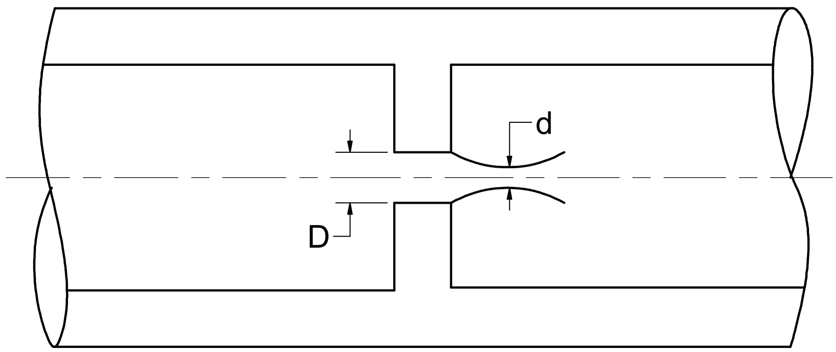
the **difference** between

THE DIFFERENCE BETWEEN:

Calibrated Orifices and Holes

ENGINEERS TASKED WITH MANAGING fluid flow talk about both holes and calibrated orifices, but they are two distinct entities. A hole can be any opening, but a calibrated orifice is specially designed to precisely control fluid flow. Consequently, its diameter, length, and geometry are critical to its intended operation. With the right design, an orifice can provide the desired control over fluid flow rates and pressure spikes.



Flow through a calibrated orifice.

Applications

In fluid management, a hole can be designed to permit fluid flow or block the flow of particles within a fluid. A "calibrated orifice" refers to a specific type of hole that can provide precise fluid flow control. Examples of household devices that use orifices to control flow include sprinklers, shower heads, and spray bottles.

Because of the level of pressure and flow control that calibrated orifices provide, they are critical in the precise metering of fluids. This applies in the medical industry to control oxygen for patients requiring breathing support, in the pharmaceutical industry for mixing chemicals, and in automotive and aerospace industries to meter fuel to an engine. In hydraulic systems, calibrated orifices are used to control the speed a hydraulic cylinder extends or retracts and to attenuate pressure pulses that could damage or confuse sensors.

Design Considerations

Orifice Geometry

Orifice diameter, length, and geometry are all important factors an engineer must keep in mind when designing an orifice to meet flow requirements. For instance, an orifice with a sharp-edged entrance results in a lower flow rate than one with a chamfered edge or a radiused edge. In addition to flow rate, the geometry of an orifice can be used to create specific fluid behavior such as spinning the fluid or generating atomized, conical or targeted spray patterns at the exit.

Flow rate, Q, through the orifice can be calculated by using the equation:

$$Q = CA\sqrt{(2\Delta P/\rho)}$$

Where

C = discharge coefficient
A = orifice area
ΔP = pressure differential
ρ = fluid density

The discharge coefficient accounts for variations in fluid flow that occur as flow is constricted through the orifice, including a reduction in discharge area (D vs. d) and fluid friction as the flow converges and diverges.

Ultimately, C is a function of the ratio D/d and the upstream Reynolds number. The Reynolds number, in turn, depends on the state of the fluid (liquid or gas), temperature, pressure, and viscosity.

To simplify these flow rate calculations, many engineers turn to a calibrated orifice supplier, like The Lee Company, that guarantees flow rates based on testing of 100% of their products. Some suppliers use standardized systems to specify orifice performance. The Lee Company sells calibrated orifices by Lohm rate, a measure of flow resistance defined such that a 1.0 Lohm restriction will permit a flow of 100 gal/min of water with a pressure drop of 25 psi at 80°F. Higher Lohm rates correspond to lower flow rates. The relationship between C and Lohm rate, L, is:

$$L = 0.67/(d^2C)$$

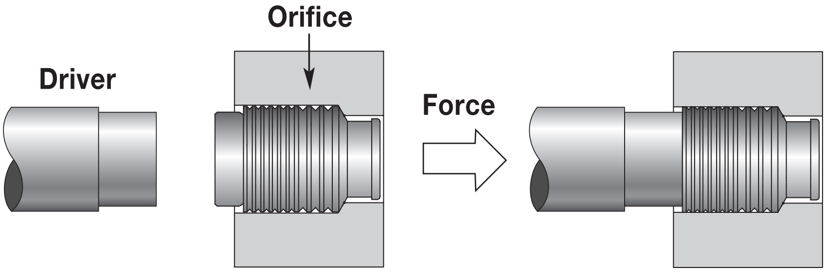
Tolerances

An engineer might choose to control fluid flow with a hole, specifying the depth and diameter with tolerances. Because flow rate is so dependent on geometry, it can vary by as much as 30% between holes with identical depth and diameter. When increasing the number of holes placed in series, the variation in flow is even more difficult to control. The added uncertainty leads engineers to oversize fluid systems, adding weight and expense.

Orifices are designed to provide a specified flow rate at a given pressure. The Lee Company has standard single orifice designs guaranteed to fall within a ±2% tolerance of the target flow performance, and multi-orifice designs that fall within a ±5% tolerance.

Housing and Material

Calibrated orifices can be manufactured directly into a device, or they can be a separate component capable of installation into a variety of end items. The most basic component is a simple plate with a single calibrated orifice in its center that can be held in place between two tubes or between a tube and a housing. Other configurations include an orifice plate with threads, an orifice plate with o-ring grooves, or The Lee Company's unique metal-to-metal expansion pin installation method.



Installation of a calibrated orifice using the controlled expansion method.

Housing material is also an important consideration. The material must withstand the pressures, temperatures, and environmental conditions in the system and must be compatible with the liquids or gases flowing through it. For example, brass is commonly used for oxygen systems because steels and other metals have the potential to generate sparks with a flammable gas. Plastics or rubbers are commonly used with bodily fluids or aggressive chemicals that can change composition or corrode metal when in contact.

Cavitation

Cavitation occurs when high fluid velocity through an orifice results in pressures within the orifice throat that fall below the fluid's vapor pressure, choking the flow and creating vapor pockets. This results in a larger than expected pressure drop across the orifice and may create erosion of the orifice or downstream materials. Cavitation is most common when the pressure upstream of the orifice is much higher relative to the downstream pressure.

To minimize the potential for cavitation, a series of larger calibrated orifices can be used in place of one smaller orifice. A multi-orifice system divides the pressure drop across many orifices and permits a larger minimum passage, which is less susceptible to clogging from particulate matter.

Conclusion

Both calibrated orifices and holes work in fluid flow applications, but only calibrated orifices are designed with the precision that lets them meter and control flow and pressure in applications from medical instrumentation to aerospace. Although calibrated orifice design encompasses many variables, engineers have resources to help them get the flow control they need. Manufacturers like The Lee Company have technical resources on their websites and can also connect engineers with experts who can assist in finding the perfect solution for unique requirements.