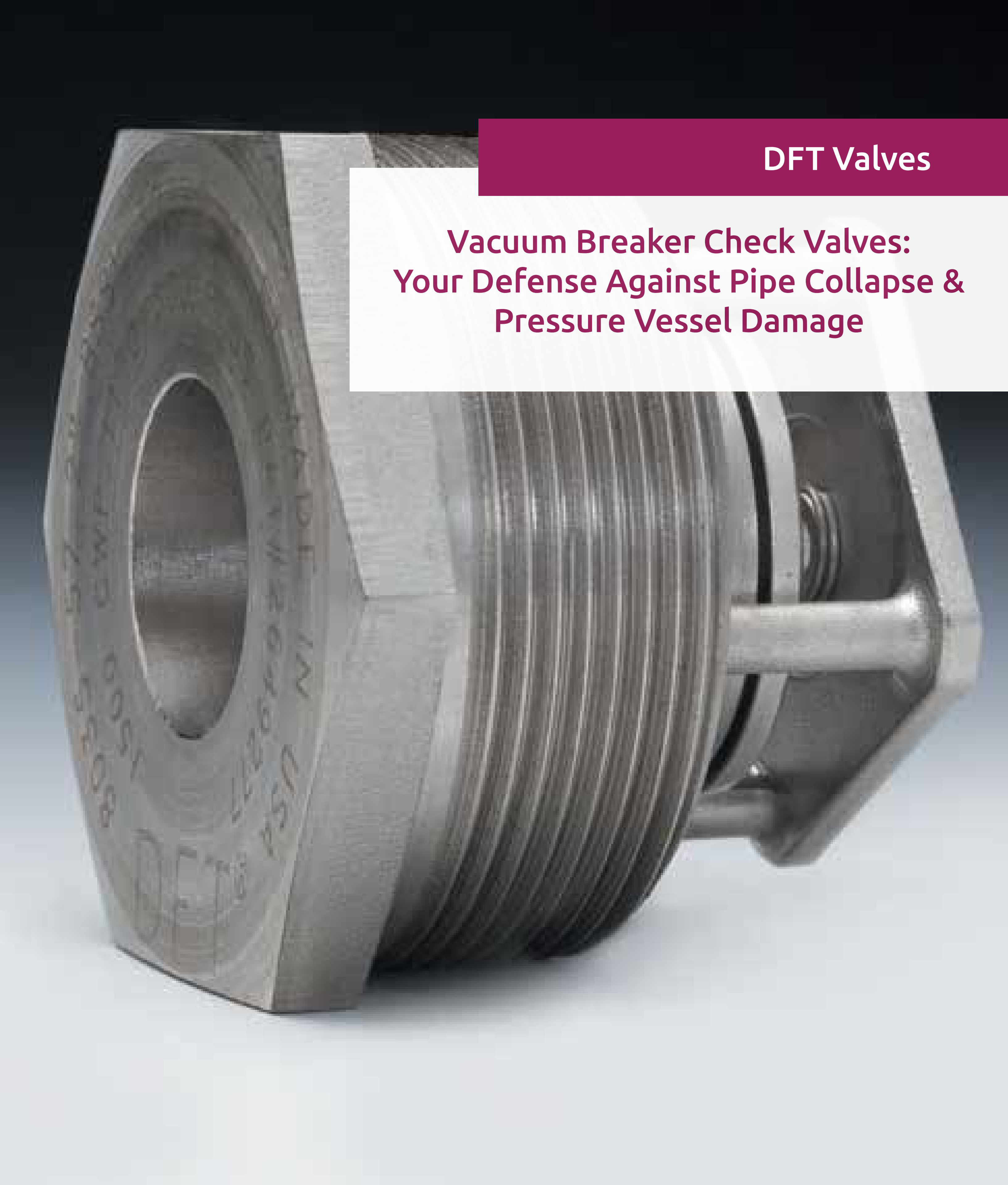
DFT Valves

Vacuum Breaker Check Valves: Your Defense Against Pipe Collapse & Pressure Vessel Damage



Introduction

In a closed heated system design, the first concern is always explosion. Extensive steps are taken to ensure that the relief valves are included in the layout and will work properly should the system undergo excessive temperature increases. Additional concerns are not always investigated as thoroughly. Implosion and collapse can have similar system damage impacts and down time challenges. To properly plan for this challenge, we must first understand the forces at work and how they originate.

Effects of Cooling On Thin-Walled Closed Systems

Pressure vessels and piping systems are often used in processes that require heated fluid or gas retention and distribution. These systems are frequently subject to temperature cycles when the heated fluid or steam is either shut off or reduced. As in any closed system, this temperature change causes a pressure discrepancy between the fluid or gas inside the system and the outside atmosphere. As the temperature in the system drops, a vacuum is created that allows the outside atmosphere to exert increased pressure on the external face of the pressure vessel or piping. Left unchecked, this situation can cause structural failure of the vessel or pipe wall. This damage typically has impact downstream to other equipment and components as well. Downtime from this type of preventable incident is usually lengthy and costly.

Image courtesy of
[The Corrosion Expert]

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[Marine Surveyors Bureau S.A.]

Your Options

1. Overdesign Your Components: Your first option is to design your components to allow for a full vacuum situation. This means that your pressure vessel or piping system is capable of withstanding a full atmosphere of pressure under normal conditions. The following equation provides a starting point for understanding the options for ring placement, material elasticity, and material thickness that can be adjusted to attempt to determine the appropriate balance between brute force and cost.

$$\left(\frac{E}{P'}\right) = f\left[\left(\frac{D}{t}\right)\left(\frac{X}{D}\right)\right]$$

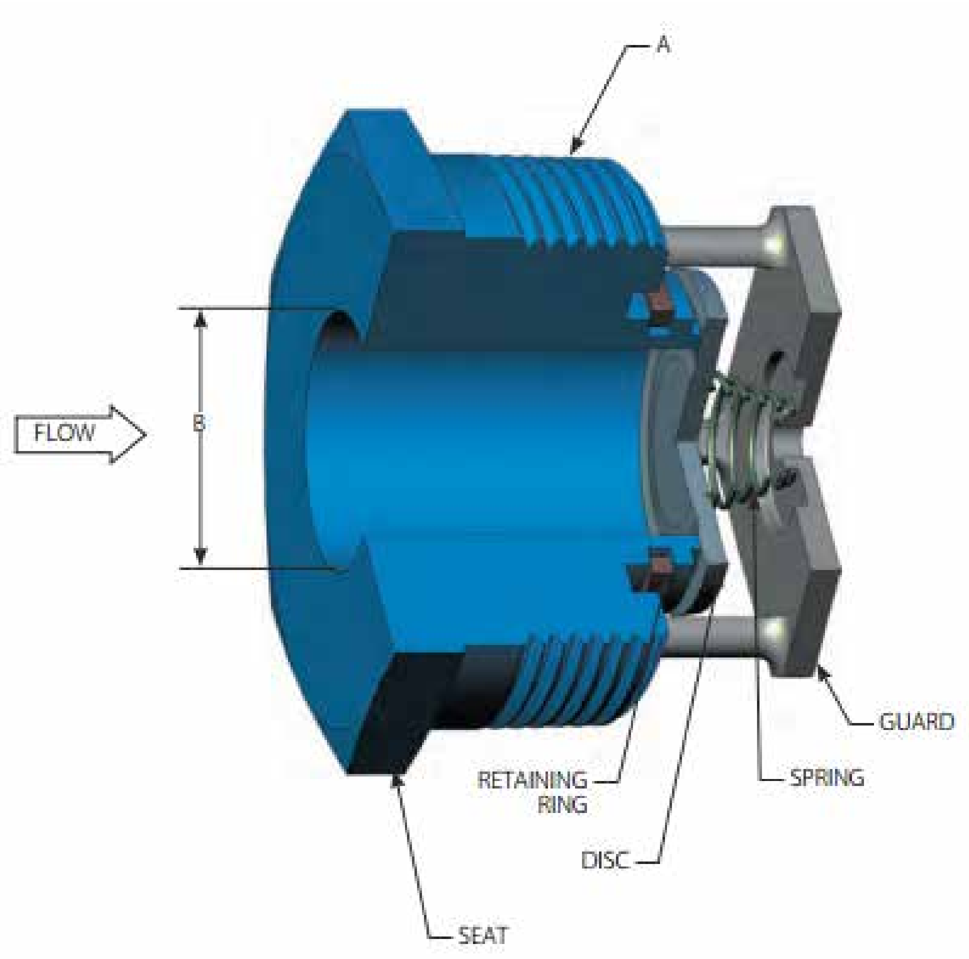
Where:
P'= vacuum at collapse, **E**= modulus of elasticity,
D= diameter of ring, **t**= thickness of wall, **X**= spacing of rings

For further mathematical analysis of your options in this area, we recommend reviewing "Pressure Vessels Field Manual: Common Operating Problems and Practical Solutions." This free resource provides ample insight into this option.

2. Include Vacuum Breaker Check Valve: Including a properly sized vacuum breaker check valve in your design will eliminate the possible negative effects of temperature change or transient pressure drops on the structural integrity of the pressure vessel or piping components. Under normal operation the valve defaults to the closed position. This means no air is introduced to the system when the vessel or pipe is under pressure and in full operation. When the system is adjusted and a cooling cycle begins, the valve will automatically open at the predetermined cracking pressure. Upon opening, air is added to the system. This immediately negates any vacuum generation, halts siphoning, and prevents condensate "back-up."

Your Options

To properly protect your system, yet keep it functioning as intended, you must identify the amount of pressure the valve must contain in the system to prevent failure. This is known as the "cold, non-shock pressure rating." It is equally important to identify the point at which you want air introduced back into the system to eliminate the vacuum. This is known as the "cracking pressure."



Your Options

Vacuum Breaker			Cracking Pressure		
A Nominal Size (MNPT)	B Unthreaded Inlet Bore	Weight	CV	PSI	Inches of Water
1	.56	.38	5.8	.60 (1)	16.7
1 1/2	.88	.88	13.2	.45	12.5
2	1.09	1.25	23.1	.38	10.5
2 1/2	1.50	2.25	36	.20	5.5
3	1.72	3.75	57.4	.14	3.9
4	2.22	7.00	90	.15	4.3

COLD, NON-SHOCK PRESSURE RATING (PSIG) (2)

	1”	1 1/2”	2”	2 1/2”	3”	4”
Vacuum Breaker BSSV	2500	2000	1500	850	700	450
Vacuum Breaker BSSV6	6000	5500	3000	1100	900	450

In weighing the two options to overcome the possibility of damage to the vessel or piping system, you must also analyze the additional investment in time, materials, repeatability, and shipping associated with increasing the pressure ratings of your systems to maintain a completely closed unit. As you investigate the options to protect your pressure vessel and piping system from negative pressure damage, we encourage you to take advantage of DFT Valve’s experienced engineering team by requesting a consultation to review your project. Our team has helped hundreds of design engineers just like you finalize their system components to eliminate the risk of collapse and downtime. Contact us today to get started!