Rupture Disc Sizing Application Knowns

Fike®

RUPTURE DISC SIZING

Adequate flow through a rupture disc can be assured if the disc is sized properly. Improper sizing can result in serious safety hazards to personnel and costly plant equipment.

To aid you in the sizing of Fike rupture discs, Fike offers disCalc, an IBM compatible software program. The program sizes rupture discs for gas, liquid and steam applications. These calculations follow the guidelines of ASME Sect VIII, Div 1, ISO 6718, and the procedures published in this catalog. disCalc is available free from your local representative or by contacting Fike directly.

The following equations and procedures meet the requirements of Section VIII, Div 1, of the ASME Code.

Assumptions and General Considerations

- Gases and vapors expand isentropically through the burst rupture disc. Thus the fluid is assumed to be a perfect or ideal gas and friction losses are small enough to be neglected.
- Incompressible fluids are low-viscosity fluids, i.e. the viscosity is less than 10.
- The sizing equations include a discharge coefficient, K, to compensate for turbulence and other losses. In normal practice K=0.62 unless determined by laboratory testing.
- The rupture disc device is assumed to be installed on a large vessel where the upstream flow velocity is negligible and the flow area through the device is small compared to the size of the vessel. This assumption results in the maximum disc size required regardless of whether the disc is installed on a vessel or in a pipe run.
- The rupture disc device is assumed to vent directly to the atmosphere with no downstream piping. If downstream piping is present, it may be necessary to consider the device as a fitting and size the piping system accordingly.
- The rupture disc device is NOT installed in combination with any other relief device. For information on rupture discs in combination with safety relief valves, see Sect. 4 of this catalog.
- The pressure in the protected equipment increases slowly. This type of problem may result from an attempt to overfill a closed vessel, from thermal expansion of a contained fluid, or faulty valving in pressure control equipment.

For information on sizing for runaway reactions, explosion venting, and protection against other hazards, consult Fike.

Overpressure Allowance

The ASME Code permits the relieving pressure to exceed the MAWP during venting based upon one of several conditions. The following sizing equations assume that the user has chosen the appropriate overpressure allowance. See Section 4 of this catalog for a discussion of overpressure allowance and the ASME Code.

Recommended Rupture Disc Device Diameter

The nominal size of the rupture disc device should be greater than or equal to the minimum calculated diameter. In cases where the inlet or outlet diameter of the device is significantly smaller than the nominal disc size, the smaller diameter should be used to determine the minimum flow area.

Example: The minimum flow area of a 1/2-30SM Screw Type assembly with 1/4 NPT inlet and 1/2" disc should be based on the nominal inside diameter of the 1/4 NPT inlet and NOT the 1/2" disc diameter.

Sizing for Liquids

The sizing equation for the flow of incompressible fluids (liquids) through a rupture disc device is derived from Bernoulli's general energy equation and the conservation of momentum. Assuming the fluid enters the device with negligible velocity and with no change in elevation, the velocity at the disc is

$$\overline{V} = \sqrt{2gh} \quad \text{ft./sec.} \qquad \text{where} \qquad h = \frac{Pf}{\gamma} \quad \text{ft.}$$

From the conservation of momentum equation, the flow rate becomes

$$Q = A\overline{V} \quad \text{cu. ft./sec.}$$

$$= KA\sqrt{\frac{2gPf}{\gamma}}$$

Simplifying and rearranging the equation, the required relief area for any free-flowing liquid through a rupture disc device is given by

$$a = \frac{L\sqrt{SG}}{37.98K\sqrt{p}} \quad \text{sq. inches} \qquad (1)$$

The pipe "bore" area at the inlet to the rupture disc device is usually taken as the maximum available relief area.

Sizing for Gases and Vapors

For compressible fluids (gases and vapors), Bernoulli's equation still holds, but the conservation of momentum equation must make use of the changes in the properties of the fluid as it passes through the orifice. These changes are found from the relationships of a gas experiencing an isentropic (frictionless, reversible) expansion. The relationships are well known and can be found in most thermodynamics textbooks.

For isentropic flow, we must consider the differential pressure ratio across the disc. Designating P_o as the upstream pressure and P_e as the pressure at the exit plane (usually atmospheric pressure) consider first that when the upstream equals the exit pressure, $P_e/P_o = 1$, there is no flow. Increasing the upstream pressure increases the flow and decreases the pressure ratio P_e/P_o until a value of P_o is reached beyond which there is no further increase in the mass rate of flow through the disc. This value of P_o is known as the *critical pressure* and P_e/P_o is known as the *critical pressure ratio*. At this point the flow velocity is **sonic**, or equal to the speed of sound. Sonic flow exists through the orifice at all pressure ratios less than the critical pressure ratio. **Subsonic** flow exists through the orifice at all pressure ratios greater than the critical pressure ratio.

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