products, and other chemicals. Oil Filtration Plants: Measures flow rates during the filtration process. HVAC Systems: Used in heating, ventilation, and air conditioning systems to measure airflow. Power Plants: Used to measure steam and cooling water flow rates. Food and Beverage Industry: Measures the flow of various liquids used in the production process. Click here for Orifice Sizing Guidelines & Rules Associated With Selection Frequently Asked Questions and Answers What materials are typically used to construct the orifice plate in an orifice meter? Orifice plates are typically made from materials such as stainless steel, carbon steel, and various alloys. The choice of material depends on the fluid being measured, the operating conditions, and the need for corrosion resistance. How is the diameter of the orifice hole selected for a specific application? The diameter of the orifice hole is selected based on the desired flow rate, the characteristics of the fluid, and the pipeline dimensions. Engineers use standardized calculations and flow equations, such as those provided by the ASME (American Society of Mechanical Engineers), to determine the appropriate size. Can orifice meters be used for measuring the flow of steam? Yes, orifice meters can be used to measure the flow of steam, but care must be taken to ensure the steam is dry. Wet steam can lead to inaccuracies and potential damage to the orifice plate. What are some common methods for calibrating an orifice meter? Common methods for calibrating an orifice meter include using a known reference flow standard, employing a secondary measurement device for comparison, and adjusting the meters readings based on empirical data obtained under controlled conditions. What role does the beta ratio play in the design of an orifice meter? The beta ratio, which is the ratio of the orifice diameter to the pipe diameter, plays a crucial role in determining the differential pressure created by the orifice plate. It affects the accuracy and range of the flow measurement. Typical beta ratios range from 0.2 to 0.8, with each application requiring careful selection based on the desired flow characteristics. How does fluid temperature affect the performance of an orifice meter? Fluid temperature can affect the density and viscosity of the fluid, which in turn influences the flow rate and pressure drop across the orifice plate. Temperature fluctuations may require compensation or recalibration to maintain accuracy. What maintenance practices are recommended for orifice meters? Recommended maintenance practices for orifice meters include regular inspection and cleaning of the orifice plate to prevent clogging and corrosion, checking for wear and tear, verifying the integrity of the pressure taps and impulse lines, and periodic recalibration of installed transducer to ensure continued accuracy. Standards and Regulations for Orifice Meters ISO 5167-1 General principles and requirements for pressure-differential devices. Installation requirements and flow rate calculation methods. ISO 5167-2 Specific guidelines for orifice plates. Specifications for design, installation, and maintenance. Equations for calculating flow rates using orifice plates. ASME MFC-3M Standards for orifice plates, nozzles, and Venturi tubes. Guidelines for construction, installation, and use. AGA Report No. 3 Guidelines for orifice metering of natural gas. Detailed procedures for installation, calibration, and maintenance. EN ISO 5167-1 and EN ISO 5167-2 European adoption of the ISO 5167 standards. Provides consistency with international guidelines. API MPMS Chapter 14.3 Orifice metering of natural gas and related hydrocarbon fluids. Methods and practices for accurate measurement in the petroleum industry. There are different types of flow meters used in various industries to measure fluid flow rates. One of the simplest types is the orifice meter, which introduces a constriction in the flow using an orifice plate and measures flow rate based on the resulting differential pressure. This article explores the working principles, components, and applications of the orifice meter. Flowmeters can be classified into at least two types: positive displacement flowmeters and inferential flowmeters. Positive displacement flowmeters directly measure the flow rate by mechanically displacing fluid in discrete volumes within a specific time frame. On the other hand, inferential flowmeters operate by creating a pressure drop across a constriction in the flow path and correlating this pressure drop to the flow rate. The orifice meter is a type of inferential flow meter that utilizes an orifice plate with an aperture that is concentrically inserted into a pipeline in order to create the required constriction in the flow path. It operates on the idea that a decrease in flow area causes an increase in velocity as well as a decrease in pressure. The typical flow pattern across an orifice plate is shown in the diagram below. Advance in Excel with engineering-focused training that equips you with the skills to streamline projects and accelerate your career. As the fluid approaches the orifice, the pressure slightly increases and reaches a maximum point followed by a sudden drop as it passes through the orifice. The pressure continues to decrease until it reaches the lowest point at the narrowest section of the flow called the vena contracta. The pressure differential developed across the orifice is typically measured using a manometer and is used to empirically obtain the flow rate. As the pressure differential increases, the flow rate also increases. Generally, the pressure differential is proportional to the square of the flow velocity. It is important to note that after passing through the vena contracta, the velocity of the fluid decreases and the pressure tends to increase back to its original value. However, due to friction and turbulence losses, a large fraction of the pressure drop is not recovered. At a distance of approximately 5 to 8 diameters downstream, a new maximum pressure point is reached, which is lower than the maximum pressure upstream of the orifice, as shown on the flow pattern diagram above. The permanent pressure loss is a function of a parameter called the beta ratio, as shown in the graph below. The beta ratio is the ratio of the diameter of the orifice plate boreto the internal diameter of the pipe. The measured pressure drop across the orifice can be used to obtain the flow rate using empirical equations. Derived from the Bernoullis equation, the actual volumetric flow rate through an orifice be calculated using the formula: Where: Q = volumetric flow rate [m3/s] Ao = cross-sectional area of the orifice [m2] C = orifice plate flow coefficient [unitless] P = pressure differential across the orifice [Pa] = fluid density [kg/m3] Note that this formula is only applicable for incompressible fluids. For compressible fluids, like gas, the equation needs to be modified to account for the effects of temperature, specific gravity, and gas expansion, among others. The discharge flow coefficient is an empirical parameter that is introduced into the equation to account for the effect of viscosity and turbulence in the behavior of the flow. Research has shown that this coefficient depends on the Reynolds number and beta ratio. To illustrate this relationship, consider the graph below, which depicts the discharge coefficient plotted against the Reynolds number for a standard concentric orifice plate at various beta ratio values. Discharge coefficient of standard concentric orifice plate as a function of Reynolds number and beta ratio The discharge flow coefficient is obtained from experimental data and can be found in reference books. However, it is important to note that different orifice plate bore configurations exist, and the coefficient value may vary among them. Typically, it ranges from 0.6 to 0.9 for most orifices. The orifice meter is arguably the most commonly used differential flowmeter in a wide range of industries such as oil and gas, water treatment, chemical processing, HVAC systems, and power generation. Since it essentially only consists of an orifice plate and pressure taps, it is simple and cost-effective compared to other types of flow meters. Because of its long history of usage, orifice meters have established standardized measurement techniques. When properly applied, designed, installed, maintained, and interpreted, it provides highly accurate measurements. However, orifice plates have some limitations. Firstly, they have limited turndown, meaning they may not provide accurate measurements at extremely low or high flow rates. Turndown is the ratio of maximum flow to minimum flow throughout which the accuracy of measurement is maintained. The turndown ratio of orifice meters is generally between 3:1 and 5:1. Another limitation is the substantial permanent pressure loss caused by the obstruction created by the orifice plate. This makes orifice meters unsuitable for low-pressure systems as the additional pressure drop can significantly impact the overall system performance. When used with highly viscous fluids or slurries, the pressure drop can also become excessively high, resulting in inaccurate flow measurements. Orifice meters are also not suitable in systems with non-homogeneous flow patterns, such as flows with presence of gas bubbles or solid particles. In general, orifice meters are designed for measuring the flow of clean, low-viscosity fluids. However, there are orifice plate configurations, such as the eccentric bore type, that can handle minimal amounts of impurities. Lastly, orifice meters operate optimally under steady-state flow conditions with a well-developed flow profile. Fluctuations in flow rate, such as pulsating or oscillating flows, can affect the accuracy of the measurement due to the inertia and response time of the measurement system. Despite these limitations, orifice meters are widely used due to their simplicity, cost-effectiveness, and acceptable level of accuracy for a range of flow rates. In the oil and gas industry and power generation, orifice meters are extensively used for measuring natural gas in pipelines, refineries, production facilities, and distribution networks. In chemical processing and water treatment, they are used to measure flow rates of various liquids to control and optimize production processes. They are also employed in irrigation systems for measuring water flow in agricultural applications. In HVAC systems, orifice meters can measure the flow of air and other gases to balance airflow in ductwork, monitor ventilation rates, and assess system performance. The orifice meter is a widely used flowmeter. However, it is important to note that there are also other inferential flowmeters that operate on the same principle of creating a constriction to indirectly measure flow rate from the pressure differential. One such device similar to the orifice meter is the Venturi meter. A Venturi meter consists of a converging section, a throat, and a diverging section. As fluid enters the Venturi meter, its velocity gradually increases through the converging section, reaching its peak velocity at the throat. At the throat, the pressure is at its lowest point, but it increases again as the fluid exits through the diverging section and returns to the full pipe diameter. The pressure differential is measured between the inlet pipe and the throat. Both the orifice and Venturi meters serve the same purpose. The main difference, however, lies in their structures. The Venturi meter has a tapered structure, causing a gradual change in fluid velocity, while the orifice has a sudden change in fluid velocity due to the flat plate. Due to this structural difference, the Venturi meter offers several advantages in terms of functionality. It experiences much lower pressure loss compared to orifice meters and has a higher turndown ratio, which can reach up to 10:1. The Venturi meter is also insensitive to changes in the velocity vector, allowing it to be installed in pipes oriented horizontally, vertically, or at any angle. On the other hand, the orifice meter must be installed on straight pipes, with the fluids velocity vector perpendicular to the orifice plate. Additionally, Venturi meters can be used even with liquids containing a high solid content because the design of the Venturi meter allows for the flowing fluid to follow a streamlined path, which prevents clogging. In contrast, the orifice meter is generally not suitable for such working fluids as the flat plate creates dead zones where solids may deposit and accumulate over time. Despite these advantages, Venturi meters are more expensive to install. Creating a tapered pipe requires ample space before and after the throttle area, and Venturi meters are permanently constructed into the pipe. On the other hand, the orifice meter is simpler and cheaper to install since it is simply inserted concentrically into the pipe. Moreover, orifice meters offer more flexibility during operation. Although Venturi meters can handle a larger range of fluid flow rates than orifice meters, once a Venturi meter is already installed in a system, the range of flow rates it can handle becomes fixed. With orifice meters, the orifice plates can be easily removed and replaced with different plates containing varying bore sizes or arrangements. Orifice Meter (Orifice Plate) Orifice Meter (Orifice Plate): Definition, Types, Parts, Application, Working Principle, Components, Advantages & Disadvantages :- An orifice is defined as the device which is used for measuring the rate of flow of a flowing fluid, for restricting flow or for reducing pressure through a pipe. They generally consist of orifice plate, meter tube and orifice plate housing. In orifice meter, there is a orifice plate which provides restriction to the flow of fluid. Orifice is placed between the pipes which contracts the streamline due to the contraction of area. Minimum area cross section is known as vena contracta. Orifice diameter is generally kept around 0.5 times of the diameter of pipe but sometimes it can vary between 0.4 times to 0.8 times of the diameter of pipe. Across the orifice plate differential pressure is developed which is directly proportional to flow rate of the fluid. Orifice meter are generally made up of carbon steel. Orifice plate is the plate which have diameter equal to the diameter of pipeline in which there is a drilled hole in it which helps in reducing the rate of flow therefore the pressure can be reduced. Inlet is the point at which fluid enters from pipeline and fluid changes its pressure as well as velocity. Overflow pipe are used for the prevention of overflow of glass cylinder. Flow dissipater in the orifice plate are responsible for the flow dissipation which is done by taps and therefore pressure changes. Outlet is the point in device at which fluid exits. It is used for measuring the pressure drop. It is the device which is provided for pressure measurement. Orifice plate is located between the inlet and outlet section. It is generally used to produce pressure drops which allow them to measure the flow rate. Flow conditioner is installed at the inlet section and is used for enhancing the linear flow at the inlet section. Outlet section are also a linear segment and used for determining the pressure of liquid or gas discharged. Inlet section is the linear segment which is extended from device and inlet section act as end connection for the flowing fluid. The working of the orifice meter depends on the principle of differential pressure measurement. The gas or liquid whose rate of flow need to be determined are passed through orifice which results in drop of pressure across the orifice plate which vary with rate of flow and then results in differential pressure between inlet and the outlet segment. This drop in pressure is measured and then this drop in pressure are measured and used for the calculation of rate of flow of the gas or fluid. Let d1 is the diameter at the section 1 D2 is the diameter at the section 2 P1 is the pressure at the section 1 P2 is the pressure at the section 2 V1 is the velocity at the section 1 V2 is the velocity at the section 2 A1 is the area at section 1 A2 is the area at section 2 P1/ g + v1/ 2g + z1 = P2/ g + v2/ 2g + z2 {P1/ g + z1} {P2/ g + z2} = v2 v1/ 2g h = v2 v1/ 2g v2 = (2gh + v1) Where h is the differential head. Let A be the area of orifice Now coefficient of contraction, Cc = A2/ A A1V1 = A2V2 V1 = ACc x V2 / A1 Now, V2 = {2gh + (A Cc V2/ A1)} V2 = (2gh)/ {1 (A Cc/ A1)} Thus, discharge Q = A2V2 = V2ACc = ACc(2gh)/ {1 (A Cc/ A1)} If we have Cd is the coefficient of discharge for the orifice meter Cd = Cc x (1 A/ A1)/ (1 A Cc/ A1) Cc = Cd x (1 A Cc/ A1)/ (1 A/ A1) Therefore, Q = Cd x AA1 (2gh)/ (A1 A) The value of coefficient of discharge of orifice meter is very less in comparison with the value of coefficient of discharge of venturimeter. There are generally three main types of orifice fittings They contain two different valves of different chambers which increase the operational safety. They also provide protection from the liquids which are toxic in nature. It have single chamber which is designed for accurate measurement of the rate of flow of the gas or fluid. Dual chambers are installed in conjunction with upstream and downstream sections and they have a O ring seal which eliminate the issue of the maintenance of gasket. In addition, a valve seal is also provided for this type of orifice fitting. Standard shape of the orifice plate is bevel or cone, on the smaller side they have sharp edges and edges are face to the upstream of the flow. Orifice plates can be used for huge variety of pipe diameters. There are various types of orifice plate used in orifice meter In eccentric orifice plate the hole is off the center. They are generally used for those liquids which contains solids or gases. In this type of orifice plate the hole is at the center. These orifice plates are most common among other types of orifice plate. They are used for various of process but generally not used for highly corrosive process or slurries. These type of orifice plates are generally used for low rates of flow. They are small tube which is mounted directly over the differential pressure transmitter. They have an orifice which is present inside the tube and are used for connecting the high side of the cavity to the low side of the cavity. The segmental orifice plate is a slender plate with an opening in the shape of a circular section. Conical orifice plates generally installed on backwards therefore flow enters through the beveled side instead of entering through the non beveled side. It is used in following industries: RefineriesNatural gas industriesPetrochemical plantsWater treatment plantsOil filtration plants They are cheap in comparison to other devices like venturimeter.They need less space for their installation; therefore they are ideal for space constrained applications.They can be used in large pipes also for the determination of flow rates.They can be installed in vertical as well as in horizontal positions. They can easily clog if there are impurities present in gas or liquid.They have low discharge coefficient.The orifice plate is corroded easily with time.To attain streamline flow, flow straighteners are needed at the outlet and inlet which increase the space for installation as well as cost.In orifice meter, downstream pressure cannot be recovered and the head loss is in between 40 percent to 90 percent of differential pressure. Image Source :- deltafluid, lsproline In fluid dynamics, orifice meters play a crucial role in accurately measuring the flow rate of liquids and gases. These devices are widely used in various industries, including oil and gas, chemical, and water management. An orifice meter is a type of flow measurement device that utilizes a precisely sized orifice plate to create a pressure drop across a flowing stream. By measuring the pressure difference, the flow rate of a fluid passing through the orifice can be determined. Orifice meters are particularly useful for measuring the flow of liquids, gases, and steam in pipelines. Orifice meters consist of three primary components: the orifice plate, the holder, and the pressure tappings. 1. Orifice Plate: The orifice plate is a thin, flat circular plate with a precisely drilled hole, known as the orifice bore, at its center. The plate is typically made of stainless steel or other corrosion-resistant materials. The diameter of the orifice bore is carefully calculated based on the desired flow range and the properties of the fluid being measured. 2. Holder: The orifice plate is held in place within the pipe by a holder, which is designed to provide a stable and secure fit. The holder ensures that the orifice plate is centered and aligned correctly within the pipe to obtain accurate measurements. It also helps to minimize the flow disturbances caused by the presence of the orifice plate. 3. Pressure Tappings: Pressure tappings are small holes drilled in the pipe upstream and downstream of the orifice plate. These tappings allow pressure sensors or gauges to be connected to measure the differential pressure across the orifice. The pressure difference is a critical parameter used to calculate the flow rate through the orifice. Orifice Meters When fluid flows through a pipeline containing an orifice meter, it passes through the orifice plate, causing a reduction in the cross-sectional area. This reduction creates a constriction point, leading to an increase in fluid velocity and a corresponding decrease in pressure. The pressure drop is measured using pressure sensors connected to the pressure tappings. The flow rate through the orifice is determined by calculating the square root of the pressure drop across the orifice and applying the principles of fluid mechanics. The calculation involves using established equations, such as the Bernoulli equation and the orifice equation, which considers factors such as the fluid density, orifice diameter, and coefficient of discharge. Orifice Meter Formula The basic formula used to calculate the flow rate through an orifice meter is known as the orifice equation or the discharge equation. It can be expressed as follows: Q = Cd * A * (2P /) Where: Q = Flow rate (volume per unit time) Cd = Coefficient of discharge A = Area of the orifice P = Pressure drop across the orifice = Density of the fluid Derivation of the Orifice Meter Formula The orifice meter formula can be derived using the principles of Bernoullis continuity equations. Lets walk through the derivation step by step: Step 1: Start with Bernoullis equation, which states that the total energy of a fluid remains constant along a streamline. P/ + V/2 + gz = P/ + V/2 + gz Where: P and P = Pressures at points 1 and 2 = Density of the fluid V and V = Velocities at points 1 and 2 g = Acceleration due to gravity z and z = Elevations at points 1 and 2 Step 2: Assume that the fluid velocity before the orifice (point 1) is negligible compared to the velocity through the orifice (point 2). Therefore, V can be considered zero. P/ + gz = P/ + V/2 + gz Step 3: Simplify the equation by canceling out the elevation terms (gz and gz). P/ = P/ + V/2 Step 4: Introduce the pressure difference P = P P. P/ = V/2 Step 5: Solve for V. V = (2P /) Step 6: Apply the continuity equation, which states that the mass flow rate is constant in an incompressible fluid. Q = Q AV = AV Since V is negligible compared to V, AV can be considered zero. AV = Q Step 7: Substitute the value of V from Step 5 into the continuity equation. A(2P /) = Q Step 8: Solve for Q. Q = A * (2P /) Step 9: Finally, introduce the coefficient of discharge Cd, which accounts for losses due to friction and other factors. Q = Cd * A * (2P /) Orifice meters offer several advantages, making them a popular choice for flow measurement in various industries: 1. Cost-effective: Orifice meters are relatively inexpensive compared to other flow measurement devices, making them a cost-effective solution for many applications. 2. Simple design: The construction of orifice meters is straightforward, with fewer moving parts, which reduces the chances of mechanical failure and simplifies maintenance. 3. Wide range of applications: Orifice meters can handle a wide range of fluid types, temperatures, and pressures, making them versatile instruments suitable for diverse industries, including oil and gas, chemical processing, water management, and HVAC systems. 4. Accuracy: With proper installation and calibration, orifice meters can provide accurate flow rate measurements within an acceptable margin of error. When fluid passes through the orifice plate, the flow is constricted, creating a pressure drop across the orifice. By measuring this pressure drop, the flow rate can be calculated using Bernoullis equation and other fluid dynamics principles.Orifice Meters are simple in design and relatively inexpensive.They can handle a wide range of fluid types, including liquids, gases, and steam.Orifice Meters have a predictable and repeatable flow measurement performance. Orifice and venturi meter works under the same principle, both meters creates a restriction in the flow channel and the pressure difference across the restriction is measured, which is proportional to the rate of discharge of flowing fluid through the pipeline. Advantages and disadvantages of Orifice and venturi meter are listed below: Orifice meter:Advantages of Orifice meter:The Orifice is small plates and easy to install/remove.Offer very little pressure drop from which 60% to 65% is recovered.The orifice meter can be easily maintained.Measures a wide range of flows.They have a simple construction.They have easily fitted between the flanges.They are the most suitable for most gases and liquids.They are cheap, The price does not increase dramatically with size.Disadvantages of orifice meter:Requires homogeneous fluid.Requires single phase liquidIt requires the flow of axial velocity vectors.It causes a pressure drop in the fluid.Its accuracy is affected by the density, pressure and viscosity of the fluid.The range of measurement of viscosity limits of fluids.It requires straight conduits to ensure accuracy is maintained.The pipe must be totally special for the measurement of the flow of liquids.They have low range capacity.Venturi meter:Advantages of venturi meter:Less chance of getting stuck with sediment.The discharge coefficient is high.Its behaviour can be predicted perfectly.It can be installed vertically, horizontally, inclined.They are more precise and can be used for a wide range of flows.About 90% of the pressure drop can be recovered.Disadvantages ofventuri meter:They are large in size and, therefore, where space is limited, they can not be used.Initial costs, installation and expensive maintenance.Requires a long placement length. That is, the venturi meter must be driven by a straight tube that has no connections or misalignments to avoid turbulence in the flow, for satisfactory operation.It can not be used in pipes of less than 7.5 cm in diameter.Maintenance is not easy.It can not be modified to measure the pressure beyond a maximum speed There are different types of flow meters used in various industries to measure fluid flow rates. One of the simplest types is the orifice meter, which introduces a constriction in the flow using an orifice plate and measures flow rate based on the resulting differential pressure. This article explores the working principles, components, and applications of the orifice meter. Flowmeters can be classified into at least two types: positive displacement flowmeters and inferential flowmeters. Positive displacement flowmeters directly measure the flow rate by mechanically displacing fluid in discrete volumes within a specific time frame. On the other hand, inferential flowmeters operate by creating a pressure drop across a constriction in the flow path and correlating this pressure drop to the flow rate. The orifice meter is a type of inferential flow meter that utilizes an orifice plate with an aperture that is concentrically inserted into a pipeline in order to create the required constriction in the flow path. It operates on the idea that a decrease in flow area causes an increase in velocity as well as a decrease in pressure. The typical flow pattern across an orifice plate is shown in the diagram below. Advance in Excel with engineering-focused training that equips you with the skills to streamline projects and accelerate your career. As the fluid approaches the orifice, the pressure slightly increases and reaches a maximum point followed by a sudden drop as it passes through the orifice. The pressure continues to decrease until it reaches the lowest point at the narrowest section of the flow called the vena contracta. The pressure differential developed across the orifice is typically measured using a manometer and is used to empirically obtain the flow rate. As the pressure differential increases, the flow rate also increases. Generally, the pressure differential is proportional to the square of the flow velocity. It is important to note that after passing through the vena contracta, the velocity of the fluid decreases and the pressure tends to increase back to its original value. However, due to friction and turbulence losses, a large fraction of the pressure drop is not recovered. At a distance of approximately 5 to 8 diameters downstream, a new maximum pressure point is reached, which is lower than the maximum pressure upstream of the orifice, as shown on the flow pattern diagram above. The permanent pressure loss is a function of a parameter called the beta ratio, as shown in the graph below. The beta ratio is the ratio of the diameter of the orifice plate boreto the internal diameter of the pipe. The measured pressure drop across the orifice can be used to obtain the flow rate using empirical equations. Derived from the Bernoullis equation, the actual volumetric flow rate through an orifice be calculated using the formula: Where: Q = volumetric flow rate [m3/s] Ao = cross-sectional area of the orifice [m2] C = orifice plate flow coefficient [unitless] P = pressure differential across the orifice [Pa] = fluid density [kg/m3] Note that this formula is only applicable for incompressible fluids. For compressible fluids, like gas, the equation needs to be modified to account for the effects of temperature, specific gravity, and gas expansion, among others. The discharge flow coefficient is an empirical parameter that is introduced into the equation to account for the effect of viscosity and turbulence in the behavior of the flow. Research has shown that this coefficient depends on the Reynolds number and beta ratio. To illustrate this relationship, consider the graph below, which depicts the discharge coefficient plotted against the Reynolds number for a standard concentric orifice plate at various beta ratio values. Discharge coefficient of standard concentric orifice plate as a function of Reynolds number and beta ratio The discharge flow coefficient is obtained from experimental data and can be found in reference books. However, it is important to note that different orifice plate bore configurations exist, and the coefficient value may vary among them. Typically, it ranges from 0.6 to 0.9 for most orifices. The orifice meter is arguably the most commonly used differential flowmeter in a wide range of industries such as oil and gas, water treatment, chemical processing, HVAC systems, and power generation. Since it essentially only consists of an orifice plate and pressure taps, it is simple and cost-effective compared to other types of flow meters. Because of its long history of usage, orifice meters have established standardized measurement techniques. When properly applied, designed, installed, maintained, and interpreted, it provides highly accurate measurements. However, orifice plates have some limitations. Firstly, they have limited turndown, meaning they may not provide accurate measurements at extremely low or high flow rates. Turndown is the ratio of maximum flow to minimum flow throughout which the accuracy of measurement is maintained. The turndown ratio of orifice meters is generally between 3:1 and 5:1. Another limitation is the substantial permanent pressure loss caused by the obstruction created by the orifice plate. This makes orifice meters unsuitable for low-pressure systems as the additional pressure drop can significantly impact the overall system performance. When used with highly viscous fluids or slurries, the pressure drop can also become excessively high, resulting in inaccurate flow measurements. Orifice meters are also not suitable in systems with non-homogeneous flow patterns, such as flows with presence of gas bubbles or solid particles. In general, orifice meters are designed for measuring the flow of clean, low-viscosity fluids. However, there are orifice plate configurations, such as the eccentric bore type, that can handle minimal amounts of impurities. Lastly, orifice meters operate optimally under steady-state flow conditions with a well-developed flow profile. Fluctuations in flow rate, such as pulsating or oscillating flows, can affect the accuracy of the measurement due to the inertia and response time of the measurement system. Despite these limitations, orifice meters are widely used due to their simplicity, cost-effectiveness, and acceptable level of accuracy for a range of flow rates. In the oil and gas industry and power generation, orifice meters are extensively used for measuring natural gas in pipelines, refineries, production facilities, and distribution networks. In chemical processing and water treatment, they are used to measure flow rates of various liquids to control and optimize production processes. They are also employed in irrigation systems for measuring water flow in agricultural applications. In HVAC systems, orifice meters can measure the flow of air and other gases to balance airflow in ductwork, monitor ventilation rates, and assess system performance. The orifice meter is a widely used flowmeter. However, it is important to note that there are also other inferential flowmeters that operate on the same principle of creating a constriction to indirectly measure flow rate from the pressure differential. One such device similar to the orifice meter is the Venturi meter. A Venturi meter consists of a converging section, a throat, and a diverging section. As fluid enters the Venturi meter, its velocity gradually increases through the converging section, reaching its peak velocity at the throat. At the throat, the pressure is at its lowest point, but it increases again as the fluid exits through the diverging section and returns to the full pipe diameter. The pressure differential is measured between the inlet pipe and the throat. Both the orifice and Venturi meters serve the same purpose. The main difference, however, lies in their structures. The Venturi meter has a tapered structure, causing a gradual change in fluid velocity, while the orifice has a sudden change in fluid velocity due to the flat plate. Due to this structural difference, the Venturi meter offers several advantages in terms of functionality. It experiences much lower pressure loss compared to orifice meters and has a higher turndown ratio, which can reach up to 10:1. The Venturi meter is also insensitive to changes in the velocity vector, allowing it to be installed in pipes oriented horizontally, vertically, or at any angle. On the other hand, the orifice meter must be installed on straight pipes, with the fluids velocity vector perpendicular to the orifice plate. Additionally, Venturi meters can be used even with liquids containing a high solid content because the design of the Venturi meter allows for the flowing fluid to follow a streamlined path, which prevents clogging. In contrast, the orifice meter is generally not suitable for such working fluids as the flat plate creates dead zones where solids may deposit and accumulate over time. Despite these advantages, Venturi meters are more expensive to install. Creating a tapered pipe requires ample space before and after the throttle area, and Venturi meters are permanently constructed into the pipe. On the other hand, the orifice meter is simpler and cheaper to install since it is simply inserted concentrically into the pipe. Moreover, orifice meters offer more flexibility during operation. Although Venturi meters can handle a larger range of fluid flow rates than orifice meters, once a Venturi meter is already installed in a system, the range of flow rates it can handle becomes fixed. With orifice meters, the orifice plates can be easily removed and replaced with different plates containing varying bore sizes or arrangements. Download the Testbook APP & Get Pass Pro Max FREE for 7 Days10,000+ Study NotesRealtime Doubt Support71000+ Mock TestsRankers Test Series+ more benefitsDownload App Now An orifice meter is a type of flow meter that measures the rate of flow through a pipe by inserting an orifice plate between two pipe flanges and setting up a proper pressure connection. The Venturi meter and the Orifice meter both operate on the same principles. What is the principle of Orifice meter? The orifice plate allows the liquid or gas whose flow rate has to be measured to pass through. The consequence is a pressure differential between the outlet and inlet segments due to a pressure drop through the orifice plate that varies with the flow rate. Orifice meter components A standard orifice meter consists of an orifice plate, a manometer, and a flange or carrier ring, pipe, flow dissipator. 1. Orifice Plate Orifice plates are metal plates with a hole punched through them that have the same diameter as the pipeline and reduce the volumetric flow rate to lower pressure. 2. Manometer A manometer is a device used to gauge the pressure within an orifices input and exit sections. 3. Flange/Carrier Ring used with orifice meters to hold the orifice plate in place. 4. Inlet this is where the fluid enters from the pipeline and the change in velocity and pressure happens here 5. Overflow pipe It would prevent the overflow of the glass cylinder 6. Flow dissipator this is the place that we can see orifice plate, flow dissipation is done by the taps and thus pressure changes 7. Outlet It is the place where the fluid exits the device 8. Pitot tube it measures the pressure drop Beta Ratio The orifice plate to be utilized, its design, and manufacture all affect how well orifice meters work. Typically, mild steel, stainless steel, and phosphor bronze are used to create orifices. The Beta Ratio is one of the general factors taken into account while developing an orifice plate. The ratio of the orifice diameter to the pipe diameter is known as the beta ratio. It is discovered that the flow coefficient is steady between beta ratios of 0.2 and 0.7. Beta Ratio A higher beta ratio will result in a modest pressure difference that is difficult to monitor and will necessitate a longer pipe length. A lower beta ratio will result in more pressure loss, which may demand a larger pump. Frictional loss will also increase the cost of the system. Operation of an Orifice Meter In the fluids upstream direction, the orifice plates aperture is approached by a fluid with a uniform cross section of flow. Prior to the orifice plate, this region of pressure is thought to be at its peak. The fluids cross section is lowest and uniform when it exits the orifice plates opening, and after traveling a certain distance, it begins to diverge in the downstream direction. The minimum cross-sectional area of the fluid obtained at downstream from the orifice edge is known as vena-contracta. When the fluid exits the orifice opening, its pressure is minimal, and this minimal pressure remains constant in the minimum cross section area of fluid flow at the downstream. Types of Orifice Plate In general, the types of Orifice meter are classified as concentric, segmental, eccentric, quadrant edge. Design of Orifice Plate Concentric square edged The main applications for this kind of orifice meter are the measurement of clean liquid, gas, and low-velocity vapour fluxes. It has a thin, flat plate with a sharp, square-edged hole punched into it. This kind is employed to lower pressure and restrict flow. High accuracy can be reached with this sort of meter if the installation is done correctly. Concentric Bore & Bevel The flow opening in an eccentric orifice is not located in the middle of the plate. Typically, fluids carrying a tiny amount of non-abrasive solids are measured using this type. The majority of chemical industry employs this type. High viscosity fluids are typically employed with this type of opening. The plate thickness will be at least the inlets radius because the inlet is a quarter of a circle. Concentric Bore without Bevel For some combinations of line size and plate thickness, a bevel is not needed to meet edge thickness requirements. In this case, the hole is drilled all the way through the plates thickness. This hole is also used for measuring in both directions and for restricting flow. Bore & Counterbore The bore and counterbore is a unique way to limit the thickness of the plate edge. Instead of the usual 45-degree angle, the edge of the plate is counterbored to the thickness that is needed. Segmental Bore Segmental bore orifice plates are offered to permit the passage of solids, liquids, and bubbles. It is manufactured so that the circular section of the bore is tangent to 98% of the pipe ID. This type is typically employed in locations with significant entrained air or water as well as locations where fluid suspension occurs. Thus, the accumulation in front of the orifice plate would be prevented. The sewage treatment, steel, chemical, water conditioning, paper, and petrochemical industries are just a few that utilize this kind of bore. Eccentric Bore The flow opening in an eccentric orifice is not located in the middle of the plate. Typically, fluids carrying a tiny amount of non-abrasive solids are measured using this type. The majority of chemical industry employs this type. High viscosity fluids are typically employed with this type of opening. steel, paper, atomic, and petrochemical industries all employ eccentric orifice plates. The plate thickness will be at least the inlets radius because the inlet is a quarter of a circle. Quarter Round Bore (Quadrant Edge) The quarter round or quadrant bore offers a rounded inlet edge. The radius of the quarter round bore is a function of the orifice to pipe ratio with thickness at the throat equal to radius. Overall plate thickness is frequently greater than the thickness is frequently greater than the thickness of standard plates. This bore is specifically designed for fluids of high viscosity, including heavy crudes, syrups. Types of Pressure tap used in Orifice Meter Corner Taps Openings for the pressure taps are situated in the upstream and downstreamflanges holding the orifice plate in this configuration. The orifice plate should be as near as feasible to these apertures. They are, prone to dirt freezing and hydration blockage. Compared to flange or vena contracta taps, they are typically less reliable and more susceptible to upstream disturbances. Radius Taps The upstream tap is far enough upstream to be unaffected by distortionof theflow in the immediate area of the orifice, and the downstream pressure tap is situated at roughly the mean location of the vena contracta, making this design the most advantageous from a practical standpoint. The upstream tap can actually be placed up to two pipe diameters away from the plate without impacting the outcome. Pipe Taps In this, the orifice plate is 2pipe diameters upstream and 8 pipe diameters downstream of the holes for the pressure taps. Both taps are situated at the area where the flow has fully grown. So they are helpful for calculating the overall pressure losses in the pipeline since they provide the whole pressure loss caused by the orifice. Flange Taps One pressure tap hole is located one inch upstream and the other one inch downstream from the orifice plate in this configuration. They can be inspected because of their accessibility and near proximity to the flanges face. They may be used to measure flow in either direction because of their symmetry. Because the downstream tap is situated in a highly unstable pressure area, they should not be used in pipe sizes smaller than 2 inches where the ratio is high. Vena Contracta Taps The downstream tap is situated at the point of minimum pressure, the vena contracta, while the upstream pressure tap is 12 to 2 pipe diameters from the orifice plate. The pressure at these taps should be the lowest and the pressure drop for fluid going through the orifice should be the greatest, according to theory. The appropriateness of these sorts of taps is, however, constrained by a practical issue, such as the vena contractas tendency to shift location with flow rate. Orifice Selection Guidelines The CPI handles a wide variety of fluid streams, including clean liquids, wet steam, and liquids with solid particles. The applicability of the various types of orifices depends on the streams characteristics. The best way to gauge the flow of pure liquids, gases, and low velocity vapours is via concentric orifices. Install square-edged orifices for Reynolds number under 10,000. However, the discharge coefficient of square edged orifices changes significantly with either flow rate or viscosity at Reynolds number lower than 10,000. Because of this, either quadrant orifices with conical edges are favored Orifices with quadrant edges are comparatively resistant to the effects of corrosion, erosion, and the deposition of materials on the orifices surface. Concentric orifices are typically not used with granular grains in flowing fluids, condensate in steam, or vapour or gas in a liquid because the projecting rims of the orifice form a dam and these foreign elements pile up in the approach pipe at the plate, changing the distribution

of flow. Install an eccentric or segmental orifice plate with the hole at the bottom ofthe horizontal pipe to allow the free flow of granular solids and condensate. However, the concentric orifice is chosen because of its greater discharge coefficient accuracy if the orifice can be situated in a vertical run with the flow going downward. Use a segmental orifice with the opening at the top of the pipe when measuring liquids that contain gas or vapour in a horizontal pipe. Concentric orifices are preferred for these fluids, albeit, for greater precision, provided suitable places are available in vertical pipes with the flow going upward Measurements of liquids containing sickly or liquid dense particulates should not be performed using segmented orifice plates. Similar to a concentric orifice, this design is impacted by deposits on the face or edge of the orifice. Annular orifices are advised when fluid streams comprise both heavy materials and gas or vapour. Application of Orifice Meter The concentric orifice plate, which has been standardized, is used to monitor the flow rates of pure fluids. Concentric orifice plates have beta ratios between 0.25 to 0.75. The flow rates of fluids containing suspended components, such as particles, oil mixed with water, and wet steam, are measured using eccentric and segmental orifice plates. Eccentric orifice plates are often utilized for contaminated gases and liquids. Segmental orifice plates are preferred over eccentric orifice plates when dealing with heavy fluids because they allow for better drainage all the way around the pipe. Advantages of Orifice Meter The method to monitor flow rate is very affordable and simple. It takes up less room and has predictable properties. It is possible to use it to gauge the flow rates in big pipes. Disadvantages of Orifice Meter The orifice plates sharpness and the pipes inner wall roughness affect the vena-length contractas. Due to the aforementioned reason, it can occasionally be difficult to tap the minimal pressure. The downstream pressure recovery is below average. When the flow of the suspended fluids, it becomes obstructed. The orifice plate corrodes, and eventually this leads to inaccuracy. Calculations on Orifice Meter The assumption that the pipe is horizontal and the disregarding of friction are necessary steps in the process of deriving the equation for the orifice meter. Taking into account the continuity equation for the constant p, we will first make a substitution, then we will multiply a factor by the result (friction loss factor in orifice), Therefore the equation for the orifice, where, Installation of Orifice Plate How to install orifice plate in pipeline? The transmitter must be connected to the process using the connectors present in the pipeline in order to measure the differential pressure. Impulse lines and differential pressure sockets are the technical names for these connection lines. These elements designs must be in line with the major element type and the kinds of connections that were employed in the computation. The orifice plate with flange sockets is typically utilized. Two valves known as root valves are inserted into the orifice flange sockets, allowing the impulse lines and the transmitter to be isolated from the primary process line. Horizontal Installation To allow trapped vapours to escape from the connection lines and to stop silt from entering these lines, pressure connections for horizontal lines should be established at the side of the line. In this manner, both the pressure taps and the instrument will only measure the differential pressure that corresponds to the flow rate, which is always full and balanced. Horizontal Installation for Clean Fluids Dirty or corrosive Fluids using a seal Clean Non-condensable gas Vapor or dirty or condensable gases Vertical Installation The impulse pipework should be configured depending on the direction the orifice plate is installed.The impulse pipework needs to be set up as stated below if the fluid is ascending. The pressure transmitters compensation setting can be used to account for variations in static head pressure. Vertical installation for clean liquids Dirty or corrosive liquids Clean non-condensable gases vapor condensable gases or dirty gases Orifice Meter installation for Vapor condensable gases or dirty gases How Venturi meter is different from Orifice meter? The main difference between a venturi meter and an orifice meter can be that the orifice plate in the orifice meter can easily alter as per the various flow rates while the venturimeter is rigid with the change in flow rate. Consequently, this represents a key distinction between the two instruments. Unlike an orifice meter, which is inappropriate for measuring higher flow rates, a venturi meter can measure higher flow rates. Because the losses in a venturimeter are so low, the coefficient of discharge is higher, whereas the losses in an orifice meter are significant and cannot support a high coefficient of discharge. When compared to an orifice meter, the installation and repair costs of a venture meter may be higher. In compared to an orifice meter, the venturi meter may also require more room.An Orifice Meter is a device used for measuring the rate of now of a fluid through a pipe. It also works on the same Bernoullis principle as that of the Venturimeter. It is a cheaper device compared to Venturimeter. Let us discuss more details of the Orifice Meter such as the construction, working principle, different parts, and moreIt consists of a flat circular plate with a circular sharp-edged hole called an orifice, which is concentric with the pipe. The orifice diameter is generally kept 0.5 times the diameter of the pipe, though it may vary from 0.4 to 0.8 times the pipe diameter.OrificeMeterOrifice MeterThe Inlet section is the linear segment extending from the device and acts as a front-end connection for the fluid flowing inside.The orifice plate is situated between the inlet and outlet and the plate is used to generate a pressure drop that will enable the flow rate which enables the measurement of the flow rate.Orifice PlateUsually, the Flow Conditioner is installed in the inlet section of the meter tube and is used to enhance linear flow in the inlet section of the meter tube.Flow ConditionerThe Outlet Section is the linear segment similar to the inlet section where the pressure of the gas or fluid discharged is determined.The differential manometer is a device used for measuring the difference in pressures between two points in a pipe or in two different pipes. A differential manometer consists of a U-tube, containing a heavy liquid, whose two ends are connected to the two points, whose difference in pressure is to be measured.Differential ManometerRead more details about the Differential manometersOrifice Meter Works is based on the principle of Bernoullis equation.In Orifice Meter, there is a pipe in which fluid is passing from one side to another side that is an inlet section to the outlet section.A differential manometer is attached between the two points to measure the pressure differences between these two points.A flow condenser also can be installed on the inlet section of the Orifice meter to enhance the linear flow of the fluid. (Flow Condenser is a filter-type section which guides the fluid flow in very linear motion).Now we place an orifice plate which is thin in size and has a small hole in between through which the fluid will pass.Due to the very small concentric hole of the orifice, the velocity increases, the decrease in pressure and vice versa.The place of the orifice plate in the pipe only determines the flow rate or discharge at that point only.The discharge through the orifice plate can be calculated by the formula specified in the below section.A differential manometer is connected at section (1), which is at a distance of about 1.5 to 2.0 times the pipe diameter upstream from the orifice plate, and at section (2), which is at a distance of about half the diameter of the orifice on the downstream Side from the orifice plate.Orifice MeterLetp1 =Prevsure at section (1)v1 = velocity at section (1)a1 = area Of pipe at section (1)p1, v1, and a1 are the corresponding values in section (2)Let us apply Bernoullis Equation at sections (1) and (2) we get,But we have the differential Head hSubstituting this h value in the above equation we get,Equation (a)Now section (2) is at the venta-contracta and a2 represents the area at the venta-contracta.if a0 is the area of office then we haveWhere Cc =Coefficient of contractiona2 = a0 CcBy Continuity equation, we havea1 v1 = a2 v2Substitute the value of v1 in Equation (a), and we getWe know the discharge of any fluid flowQ = v2 a2Q = v2 a0 CcEquation (b)The above expression can be simplified by usingSubstituting this value of Cc in equation (b), we getThis is the expression for the flow discharge through the orifice. where Cd is the Coefficient of discharge for the orifice meter.An Orifice Meter can measure the flow rate of fluids in their single state as either a gaseous state or liquid state and also be used to measure the flow rate of fluids in a mixed state that is both gaseous and liquid states, such as wet steam, or natural gas with water.Theorifice meters main applicationis used at several places to measure flow rates such asWater Treatment Plants,Natural GasPetrochemicalsOil Filtration PlantsRefineries.The Orifice meter is very cheap compared to other flow meters like theventuri meter.The orifice meter alignment can be vertical, horizontal, and inclined as required.The space required for the Orifice meter installation is less.As you can see from the orifice plate image above, this plate is thin enough to fit between an existing pipe.The maintenance cost for the orifice meter is low.It offers very less pressure drop.The construction and design of this orifice meter are very simple.It is capable to determine a wide range of flow rates the main advantage.Due to limitations in the vena-contracta length, the minimum pressure for reading the flow is sometimes difficult.In the Venturi meter, downstream pressure can be recovered. But with the Orifice meter downstream pressure can not be recovered.The orifice Accuracy can be affected by the viscosity, density, and pressure of the fluid.It requires a straight pipe for good precision and accuracy.The 40% to 90% overall head loss of the differential pressure.The obtained coefficient of discharge is low.This is all about the Orifice Meter, Let us know what you think about this article in the comment section below. Piezoelectric actuators represent an important new group of actuators for active control of mechanical systems. Piezoelectric actuators is used to convert electrical energy into mechanical movement, for precise positioning to nanometric levels, to produce ultrasonic energy and sonar signals, and for the conversion of pressure and vibration into electrical energy. Piezoelectric actuators can also be manufactured in a variety of configurations and fabrication techniques Piezoelectric actuators are also used to control hydraulic valves, act as small-volume pumps or special-purpose motors, and in other applications. Certain crystalline minerals: when subjected to a mechanical force, the crystals became electrically polarized. These behaviors were called the piezoelectric effect The three basic types of piezoelectric actuators are stacks, linear motors, and benders. The linear movement produced by the piezoelectric effect has been used to make a stack actuator, which is a multilayer construction: each stack is composed of several piezoelectric layers The required dimensions of the stack can be easily determined from the requirements of the application in question. Since the voltage of the piezoelectric ceramic is relatively small, displacement amplifiers or hybrid structures are needed. There are many amplification techniques, such as levers and hydraulic systems, and piezoelectric motors. The output force of the lever system is significantly less than the force of the actuator. Hydraulic systems generally use a piston for amplification. This kind of piezohydraulic motor uses a linear piezoelectric actuator to control the liquid input to the fluid chamber which drives the bellows. The orifice Meter is a topic of fluid machinery and it is a device that is used to measure the flow rate or average velocity of the flowing fluid (Liquid or gases) in a pipe. Here the orifice plate is used for the restriction in the direction of the fluid flow. Therefore the restriction process we also called Orifice Plate. The restriction effect results in pressure drops of the flowing fluid. The drop in pressure is associated with the rate of flowing fluid or the average velocity of the fluid. Now lets see definition, The orifice Meter or Plate can be defined as the device in Fluid Mechanics and machinery which is used for measuring the flowing fluid rate or in other terms the average velocity. The orifice meter or Plate works on the principle of Bernoullis theorem and that is the sum of all the energy at a point is equal to the sum of all the energy at point 2. There are 4 different types that include Eccentric, Conical, Sharp Edge, Segmental, and Quadrant Orifice Plate. It is used for measuring fluids who carry small amount of or gases with small amounts of liquid and non-abrasive solids. It has a round opening (bore) tangent to the inside wall of the pipe. Conic Edge orifice plate is useful for lower Reynolds numbers. It has a 45 bevel facing upstream into the flowing stream. The segemental plate is also used for measuring fluids that is liquid or gases carry non-abrasive impurities such as light slurries or exceptionally dirty gases. This orifice is used for high viscosity Fluids. Now moving to construction, Orifice Meter Consists of following four Parts: Inlet SuctionOrifice PlateFlow Conditioner andOutlet section The name inlet section means the fluid will enter into the orifice meter through the inlet section. The orifice plate is situated between the inlet and outlet and the plate is used to generate pressure drop that will enable the flow rate. The orifice plate construction: It is thin size having one hole from that the water will pass. The flow conditioner is used to increase the linear flow in the inlet section of the meter tube. The flow conditioner is installed nearly the inlet section of the meter tube. Now Here in the outlet section, the pressure of the fluid is being discharged and determined. The working of the orifice meter is based on the principle of Bernoullis equation. As you can see in the diagram there is a pipe in which fluid is passing from one side to another side that is an inlet to outlet. The manometer is attached hereto measure the pressure differences between two-point. Now we place an orifice plate which is thin in size and having a small hole in between through which the fluid will pass. Now when the increases in the velocity, the decrease in the pressure and it is vice versa. The place of the orifice plate in the pipe only determines the flow rate or discharge at that point only. The discharge can be calculated by the formula and that will be explained in the derivation section. Video Credit: Gate Academy plus (Youtube) There are four hydraulic coefficient of Orifice meter and those are: Coefficient of ContractionCoefficient of VelocityCoefficient of ResistanceCoefficient of Discharge Coefficient of contraction can be defined as the ratio of the area of the jet at vena contracta to the area of Orifice. Coefficient of discharge can be defined as theratio of actual velocity of jet at vena contracta to the theoretical velocity of the jet. Coefficient of resistance can be defined as the ratio of loss of head in the orifice to the head of water available at the exit of the orifice. The coefficient of discharge can be defined as the ratio of Qact (actual discharge) to the Qthe (theoretical discharge). Now our main topic derivation, As you can see in the diagram, d1= Inlet section diameterP1= Inlet section pressurev1= Inlet section velocity of the fluidA1= Inlet section Aread2= Outlet section diameterP2= Outlet section pressurev2= Outlet section velocity of the fluidA2= Outlet section AreaCd= Coefficient of discharge There are some assumption to derive orifice meter discharge and that is Fluid must be idealFluid flow irritation. steady and continuousThe inner surface must be frictionless Bernoullis Therom: In an ideal that is an incompressible fluid, the sum of all pressure energy, kinetic energy, and Potential energy is equal in section 1 will be the same as in section 2 Now applying the Bernoullis equation in this at point 1 and 2: Here h is the differential head. And A0 is the area of orifice and Cc is coefficient of contraction. Cc=A2/A0 Now the continuity equation which is A1v1=A2v2 Therefor the discharge is, If Cd is the coefficient of discharge for orifice meter then, Now the above equation we will use the Cc value in the discharge Q therefore we will get the value of discharge is, Here the Cd value will be low as compare to Cd value of Venturimeter. From the below formula you can easily calculate the actual discharge of Orifice Meter. The specification of orifice Meter or Plate is: The length of the Orifice can be from 10 mm to 800 mm.The diameter of the orifice plate can be 0.5 times the diameter of the pipe though it may vary from 0.4 to 0.8 times.Up to 800 degrees celsius Operating Temperature.The Operating Pressure is up to 400 bar. The following advantages of Orifice meter is: The Orifice meter is very cheap compared to other flow meters like the venturi meter and so on. The direction possibility can be vertical, horizontal, and inclined.The space required for installation is less.It is usually thin enough to fit between an existing pipe.The maintenance cost is low. It offers very less pressure drop.The construction and design of this orifice meter are very simple.It is capable to determine a wide range of flow rates that the main advantages. The following disadvantages of Orifice Meter is: Due to limitations in the vena-contracta length, the minimum pressure for reading the flow is sometimes difficult. In the Venturi meter, downstream pressure can be recovered. But In Orifice meter downstream pressure can not be recovered in Orifice Meters.It requires a single phase of liquid.The orifice Accuracy can be affected by the viscosity, density, and pressure of the fluid.It requires a straight pipe for good precision and accuracy.The 40% to 90% overall head loss of the differential pressure. The obtained coefficient of discharge is low. The main application of orificemeter is used at several places to measure flow rates such as Water Treatment Plants, Natural Gas, Petrochemicals, Oil Filtration Plants, and Refineries. Internal Resources:Pump vs CompressorFrancis TurbinePelton Wheel TurbineTypes of Fluid Flow So finally our article ends here. I have also explained another flow meter that is the venturi meter you can read that too. And if you like the article then do not forget to spread the love. A hole with a sharp edge on a long plate is called an orifice. A plate with this type of hole is called an orifice plate, and now this plate is used to measure the discharge of a liquid. So it is called anorifice meter.{tocify} $title={Table of Contents}ConstructionThe orifice made in the plate is made concentric with the pipe, in which it is tightened between two flanges, and remains perpendicular to the liquid when it flows.The orifice meter is attached to the pipe with the help of a flange, then the connection for the pressure gauge is taken out from both the side pipes of the plates, and the connection of the pressure gauge is made.Working PrincipleDue to this, there is a decrease in the pressure of the flowing current while coming out of the orifice of the cross-section. This decrease is due to the conversion of the kinetic energy of the get into vertex and eddies and hence the velocity head increases. The decrease in pressure between the nozzles can be determined with the help of a manometer.Derivation (Orifice derivation of formula)Let the pressure and velocity at points 1 and 2 be P1 and P2 and velocity v1 and v2 respectively.Bernoulli's Theoremif the orifice meter is connected to the horizontal pipe then z1 =z2From theContinuity equation,we getA1v1 = A2v2Substituting the value of v1 in equation (1)If the losses are taken as negligible while deriving the value of v2, the theoretical velocity of v2 will be equal to the velocity of a jet component.If Cv = coefficient of velocity thenWhere A1 = Area of sectional tubeA2 = Area of vena ContraAs the jet comes out of the orifice it is the minimum area A2 ifCE = The CoefficientA2 = Ce AA = Area of orifice

Orifice meter experiment calculations. Working principle of venturimeter and orifice meter. Orifice meter. Orifice meter working principle. Describe with neat sketch construction and working principle of orifice meter. Orifice meter principle construction and working ppt. Orifice meter pdf. Orifice meter working. Orifice meter working principle pdf. Orifice meter principle.