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Rupture Disk, Understanding its Operation and Application – Part 1

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Introduction

This paper outlines the basic understanding of the operability of rupture disks, the concept of Manufacturing Design Range, ASME-dictated tolerance, and how the owner of rupture disks may inadvertently and surreptitiously slip into code violation due to misinterpretation of technicalities and testing lot-creeps. In a subsequent paper, the plethora of mechanical designs of rupture disks and information necessary to complete the specification sheet will be presented.

What is a Rupture Disk?

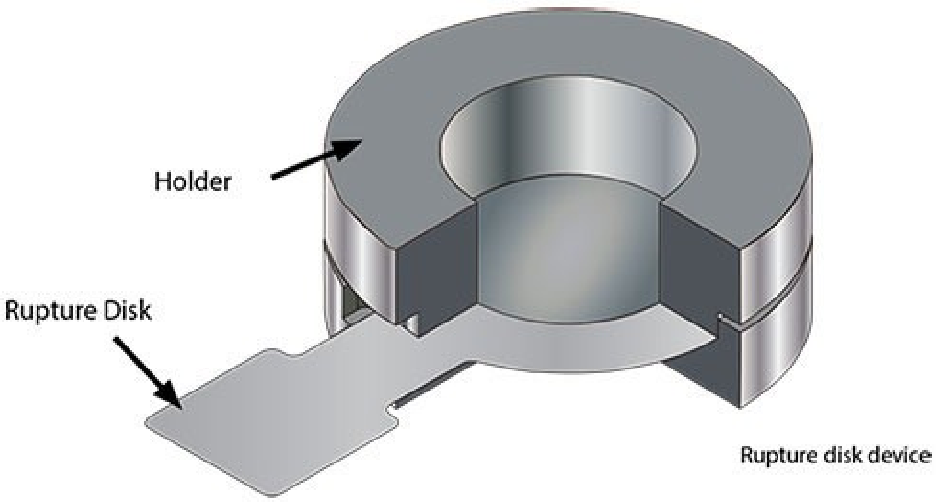
A rupture disk is a non-reclosing, self-sacrificial device that protects equipment from overpressure by bursting at the specified burst pressure marked on the disk within code-allowed tolerance. It can be used as the primary protective device or in a combination with a pressure relief valve (PRV) when it is placed before the pressure relief valve to protect the PRV from exposure to harsh process environment and minimize fugitive emission, or as a supplementary device on a parallel nozzle of the protected equipment. It can be installed after a PRV to protect the PRV from exposure to a harsh process environment. In such applications, its burst pressure is lower than what impedes the operation of the associated PRV but higher than the superimposed backpressure in the downstream equipment. Rupture disks, like PRVs, are generally the last line of defense. It should neither be misused as a control device, nor as the only line of defense.

Components of a Rupture Disk Device

The rupture disk is made of two main components:

- the rupture disk holder which provides the pressure boundary and clamps the disk into position,
- and the actuating element or the disk itself.

Figure 1: Components of a Rupture Disk Device [Source: NBBI website]



Principle of Operation of a Rupture Disk Device

The rupture disk and the pressure relief valve are differential pressure relief devices, but there is a very important difference between the two regarding how the pressure downstream of the device affects the operability of the device. In the case of a PRV, the effect of downstream pressure may be compensated by the mechanical design of PRV.

The rupture disk bursts when the marked burst pressure equals the difference between the upstream pressure and the pressure across the disk. The upstream pressure is the static pressure in the protected equipment and the pressure across the disk is the static pressure of downstream equipment or the static pressure of the interstitial space between the disk and PRV in a combination system. It is very important to understand this unique principle of operation to appreciate the necessity to vent the interstitial space between the disk and PRV in a combination system which will be discussed later in the text. The venting of the interstitial space is a code requirement. Catastrophic failures are known for not venting the interstitial space of a combination system (Rupture Disk in series with a PRV).

Replacement of Rupture Disks

The rupture disk, obviously, requires replacement after it actuates or activates. Such actuation is triggered when a real overpressure scenario is encountered. It may also actuate due to metal fatigue or creep. The second category of replacement is done through a routine preventative maintenance procedure to avoid failure due to fatigue or creep causing unwanted shutdown.

Explanations of Fatigue and Creep

Fatigue is the reluctance of a metal to deform when subjected to a load or regain its original shape when the applied load is withdrawn at areas where high-stress concentration is developed during the fabrication process. Fatigue results in cracks at the stress concentration zone. When a metal rupture disk is subjected to a cyclic load, the disk may prematurely activate because of fatigue. Unique features of graphite disks are that they are not affected by thermal shock, cyclic loads, or fatigue. They have excellent corrosion resistance and are accurate at pressures as low as 0.5 psig.

Creep is a slow, but permanent deformation of a metal at high temperature when a metal is subjected to a load for a long time. Metals deform when a load is applied but return to the original shape after the load is removed provided the load did not exceed the elastic limit. But even within the elastic limit, if the load is applied for a long time, the deformation becomes permanent, especially at higher temperatures. Such permanent deformation under a load kept for a long time is known as creep.

The above two properties of solid materials should be kept in mind while choosing the material of construction of a rupture disk and coincident design temperature of the disk.

Understanding the Terminology used in the Specification of Rupture Disks

There are some words, which are used in the specification of rupture disks, which are context-sensitive and code-related. All Emergency Relief System (ERS) designers should be familiar with them and understand not only their literal meanings but also their technical and context-sensitive meanings and code implications.

Understanding Operating Pressure Ratio and Operating Margins of a Rupture Disk

Operating Pressure Ratio is the ratio of the operating pressure to the marked burst pressure, both expressed in the same unit, typically in gage pressure.

Operating Margin is the difference between the marked burst pressure and the operating pressure. The concept of operating pressure should not be taken lightly. It is the value that is arrived at by adding margin to expected high operating pressure to decide on the alarm value. To the alarm value, a further margin is added to arrive at the interlock value. This interlock value should be less than 70% of the Marked Burst Pressure for a metal disk and less than 80% of the Marked Burst Pressure of a graphite disk. If the protected equipment is existing and operational changes require higher working pressure or lower operating margin, specific types of rupture disks may be needed. Without a reasonable margin, rupture disks are susceptible to nuisance failure.

Understanding Manufacturing Design Range (MDR) and Tolerance

The Manufacturing Design Range (MDR) is the range between the Maximum Marked Burst Pressure and the Minimum Marked Burst Pressure, both inclusive, that a lot of purchased rupture disk MUST activate. The MDR is the range of pressures or the window of pressures within which the Manufacturers' destructive testing breaks must fall to be acceptable for a particular requirement. The rupture disk tab must provide this information along with the coincident design temperature and the lot number. The Maximum Marked Burst Pressure must be equal to or less than the MAWP of the equipment it protects. The Maximum Marked Burst Pressure can never exceed the MAWP of the protected equipment. When the Operating Margin is low, a zero MDR may be specified. The actual burst pressure of a disk may exceed the Maximum Marked Burst Pressure and is allowed by the code provided: (1) the Maximum Marked Burst Pressure </= MAWP of the vessel and (1) the actual burst pressure is within the code-allowable Burst Pressure Tolerance.

The Burst Pressure Tolerance of a rupture disk is dictated by ASME VIII, Division I. It is expressed as a plus/minus % figure of the burst pressure. The Burst Pressure Tolerance is expressed as a plus/minus 5% of the burst pressure when the burst pressure is above 40 psig and plus/minus 2 psi when the burst pressure is up to and including 40 psig. Tolerance signifies code-allowed excursion of Maximum Marked Burst Pressure provided the Maximum Marked Burst Pressure is =/< MAWP of the protected equipment. Thus, if Maximum Marked Burst Pressure stamped on a disk is 100 psig protecting the equipment with MAWP=100 psig and the disk bursts at 105 psig, the owner does not violate the ASME VIII Division I code. However, in the same case, if Maximum Marked Burst Pressure stamped on the disk is 100.1 psig, and the disk bursts at 105 psig, the owner violates the code.

Which Codes guide the manufacture, specification, testing, and operation of rupture disk devices?

The guiding codes are the ASME Boiler and Pressure Vessel Code Division I, Section VIII, and the National Boiler and Pressure Vessel Inspector (NBBI) program. The latter has a procedure to test samples of disks for correct burst pressure and determine the flow resistance factor, KR, required to size the device. The inspectors also check the marked burst pressure of the rupture disk assembly and compare that with MAWP of the protected equipment to examine any violation of rules.

It is the responsibility of the pressure vessel users to select the rupture disk assembly appropriately.

What are the rules concerning the burst pressure of a rupture disk assembly and the MAWP of protected equipment?

The Rules of ASME Division I, Section VIII (2019) apply.

1. UG-134(a):

> (a) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure of the vessel. When the required capacity is provided in more than one pressure relief device, only one pressure relief device need be set at or below the maximum allowable working pressure, and the additional pressure relief devices may be set to open at higher pressures but in no case at a pressure higher than 105% of the maximum allowable working pressure, except as provided in (b) below.
>
> (b) For pressure relief devices permitted in UG-125(c)(2) as protection against excessive pressure caused by exposure to fire or other sources of external heat, the device marked set pressure shall not exceed 110% of the maximum allowable working pressure of the vessel. If such a pressure relief device is used to meet the requirements of both UG-125(c) and UG-125(c)(2), the device marked set pressure shall not be over the maximum allowable working pressure.
>
> (c) The pressure relief device set pressure shall include the effects of static head and constant backpressure.
>
> (d) See below.
>
> > (1) The set pressure tolerance for pressure relief valves shall not exceed ±2 psi (15 kPa) for pressures up to and including 70 psi (500 kPa) and ±3% for pressures above 70 psi (500 kPa), except as covered in (2) below.
> >
> > (2) The set pressure tolerance of pressure relief valves that comply with UG -125(c)(3) shall be within -0%, +10%.
>
> (e) The burst pressure tolerance for rupture disk devices at the specified disk temperature shall not exceed ±2 psi (15 kPa) of marked burst pressure up to and including 40 psi (300 kPa) and ±5% of marked burst pressure above 40 psi (300 kPa).
>
> (f) The set pressure tolerance for pin devices shall not exceed ±2 psi (15 kPa) of marked set pressure up to and including 40 psi (300 kPa) and ±5% of marked set pressures above 40 psi (300 kPa) at specified pin temperature.
>
> (g) Pressure relief valves shall be designed and constructed such that when installed per UG-135, the valves will operate without chattering and shall not flutter at the flow-rated pressure in a way that either would interfere with the measurement of capacity or would result in damage.

2. UG-127 NONRECLOSING PRESSURE RELIEF DEVICES

(a) Rupture Disk Devices

(1) General. Every rupture disk shall have a marked burst pressure established by rules of UG-137(d)(3) within a manufacturing design range at a specified disk temperature and shall be marked with a lot number. The burst pressure tolerance at the specified disk temperature shall not exceed ±2 psi (±15 kPa) for marked burst pressure up to and including 40 psi (300 kPa) and ±5% for marked burst pressure above 40 psi (300 kPa).

(2) Relieving Capacity. Rupture disk devices certified using the flow resistance method shall use (-a), and rupture disk devices certified using the coefficient of discharge method shall use (-b) below.

(-a) The rated flow capacity of a pressure relief system that uses a rupture disk device as the sole relieving device shall be determined by a value calculated under the requirements of (-1) or (-2) below.

(-1) When the rupture disk device discharges directly to the atmosphere and

(+a) is installed within eight pipe diameters from the vessel nozzle entry; and

(+b) with a length of discharge pipe not greater than five pipe diameters from the rupture disk device; and

{+c) the nominal diameters of the inlet and discharge piping are equal to or greater than the stamped NPS (DN) designator of the device, the calculated relieving capacity of a pressure relief system shall not exceed a value based on the applicable theoretical flow equation *[see UG-131(e)(2) and Mandatory Appendix 11]* for the various media multiplied by a coefficient of discharge K equal to 0.62. The area A in the theoretical flow equation shall be the minimum net flow area as specified by the rupture disk device Manufacturer.

(-2) The calculated capacity of any pressure relief system may be determined by analyzing the total system resistance to flow. This analysis shall take into consideration the flow resistance of the rupture disk device, piping and piping components including the exit nozzle on the vessels, elbows, tees, reducers, and valves. The calculation shall be made using accepted engineering practices for determining fluid flow through piping systems. This calculated relieving capacity shall be multiplied by a factor of 0.90 or less to allow for uncertainties inherent with this method. The certified flow resistance K_R for the rupture disk device, expressed as the velocity head loss, shall be determined in accordance with UG-131(n) through UG-131(u).

(-b) The relieving capacity of the pressure relief system that uses a rupture disk device as the sole relieving device shall be determined by taking into consideration the certified capacity marked on the device and the characteristics of the system fluid and system components upstream and downstream of the rupture disk device. The certified coefficient of discharge K_D for the rupture disk device shall be determined in accordance with UG-131 (b) UG-131 (j).

(3) Application of Rupture Disks

(-a) A rupture disk device may be used as the sole pressure-relieving device on a vessel.

NOTE: When rupture disk devices are used, it is recommended that the design pressure of the vessel be sufficiently above the intended operating pressure to provide a sufficient margin between operating pressure and rupture disk bursting pressure to prevent premature failure of the rupture disk due to fatigue or creep.

Application of rupture disk devices to liquid service should be carefully evaluated to assure that the design of the rupture disk device and the dynamic energy of the system on which it is installed will result in sufficient opening of the rupture disk.

(-b) A rupture disk device may be installed between a pressure relief valve and the vessel, provided:

(-1) the combination of the pressure relief valve and the rupture disk device has ample capacity to meet the requirements of UG-125(c);

(-2) the marked capacity of a pressure relief valve (nozzle type), when installed with a rupture disk device between the inlet of the valve and the vessel, shall be multiplied by a factor of 0.90 of the rated relieving capacity of the valve alone, or the capacity of such a combination shall be established following (-3) below;

(-3) the capacity of the combination of the rupture disk device and the pressure relief valve may be established following the appropriate paragraphs of UG-132;

(-4) the space between a rupture disk device and a pressure relief valve shall be provided with a pressure gauge, a try cock, free vent, or suitable telltale indicator. This arrangement permits the detection of disk rupture or leakage.

(-5) the opening provided through the rupture disk, after burst, is sufficient to permit a flow equal to the capacity of the valve [(-2) and (-3) above], and there is no chance of interference with the proper functioning of the valve; but in no case shall this area be less than the area of the inlet of the valve unless the capacity and functioning of the specific combination of rupture disk device and pressure relief valve have been established by testing in accordance with UG-132.

[Rupture Disk on the Outlet side of PRV]

(-c) A rupture disk device may be installed on the outlet side of a pressure relief valve which is opened by the direct action of the pressure in the vessel, provided:

(-1) the pressure relief valve will not fail to open at its proper pressure setting regardless of any back pressure that can accumulate between the pressure relief valve disk and the rupture disk. The space between the pressure relief valve disk and the rupture disk shall be vented or drained to prevent accumulation of pressure, or suitable means shall be provided to ensure that an accumulation of pressure does not affect the proper operation of the pressure relief valve.

(-2) the pressure relief valve has ample capacity to meet the requirements of UG-125(c);

(-3) the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping shall not exceed the design pressure of the outlet portion of the pressure relief valve and any pipe or fitting between the valve and the rupture disk device. However, in no case shall the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping exceed the maximum allowable working pressure of the vessel or the set pressure of the pressure relief valve.

(-4) the opening provided through the rupture disk device after breakage is sufficient to permit a flow equal to the rated capacity of the attached pressure relief valve without exceeding the allowable overpressure;

(-5) any piping beyond the rupture disk cannot be obstructed by the rupture disk or fragment;

(-6) the system is designed to consider the adverse effects of any leakage through the pressure relief valve or through the outlet side rupture disk device, to ensure system performance and reliability.

(-7) the bonnet of a balancing bellows or diaphragm-type pressure relief valve shall be vented to prevent accumulation of pressure in the bonnet.

Recommendations from the National Board of Boiler and Pressure Vessel Inspectors (NBBI)

Problems occur when specifying the disk temperature. Often the vessel’s design temperature is used. In most cases, coincident temperature (the temperature that should be used), is not the same as the vessel design temperature, and should be less than the design temperature. Most rupture disk materials are sensitive to temperature (the burst pressure will typically decrease as the temperature increases).

When disk manufacturers qualify a disk lot, they use specified coincident temperature (given to them by customers) as the manufacturing specification for the test temperature. Test procedures require a disk to be installed into a test assembly which is placed into a test oven, heated to the coincident temperature, and tested for burst pressure. When that disk is used in service at a lower temperature, the burst pressure is usually higher, and if the disk marked burst pressure was equal to vessel MAWP, it will burst at a pressure higher than the MAWP when an overpressure condition occurs. As mentioned above, the set pressure of the pressure relief device should not exceed MAWP at any temperature.

One disk manufacturer supplied a sample of its proprietary data on the effect of temperature on burst pressure for a sample material, where a difference in set pressure for a temperature difference of 100° F could be as much as 10 percent. Therefore, if the specified temperature differed from the temperature of the disk by several hundred degrees when called upon to actuate, the set pressure could be off by as much as 20 percent!

So, what is the proper temperature to use for coincident temperature? The next choice is usually normal process temperature. However, upset conditions and normal operating conditions need to be considered. In chemical processing, an overpressure condition can be caused by a runaway chemical reaction, in which case coincident temperature could be higher than the normal process temperature.

When the temperature of the process is known during an upset condition, disk position in the system could be such that it does not experience the same temperature as the bulk process temperature. Disk temperature may be based more upon its environment than the temperature of the process fluid.

A recent incident involving a rupture disk pointed out some of these problems. A vessel was rated at 150 pounds per square inch (psi) at 400° F, and a rupture disk was specified with a set pressure of 150 psi at 400° F. The process fluid was mostly steam, and at 150 psi, the saturation temperature of the steam is about 366° F. The disk was located on a nozzle on top of the vessel and extended from the vessel surface approximately six inches. The nozzle and disk assembly were not insulated. Although actual disk temperature was not known, heat transfer theory tells us disk assembly temperature is somewhere between fluid temperature and atmospheric temperature. The disk could have been operating at as much as 200° F lower than the specified temperature, and the actual burst pressure under those conditions would have been much higher than expected. The vessel may have experienced an overpressure condition, but the disk did not open, and the head connection failed. It flew across the plant where the vessel was located, causing significant property damage. Fortunately, there were no personnel in the area when the vessel failed, so there were no injuries.

Another problem occurs when the Manufacturing Design Range (MDR) is not considered during the ordering of the disks. The code definition of MDR is a range of pressures or window of pressures within which the Manufacturers' destructive testing breaks must fall to be acceptable for a particular requirement as agreed upon between the rupture disk manufacturer and user of his/her designated agent. The MDR is set by the manufacturer. Thus +/-5% MDR means MDR= +5-(-5) = 10. Sometimes confused with burst pressure tolerance, the stamped burst pressure can vary from the value marked on the disk as allowed by the code-tolerance and still be acceptable.

Rupture disk burst pressure is usually rated based upon test values determined during lot qualification. The value marked on the disk would be the test burst pressure average. If that average falls within the MDR, the lot is considered acceptable. Because of small variations between tests, it could be difficult to hit the exact required value. Producing another lot to hit an exact specified burst pressure adds cost and time to disk production, but the product quality is not changed. If a customer wants an MDR tighter than the standard value for a particular product, the manufacturer can provide it at additional cost to the user.

An example illustrates the use of MDR

A manufacturer offers a disk design having a standard MDR of +6% to -3% for burst pressures greater than 271 psig. A customer orders a disk with a specified burst pressure of 300 psig and standard MDR. The MAWP of the vessel to be protected by the disk is 300 psig. When the disk lot is manufactured, the two test burst pressures are 302 and 306 psig, resulting in an average burst pressure of 304 psig. The manufacturer marks the disk burst pressure as 304 psig and has met its contractual requirement because marked burst pressure is 1.3% above the specified value (MDR allows 6%). The disk lot meets code tolerances because each test burst is within +/-5% of the marked set pressure. An alert inspector performs an inspection and rejects the disk because marked set pressure exceeds vessel MAWP, which is not permitted per paragraph UG-134(a) of Section VIII.

The customer's solution is to either specify a disk with a “zero manufacturing range” which ensures the marked set pressure will equal specified set pressure (but perhaps be more expensive) or specify burst pressure so the MDR will never result in a disk with a set pressure that is too high. If the customer had ordered a disk with a specified burst pressure of 283 psig, the highest it could have been marked would be 300 psig (6% above the specified burst pressure).

Recognizing this potential problem, most manufacturers' newer designs have MDRs ensuring the marked burst pressure can only be equal to or less than specified burst pressure. A typical range is -10% and +0%. Older designs often used MDRs like the one above, and the user should be alert to this possibility. This information can be found in catalog literature for each design. In general, maximum marked burst pressure, nominal burst pressure, and minimum marked burst pressure along with the coincident design temperature should be supplied in the specification sheet.

The following recommendations are advised to Inspectors from NBBI when rupture disks are used.

1. Confirm the marked disk set pressure is equal to or less than the vessel MAWP.
2. Look at the marked disk temperature and confirm it has been specified so that it is the temperature of the disk when it is expected to burst, and not the vessel design temperature. Normal operating conditions, upset conditions, and environmental effects should all be considered.

Recommendations to Rupture Disk Users

1. Ensure the disk temperature specification has been determined properly and considers normal operating conditions, upset conditions, and environmental effects.
2. When specifying a disk, check the MDR so it does not result in a disk stamped greater than the vessel MAWP.
3. When ordering replacement disks, supply the previous lot number and specified burst pressure. Disk manufacturers maintain extensive records based upon lot numbers, and the user should always refer to this information when ordering replacement disks.

Specifying only the set pressure marked on an old disk can result in "lot creep"- when each lot has a slightly lower or higher set pressure than the previous lot.

Computation of Nominal Burst Pressure, Minimum Burst Pressure, and Maximum Burst Pressure.

The following text shows how we arrive at the nominal burst pressure and minimum burst pressure of a disk by using the tolerance and manufacturing range data. We fix the maximum burst pressure at or below MAWP of the protected equipment.

Maximum Marked Burst pressure = MAWP = P0
Nominal burst pressure (1 + ptol/100)(1 + pmr/100) = P0
Minimum Marked Burst pressure = Nominal burst pressure (1 – mtol/100)(1- mmr/100)

Where:
ptol = positive tolerance %
mtol = negative tolerance %, numerical value
pmr = positive manufacturing range, %
mmr = negative manufacturing range, %, numerical value.

In the above formulae, factors including the tolerance are included for conservative designs. These factors may be excluded if needed to meet existing designs.

Example1.

The MAWP of a vessel is 100 psig. The selected disk has a tolerance of +4/-5%, and a manufacturing range of +6/-10%. Specify the Maximum Marked Burst pressure, Nominal Burst pressure, and Minimum Marked Burst Pressures.

Solution:
Maximum Marked Burst pressure = MAWP = 100 psig
Nominal Burst Pressure = 100/[(1 + 4/100)(1 +6/100)] = 90.71 psig
Minimum Burst Pressure = 90.71 x (1 - 5/100) x (1 - 10/100) = 77.56 psig.

Summarizing:
Maximum Marked Burst pressure = 100 psig
Nominal Burst Pressure = 90.71 psig
Minimum Marked Burst Pressure = 77.56 psig

Example 2

The Maximum Marked Burst pressure of a disk is 35 psig. It has a tolerance of +2/-2 psi, and a manufacturing range of +5/-5%. The MAWP of a vessel is 35 psig. Calculate the Nominal and Minimum Marked Burst Pressures.

Solution:
(Nominal Burst Pressure +2)(1 +5/100) = 35
Nominal Burst Pressure = 35/1.05 - 2 = 31.33 psig
Minimum Marked Burst Pressure = (Nominal Burst Pressure -2)(1 - 5/100)
= (31.33 -2)(0.95)
= 27.87 psig

Summarizing:
Maximum Marked Burst Pressure = 35 psig
Nominal Burst Pressure = 31.33 psig
Minimum Marked Burst Pressure = 27.87 psig

ASME VIII UG 134(e) allows the bursting of a disk at a 5% higher pressure than the marked burst pressure when the marked burst pressure is above 40 psig. In Example 1, the disk is marked at 100 psig and is intended to protect a vessel with MAWP of 100 psig; ASME allows the disk to burst at a maximum pressure of 105 psig. Therefore, the nominal burst pressure could be specified as 100/1.06 = 94.34 psig if the plus tolerance does not exceed 5%. For the specification purpose, the minimum burst pressure could be similarly calculated without considering tolerance as 94.34 x 0.9 = 84.91 psig. To summarize, the below specifications are acceptable and only consider the manufacturing range:

Maximum Marked Burst pressure = 100 psig
Nominal burst pressure = 94.34 psig
Minimum Marked Burst pressure = 84.91 psig

For specification purpose, the figures are rounded to lower integer values. For example, the Minimum Marked Burst Pressure as calculated above may be specified as 84 psig. The Nominal burst pressure may be specified as 94 psig. Therefore, the Manufacturing Design Range (MDR) = 100 – 84 = 16. This is also (+6 – (-10)) = 16 in Example 1.

The minimum burst pressure should still be calculated as shown above considering both tolerance and manufacturing range for internal process evaluation to see whether it is too close to the operating pressure, which should be generally no more than 70% of the burst pressure, even though it could be increased for special design.

Similarly, the code allows the bursting of a disk at a pressure 2 psi higher than the marked burst pressure when the marked burst pressure is up to and including 40 psig. In other words, if a disk is marked at 30 psig and is protecting a vessel with MAWP of 30 psig, ASME allows the disk to burst at a maximum pressure of 32 psig.

Temperature Factor

Normally, the coincident design temperature of a disk is specified as 72° F. However, if the operating temperature is appreciably higher, such as above 100° F, the coincident design temperature should be increased to avoid nuisance activation. This will, however, increase the unit price as the testing is to be done in a temperature-controlled oven.

Conclusion:

In general, the plus-tolerance factors in the above examples and equations are NOT necessary if the marked burst pressure is not greater than MAWP with a maximum plus tolerance of 5%. The minus tolerance may also be excluded for calculating the minimum burst pressure. The plus-tolerance may be included to calculate the burst pressure at the discretion of the designer to make a conservative specification.

The minus-tolerance factor may be important, especially in the low burst pressure range, to determine the safe margin between the operating pressure and the minimum burst pressure. The Minimum Marked Burst pressure determined as above would provide a diagnostic tool for determining nuisance bursting of a disk especially when the temperature correction has not been applied. When the operating margin is small, the minimum burst pressure should be checked for the effect of relief temperature, remembering that the marked burst pressure is generally rated at 72° F. This checking is done using the dp/dT data or the stress values of the material of construction.

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