**Introduction**

Steam is simply defined as the vapor or gaseous state of water. Water in an open vessel will boil at 212°F (100°C) at standard atmospheric pressure of 14.7 psia or 29.92 in. of mercury. No matter how vigorously it is heated, the boiling water will not become any hotter than 212°F (100°C). The extra heat is used to change water into steam, and the resulting steam will also be at a temperature of 212°F (100°C).

If the top of the vessel is sealed, as is the case with a boiler, the water will begin to boil at 212°F (100°C) and the steam vapor will fill the space above the water. Now the temperature of the boiling water will increase as heat is added, and the pressure in the vessel will also increase. The “saturated” steam just above the liquid will again remain at the temperature of the water just below. The graph in Figure 1 illustrates the combinations of pressure and temperature that result in saturated steam. Any combination to the left or above the curve will be a water service. Saturated steam will fall on the curve, and anything below or to the right of the curve will be superheated steam.

**Saturated Steam**

Most steam services are called “saturated steam”; however, droplets of water will form as heat is lost or used in the system. Steam traps are used to collect this water phase, yet some water droplets will be carried along into the stream. These droplets, or actual slugs of water, impinge upon valve surfaces at high velocity. Seating surfaces are subjected to this abrasive attack at all times. The greatest destructive effect occurs at the moment of disc opening and closure. At this point, all of the droplets are forced through the tiny opening between mating closure surfaces. The cam action of the disc moves it quickly out of contact and away from the seat, in order that this very critical “just open” position is brief in comparison to other styles of valves.

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**Figure 1: Pressure and Temperature Combinations for Saturated Steam**

![Graph showing pressure and temperature combinations for saturated steam](image-url)
**Lower Quality Steam**

Steam that contains considerable amounts of liquid water may be graded according to the amount of liquid water in the stream. A steam containing 10% water would be 90% quality steam, while a stream containing 30% water would be 70% quality steam. This steam may be extremely destructive to valves and piping, especially on the downstream side of the valve. At this point, the release of pressure allows the water droplets to flash to steam, either within the valve or just downstream of the valve. This built-in "cavitation" effect may also be evident at elbows, tees, or other fittings that may introduce pressure variations.

**Flashing Hot Water**

Pressurized hot water may produce many of the same effects that are seen in lines that handle wet or low quality steam. Consider a system handling water at 60 psig (413 kPa) with a temperature of 300°F (149°C). The graph in Figure 1 determines that this is water; however, note that a pressure drop of approximately 10 psi (69 kPa) will allow the water to flash into steam. This is a steam application even though the apparent service is water at a fairly low pressure.

**Superheat**

If ordinary saturated steam is heated to temperatures above the saturation point in a secondary operation, the steam is said to be superheated. Referring to the graph in Figure 1, assume a system of 50 psig (345 kPa) steam at 325°F (163°C). Note that 50 psig (345 kPa) steam would be saturated at about 300°F (149°C). In this example, the steam has 25°F (14°C) of superheat. The valve would simply be handling a hot gas as long as superheat is maintained. Some superheat is desirable since valve service would be improved (only if this superheat is maintained at the valve). This ideal rarely exists in practice. It is important to note that in superheated situations, plastic seating materials are softened at high temperatures.

**Throttling Service**

The very nature of throttling service dictates conditions unfavorable to extend valve life. Effective throttling/modulation requires that the modulating valve absorb a fairly high percentage of the available absolute pressure. A 30% drop in pressure will provide good control. At higher pressures, this 30% figure produces a high pressure drop through a valve that is intentionally operated in a partially open position. If the service requires a wide range of flow rates, the valve must first be large enough to provide the maximum required flow. This large valve must then be operated in a nearly closed position in order to provide the minimum controlled flow rate. When the required control range is high, the destructive conditions previously noted for the instant of opening and closure may exist continuously. Steam throttling range should be limited to 5:1 when using VF Series High-Pressure, High-Temperature Butterfly Valves.

Pressure/temperature combinations allowed should fall well within the RPTFE seat limits dictated in the *VF Series High-Pressure, High-Temperature Butterfly Valves Product Bulletin (LIT-977208)*.

**Johnson Controls High-Pressure, High-Temperature Butterfly Valves**

In order to determine how suitable a valve would be for a particular steam application, all known service conditions must be taken into consideration. Johnson Controls VF Series High-Pressure, High-Temperature Butterfly Valves will handle many industrial and commercial steam services. These valves may be recommended for two-position service up to 150 psig (1,034 kPa) saturated steam at 366°F (185°C). Modulating service should be limited to a 5:1 throttling range, and up to a maximum of 50 psig (345 kPa) saturated steam at 297°F (147°C).

For steam service, a VF Series High-Pressure, High-Temperature ANSI Class 150 or ANSI Class 300 Butterfly Valve should be used. These valves feature a carbon steel body, an RPTFE seat, a 316 stainless steel disc, and a 17-4 PH stainless steel stem.