Bulletin No. 221

Rupture Discs

Considerations for selection of a safety rupture disc.

Background

All pressure vessels must be protected with a safety device to relieve the pressure within the vessel before it can reach a level which will destroy the vessel, perhaps damage surroundings and injure the operator or other personnel.

Rupture discs are used as the primary relief device on all pressure vessels. These discs are usually thin metal discs which blow out at their design burst pressure. Once open, they cannot reseal and must be replaced. They have no moving parts which can fail. Any damage to the disc will lower its actual burst pressure.

Spring loaded relief valves can be used as auxiliary safety devices. These are sometimes used to protect components such as low range pressure gages which might be damaged below the design pressure of the vessel. These valves do have moving parts that can fail. These valves normally will reseal once the pressure in the vessel falls below their relief pressure. These valves are sometimes used to establish a maximum operating pressure for a reaction (as opposed to a vessel) although back pressure regulators are a more reliable means to do this.

Conventional Pre-Bulged Design

Our standard rupture discs are made of thin metal foils which are domed. The discs are installed with the inside of the dome (concave side) exposed to the pressure. The general guidance for rupture discs of this design is that their maximum operating pressure should not exceed 90% of their design burst pressure. This guidance was developed to protect these discs from the effects of repeated pressure pulsing. While no cycle life is guaranteed, at 90% of design, the service life might be more like 5,000 cycles. For most Parr Pressure Vessels 5,000 cycles represents many years of service.

It should be noted that the burst tolerance of one of these discs is $\pm$ 5%. So to take a disc to 90% of its design may in fact be taking it to 95% of its actual burst pressure. This does not leave much room for pressure excursions.

There are a number of factors that will effect service life of rupture discs. In addition to pressure cycles, temperature cycles and the duration of cycles are important.

Corrosion of these extremely thin metal discs is, of course, a completely independent factor which can cause discs to fail at lower pressures after short service lives. There is a legitimate concern that the gold facing on gold faced rupture discs may not stand up to more and wider cycles. If this protective barrier fails, the underlying disc will be exposed to the corrosive vapors of the system.

Because of the many factors that can effect service life (corrosion, cycles, temperatures, installation etc.), there is never a guarantee on service life for rupture discs. As always a preventative maintenance program would be a good idea.

Burst Pressure

The burst pressure of a disc is determined essentially by the thickness and the strength of the disc material. As the temperature of the disc changes, the strength of the material, and hence the burst pressure, will also change. We have selected Alloy 600 as our standard material of construction for two principal reasons. Its strength changes very little with temperature changes over the operating temperatures we expect to see in these vessels. Alloy 600 retains over 90% of its room temperature rating at temperatures of 22°C – 500°C, and provides excellent broad range corrosion resistance.

All Discs Proof Tested

All rupture discs are individually proof tested to 90% of their design burst pressure. It is this proof test, not a mechanical forming process which produces the pre bulge in these discs.

Scored Disc after burst

Minimum Burst Pressures

The minimum rupture pressure available will be a function of how thin the discs can be made and still be repeatable (approximately 0.03 mm), the material strength, and the disc size (larger discs have lower burst pressures). As a high strength material, Alloy 600 produces a fairly high minimum burst pressure especially in the 526HC/ 581HC size with a 0.25 inch diameter.

Table 1 below lists the materials available, their minimum burst pressure at room temperature, their maximum service temperature, and their percent of room temperature rating at 250ºC. Rupture discs typically will have a tolerance of +/-5% from the stated value.

To provide enhanced corrosion resistance in the 0.25 inch size discs we use a thin gold foil on the reaction side of the disc. Part number 581HC is used to identify 526HC Discs equipped with this gold foil. We do not typically use these gold foils on the larger 708HC or 1415HC style discs used on one gallon and larger vessels.

We generally recommended a combination of an Alloy 600 disc and spring-loaded valves for lower pressures rather than silver or aluminum listed in Table 1 because aluminum and silver have poor corrosion resistance and their burst pressure is highly temperature sensitive. In reality, PTFE coating does not solve the corrosion problem because it is very porous when this thin and will not withstand the temperature commonly encountered in these vessels.

Table 1

526HC Style 1/4" Dia. Material	Minimum Burst	Maximum Temperature ºC	% RT at 250ºC
Alloy 600	750	500	92
Alloy C-276	2000	425	90
Nickel	640	350	85
Type 316SS	1150	300	75
Alloy 400	740	400	82
Silver	410	120	0
Aluminum	160	120	0
PTFE Coated Aluminum	210	120	0

708HC Style 1/2" Dia. Material	Minimum Burst	Maximum Temperature ºC	% RT at 250ºC
Alloy 600	450	500	92
Alloy C-276	550	425	90
Nickel	275	350	85
Type 316SS	500	300	75
Alloy 400	380	400	82
Silver	245	120	0
Aluminum	65	120	0
PTFE Coated Aluminum	65	120	0
Tantalum	1000	425	74

Special Order Discs

Please note that Alloy C-276 discs are now available in both sizes. Alloy B-2, platinum and tantalum are also available on very special orders.
We try to stock standard ratings in Alloy 600 in both the 1/4" and 1/2" sizes. We can special order different ratings and materials consistent with the foils our supplier has available. Special orders will normally require a minimum order of six discs of the same specifications.

Maximum Design Pressure vs. Maximum Operating Pressure

All of the published maximum pressure and temperature ratings are calculated using the American Society of Mechanical Engineers (ASME) Pressure Vessel Code. This code incorporates into these ratings a four times (4X) safety factor for ultimate failure and a minimum 1.5X safety factor for permanent deformation of the vessel. This code, as well as essentially all other recognized pressure vessel codes, states that a vessel must be equipped with a rupture disc rated no higher than the maximum design pressure. A vessel that is designed to 3000 psi and equipped with a standard 3000 psi rupture disc should not be operated above 90% of it's rating (2700 psi).

Disc Identification

We purchase the rupture discs used in Parr pressure vessels from Fike Metal Products Company. Fike is one of the leading manufacturers in this specialized field. Each disc is furnished with a metal tag which fully identifies the disc, its material of construction and its designed burst pressure. These tags should be attached to the vessel in which the disc is installed to identify the level of protection installed.

All standard range rupture discs offered by Parr Instrument Company are CE approved.

Discharge Rates

At 2000 psi, the 1/4" diameter disc will pass approximately 23,000 standard liters of air per minute. At this same pressure, the 1/2" diameter disc will pass approximately 87,000 standard liters per minute. We believe those flow rates are more than adequate for the vessels on which they are installed.

Safe Venting Necessary

Every Parr safety head assembly is equipped with a threaded connection (1/4" NPT or 1/2" NPT) on the discharge side of the rupture disc. The user must use this connection to attach an adequate and safe venting system to remove any toxic, flammable, or volatile materials which might be released if the rupture disc should burst.

Explosions - Detonations

Rupture discs are designed to protect pressure vessels in the event of relatively slow build-ups of internal pressure. Fast and slow are, of course, relative terms. We tend to use three terms to describe the rates of pressure build-up in vessels.

Slow is how we describe pressure build-ups such as those that would occur as gas is added to a system or as the temperature is increased. Explosions and detonations are the terms we use for faster pressure buildups. Explosions generally represent exothermic chemical reactions which generate large quantities of heat and sometimes large volumes of gas. A detonation is an explosion which occurs so violently that a shock wave is formed. Rupture discs will normally relieve the pressures produced by fast chemical reactions including those classified as explosions. The shock waves produced by detonations, however, can rupture a pressure vessel before a pressure build-up can reach the rupture disc. For this reason, if there is any possibility that reactions of this type might take place, the vessel must be operated in an adequate blast cell.

PARR INSTRUMENT COMPANY
211 Fifty-Third Street
Moline, Illinois 61265 USA Phone 309/762-7716 Fax 309/762-9453
http://www.parrinst.com E-Mail: parr@parrinst.com