FLOW CONTROLS
WHITE PAPER

Material selection: Hard Components and Soft Components

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Material Selection

Material selection is critical for any successful valve application. These materials are typically categorized into two types:

- Hard Components
- Soft Components

All these components make up the pressure boundaries of the valve and selecting the right materials will provide robust, trouble-free solutions for these applications. The body, end connections, stem and ball (hard components) are fabricated from materials that can resist the mechanical forces of pressurized fluids, abrasion, piping stress and weight. They need to be resistant to the corrosive properties of the fluid it carries as well as the environment. These are typically composed of different grades of stainless steel, carbon steel, bronze, brass, copper, plastics like PVC or CPVC, and specialized alloys like Hastelloy, Monel, Alloy 20, Duplex, etc. The valve seats, seals, stem seals (soft components) are utilized to contain the pressurized fluids. These are typically composed of elastomers, fluorocarbons, and graphite that are able to provide corrosion resistance to the fluid as well as hold its structural integrity even when subjected to different temperatures and pressures.

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Valve Construction – Hard Components

A variety of materials can be used for valve construction and these will all be driven by application requirements. The following are some of the materials used to manufacture valves and their properties, features, and benefits.

1.1 Stainless Steel

Stainless steel covers a variety of corrosion resistant steels that contain a minimum of 11% Chromium. Changing the Chromium content and adding other elements changes the mechanical and physical properties of the steel. Two important properties of stainless steel are corrosive resistance and weldability.

CORROSIVE RESISTANCE

- Generally more resistant than 304 in range of atmospheric environments and many corrosive media due to the increased chromium and molybdenum content.

WELDING CHARACTERISTICS

- Excellent weldability by all standard fusion methods, both with and without filler metals.
- Heavy welded sections in Grade 316 require post-weld annealing for maximum corrosion resistance, this is not required for Grade 316L/316LN.

316 Stainless Steel

Stainless steel 316 contains an addition of molybdenum that gives it an improved corrosion resistance, particularly higher resistance to pitting and crevice corrosion in chloride environments, like, water-treatment plants.

CHEMICAL FORMULA (% BY WEIGHT):

	C	Mn	Si	P	S	Cr	Mo	Ni	N
MIN	-	-	-	-	-	16.0	2.00	10.0	-
MAX	0.08	2.0	1.0	0.045	0.03	18.0	3.00	14.0	0.10

316L Stainless Steel

The low carbon version on Stainless steel 316, is resistant to carbide precipitation, making it suitable to use in heavier and thicker welded components.

CHEMICAL FORMULA (% BY WEIGHT):

	C	Mn	Si	P	S	Cr	Mo	Ni	N
MIN	-	-	-	-	-	16.0	2.00	10.0	-
MAX	0.035	2.0	1.0	0.045	0.03	18.0	3.00	15.0	0.10

316LN Stainless Steel

Stainless steel 316LN is a low carbon and nitrogen-enhanced version of stainless steel 316. The nitrogen content in 316LN provides a solid solution for hardening and raises its minimum specified yield strength.

CHEMICAL FORMULA (% BY WEIGHT):

	C	Mn	Si	P	S	Cr	Mo	Ni	N
MIN	-	-	-	-	-	17.0	2.00	13.0	0.10
MAX	0.03	2.0	0.75	0.25	0.1	19.0	3.00	15.0	0.30

1.2 ASTM A276-316L (BAR) vs ASTM A182-316L (FORGED)

Stainless Steel Bars & Shapes

- The semi-finished stainless steel is hot rolled into bars.
- Components are machined from stainless steel bars.
- This specification covers hot-finished or cold-finished bars except bars for re-forging.

Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings & Valves & Parts for High Temperature Service

- Forging is the process by which metal is heated in its "plastic state" and is shaped by applying compressive force. Forging refines the grain structure and improves physical properties of the metal making it stronger than cast or machined parts.
- This specification covers forged low alloy and stainless piping components for use in pressure systems.
- Included are flanges, fittings, valves and similar parts to specified dimensions or dimensional standards.

ASTM	A276 - 316L	A182F - 316L
MAJOR ELEMENTS		
CARBON	0.03% max.	0.03% max.
CHROMIUM	16.00 - 18.00%	16.00 - 18.00%
MOLYBENDUM	2.00 - 3.00%	2.00 - 3.00%
NICKEL	10.00 - 14.00%	10.00 - 15.00%
MECHANICAL PROPERTIES		
Tensile Strength	70,000 psi min.	70,000 psi min.
Yield Strength	25,000 psi min.	25,000 psi min.
Elongation in 2in. %	40 min.	30 min.
Reduction in Area %	50 min.	50 min.

1.3 Carbon Steel

Carbon steel costs less and is easier to manufacture than stainless steel. However, it does not carry the same corrosion resistance properties as stainless steel. Carbon steel valves are great for applications that do not involve moisture. The extra carbon in the carbon steel improves its abrasion resistance. Carbon steel valves also have good heat resistance.

CHEMICAL FORMULA (% BY WEIGHT):										
GRADE		C	Mn	Si	P	S	Cr	Mo	Ni	N
WCB	MIN	-	-	-	-	-	-	-	-	-
	MAX	0.30	1.0	0.60	0.04	0.045	0.50	0.20	0.50	-

1.4 Bronze

Bronze is an alloy that consists of copper, tin and usually with added metals, i.e. aluminum, manganese, nickel or zinc. Bronze is the first alloy made by man and is one of the most common valve materials. Bronze is very resistant to cracking, is malleable and be cast or machined. It is low cost and provides great resistance to corrosion, ***however, it does contain lead and has the potential of contaminating the media, like water in different applications***.

CHEMICAL FORMULA (% BY WEIGHT):												
GRADE		Si	S	P	Ni	Cu	Fe	Tn	Pb	Zi	Al	An
C84400	MIN	-	-	-	-	78.0	-	2.3	6.0	7.0	-	-
	MAX	0.005	0.08	0.02	1.0^{K}	82.0	0.4	3.5	8.0	10.0	0.25	0.005

1.5 Hastelloy

Hastelloy is one of the most corrosion-resistant alloys used today. It is primarily composed of nickel with molybdenum and chromium additions. It is considered to be a super alloy due to is extreme resistance to corrosive substances. Hastelloy also had very good mechanical and thermal properties making it a very popular selection for critical, corrosive applications.

Corrosion Resistance

Super Alloy

+ Good Thermal Properties

+ Good Mechanical Properties

CHEMICAL FORMULA (% BY WEIGHT):

GRADE		C	Mn	Si	P	S	Cr	Mo	Ni	V	Fe	W
C276	MIN	-	-	-	-	-	15.5	16.0	-	0.20	4.5	3.75
	MAX	0.12	1.0	1.0	0.040	0.03	17.5	18.0	Balance	0.40	7.5	5.25

Chemical composition of the more common Hard Components

CHEMICAL COMPOSITION % (MAXIMUM % EXCEPT WHERE RANGE IS GIVEN):

SPEC	Carbon C	Manganese Mn	Silicon Si	Sulfur S	Phosphorus P	Chromium Cr	Nickel Ni	Molybdenum Mo	Columbium (Nibium) Cb (Nb)	Cobalt Co	Vanadium V	Nitrogen N	Copper Cu	Iron Fe	Tungsten W	Tin	Lead	Zinc	Antimony	Aluminum
A351-CF8M	0.08	1.50	1.50	0.040	0.040	18.0-21.0	9.0-12.0	2.0-3.0												
A351-CF3M	0.03	1.50	1.50	0.040	0.040	17.0-21.0	9.0-13.0	2.0-3.0												
A351-CF3M[A]	0.035	2.00	1.00	0.005-0.017	0.045	16.0-18.0	10.00-15.00	2.0-3.0												
A351-CF3MN[A]	0.035	2.00	1.00	0.005-0.017	0.045	16.0-18.0	10.00-15.00	2.0-3.0				0.10-0.20								
A351-CN7M	0.07	1.50	1.50	0.040	0.040	19.0-22.00	27.5-30.5	2.0-3.0					3.00-4.00							
A494-CW12MW	0.12	1.00	1.00	0.030	0.040	15.5-17.5	Balance	16.0-18.0			0.20-0.40			4.5-7.5	3.75-5.25					
A216-WCB	0.30[B]	1.00[B]	0.60	0.045	0.04	0.50	0.50	0.20			0.03		0.30							
A182-F316	0.08	2.00	1.00	0.030	0.045	16.0-18.0	10.0-14.0	2.0-3.0												
A182-F316L[A]	0.30	2.00	1.00	0.005-0.017	0.045	16.0-18.0	10.00-15.00	2.0-3.0												
A105	0.35[C]	0.60-1.05[C]	0.10-0.35	0.040	0.035	0.30[E]	0.40[D]	0.12[E]	0.02		0.08		0.40[D]							
A479-316	0.08[F]	2.00	1.00	0.030	0.045	16.0-18.0	10.0-14.0	2.0-3.0												
A479-316L	0.03	2.00	1.00	0.030	0.045	16.0-18.0	10.0-14.0	2.0-3.0												
B574-N10276	0.01	1.00	0.08	0.030	0.04	14.5-16.5	Balance[G]	15.0-17.0		2.5	0.35			4.0-7.0	3.0-4.5					
A564 GR.630	0.07	1.00	1.00	0.030	0.040	15.0-17.5	3.00-5.00		[H]			0.10-0.20								
A494-CY40	0.04	1.50	3.00	0.030	0.03	14.0-17.0	Balance				0.20-0.40			11.0						
A890-CD3Mn	0.04	1.00	1.00	0.040	0.040	24.5-26.5	4.75-6.00	1.75-2.25					2.75-3.25							
A351-CD4MCu	0.04	1.00	1.00	0.040	0.040	24.5-26.5	4.75-6.00	1.75-2.25					2.75-3.25							
A494-M30C	0.30	1.50	1.0-2.0	0.030	0.03		Balance		1.0-3.0				26.0-33.0	3.50						
A276-316L[J]	0.030	2.00	1.00	0.030	0.045	16.0-18.0	10.0-14.0	2.00-3.00												
B584-C84400			0.005	0.08	0.02		1.0[K]						78.0-82.0	0.4		2.3-3.5	6.0-8.0	7.0-10.0	0.25	0.005

[A] per ASME BPE DT-3

[B] For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% Mn above the specified maximum will be permitted up to a maximum of 1.28%

[C] For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.06% Mn above the specified maximum will be permitted up to a maximum of 1.35%

[D] The sum of copper, nickel, chromium, molybdenum and vanadium shall not exceed 1.00%

[E] The sum of chromium and molybdenum shall not exceed 0.32%

[F] Except as required for specific alloy type, molybdenum, titanium, nickel, cobalt, tantalum, nitrogen and copper need not be reported but shall not be present in other than residual amounts.

[G] For elements not covered by Test Methds E 1473, the referee method shall be as agreed upon between the manufacturer and the purchaser. The nickel composition shall be determined arithmetically by difference.

[H] Columbium plum tantalum 0.15-0.45.

[J] For some applications, the substitution of Type 304L for Type 316L for Type 316 may be undesirable because of design, fabrication, or service requirements. In such cases, the purchaser should so indicate on the order.

[K] including Cobalt. In determining copper minimum, copper may be calculated as copper plus nickel.

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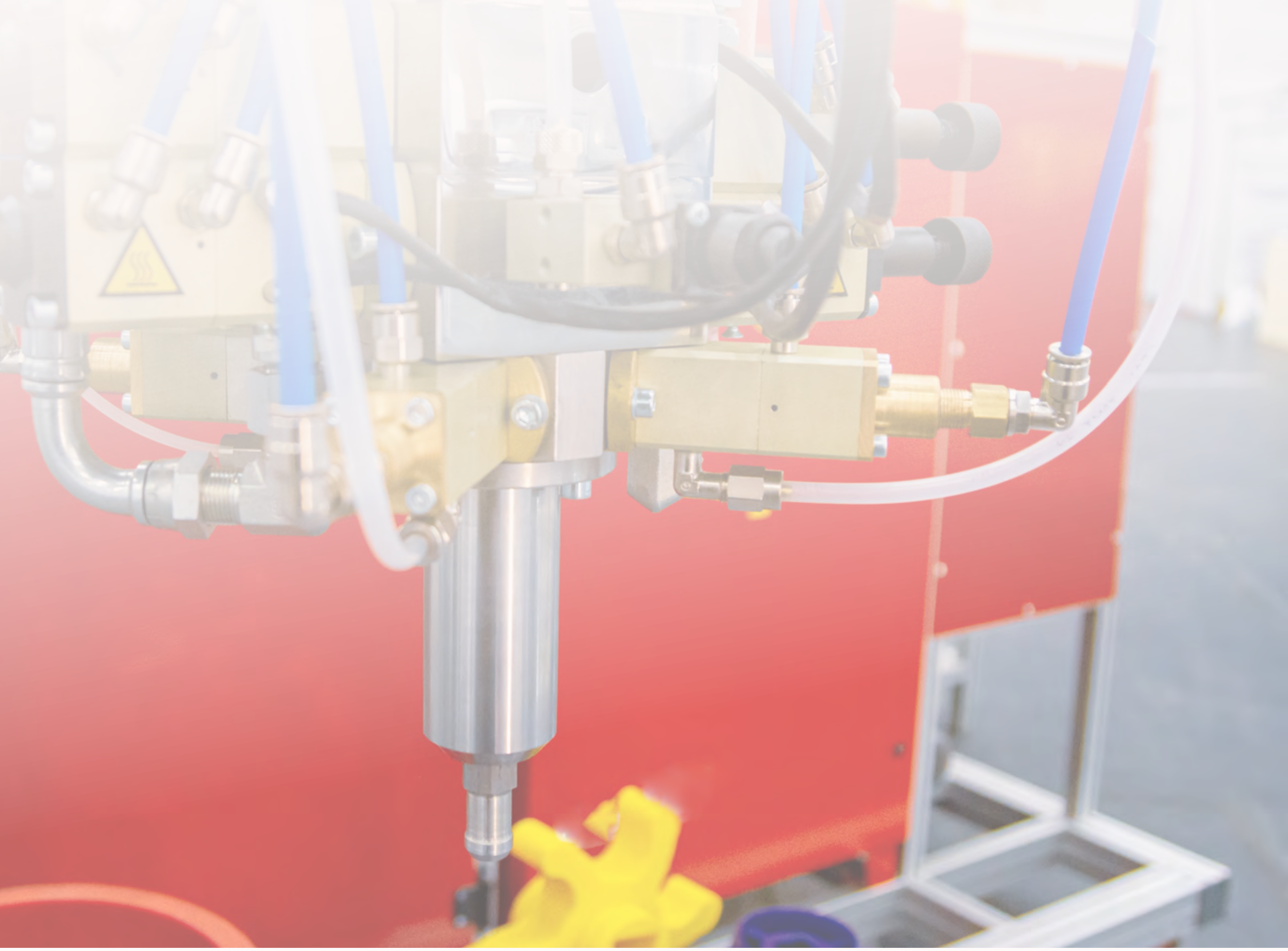
II Valve Construction – Soft Components

The internal parts of the valve include “soft components” which are designed to fill the interstitial space between the metals. Seats are fitted to the valve body and made of softer materials like PTFE or various elastomers such as Buna, EPDM, FKM depending on the maximum operating temperatures. These seats are designed to provide a bubble tight shut off and a long valve life cycle. “Soft Components” are also utilized to prevent metal to metal contact and grinding as well as sealing, thus prolonging optimal performance of the valve.



2.1 Materials Used in Valve Construction – Soft Components

A variety of materials can be used for valve construction and these will all be driven by application requirements. The following are some of the materials used to manufacture valves and their properties, features, and benefits.

UHMWPE — ORDER CODE: U

COLOR: WHITE

COLOR CODE: NONE

DESCRIPTION:
Ultra High Molecular Weight Polyethylene, UHMWPE is rated to 1500 psi at temperatures from -70°F to 200°F. It can be used in low to medium level radiation service and in applications where fluoro-carbons cannot be tolerated. Abrasive resistance is very good.

TEMPERATURE RANGE: -70°F to 200°F

TFM1600™ — ORDER CODE: A

COLOR: WHITE

COLOR CODE: RED

DESCRIPTION:
(PTFE-TFM), This material is a derivative of PTFE and is a standard seat material for our CleanFLOW and all Series 8 valves.

TEMPERATURE RANGE: -100°F to 450°F

DELRIN® — ORDER CODE: D

COLOR: TRANSLUCENT

COLOR CODE: GREEN

DESCRIPTION:
(Dupont Acetal Homopolymer), This seat is very rigid and does not undergo cold flow. Delrin can withstand pressures up to 6000 psi dependent on valve size. Delrin also withstands nuclear radiation at dose of up to 106 rads. Do not use Delrin on oxygen service.

TEMPERATURE RANGE: -70°F to 180°F

SUPRALON™ — ORDER CODE: S

COLOR: BLACK

COLOR CODE: WHITE

DESCRIPTION:
SupraLon™ - Carbon Infused TFM, A carbon infused TFM is the seat of choice for valves used in steam or thermal fluid applications. This seat has a high density polymer structure and abrasion resistance.

TEMPERATURE RANGE: -328°F TO 650°F

PEEK — ORDER CODE: K

COLOR: BLACK

COLOR CODE: GREEN (x2) & SILVER (x1)

DESCRIPTION:
TEMPRE K, This material offers a unique combination of chemical, mechanical, electrical and thermal properties. The only known solvent of PEEK is concentrated sulfuric acid. It will withstand temperatures up to 600°F and pressures up to 6000 psi. PEEK is excellent for steam applications.

TEMPERATURE RANGE: -40°F to 600°F

VIRGIN TEFLON® — ORDER CODE: W

COLOR: WHITE

COLOR CODE: BLUE

DESCRIPTION:
VIRGIN TEFLON (See "A" - TFM), This seating material has excellent chemical resistance and low co-efficient of friction.

TEMPERATURE RANGE: -60°F to 450°F

PEEK — ORDER CODE: L

COLOR: OPAQUE

DESCRIPTION:
VIRGIN PEEK, This material is a naturally abrasion resistant and offers excellent resistance in harsh chemical environments.

TEMPERATURE RANGE: -40°F TO 500°F

2.2 TFM1600™

TFM1600™ is a seating material classified as a homo-polymer under ISO 12086 that utilizes the superior performance of a modified version of PTFE resulting in chemical compatibility and thermal properties.

The performance of the TFM1600™ (second generation polytetra-fluoro-ethylene) makes it an ideal choice for many different types of applications, i.e. high purity, semi-conductor, food and beverage, chemical, etc.

Note: TFM1600 can be utilized where PTFE and RPTFE seat materials are currently used.

Temperature Range:

-100°F to 450°F

The advantages of *TFM1600™* over PTFE and RTFE:

- Maintains the chemical and heat resistance properties with significantly lower melt viscosity (smoother ball to seat sealing surface).
- Improved stress recovery, particularly at elevated temperatures.
- Denser polymer structure
- Improved flexibility
- Lower permeability
- Smoother surface

TFM1600™ complies with:

- ASME – BPE compliant for sealing components and materials (PTFE and TFM)
- 3A Sanitary standard for multiple-use plastic materials used as product contact surfaces
- FDA-21 CFR 177.1550 direct contact with meat and poultry food products prepared under FDA inspection.
- USP23, Biological test for plastics/Class VI

TFM1600™ Seat Design:

- O.D. groves for optimal performance
- Flexible lip seat design provides bubble tight shut-off at low and high pressures

2.3 SupraLon™

SupraLon™ is a seating material developed by SVF that utilizes the superior performance of specially blended carbon fillers. The superior performance of the carbon-blended (SupraLon)

maintains the exceptional chemical and heat resistance properties of the first generation PTFE, but with significantly lower melt viscosity. This property results in better particle fusion during the sintering and much smoother ball to seat sealing surface.

Temperature Range:

-328°F to 650°F

The advantages of *SupraLon* over TFE and NRG:

- Lower coefficient of friction results in lower valve torque and wear
- High density polymer structure
- Reduced permeability
- Superior abrasion resistance
- Reduced “cold flow” (increased resistance to deformation)
- Enhanced deformation recovery (compressive strength)
- Increased pressure recovery (compression stress relaxation)

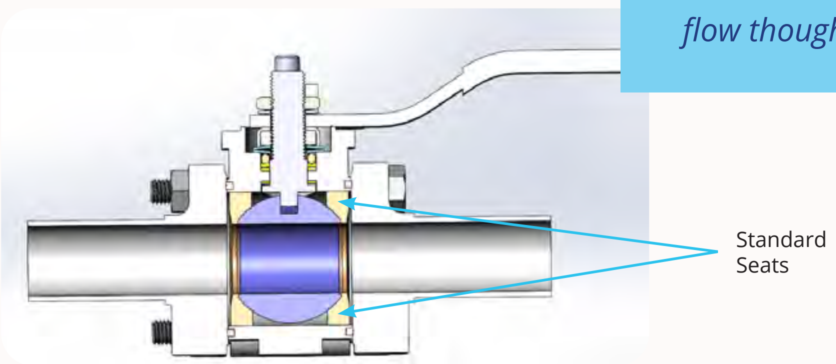
SupraLon:

- Temperature range up to 650°F (@ 30 psig)
- Temperature range up to 550°F for modulating valves and valves in normal-to-dirty service
- Saturated steam rating to 425 psi
- Maintains the same excellent chemical resistance and thermal stability as TFM
- Does not affect the fire safe capability of our fire-rated valves.

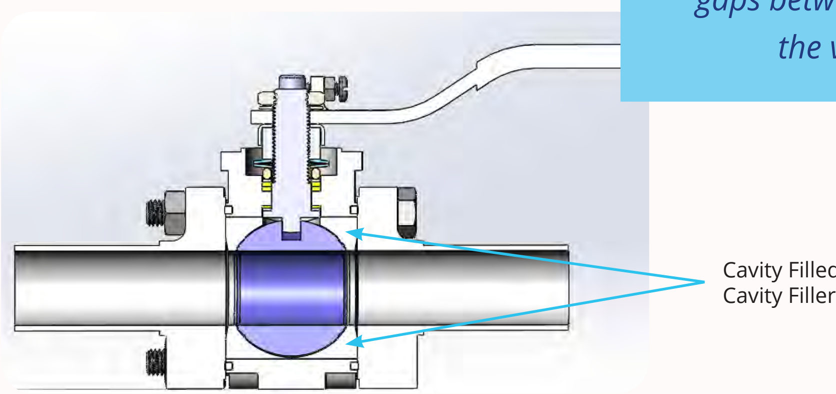
2.4 Standard Seats VS Cavity Filler

TFM1600™ is available as a standard or as a cavity filled seat. A floating ball valve design relies on the seat performance to obtain optimal sealing capabilities in any application. A floating ball valve seals off the line pressure by utilizing the flexibility of soft seats, such as TFM1600. Pressure on a closed valve pushes the ball against the seats creating a bubble tight shut off. Standard seats allow media to flow through the valve body cavity while a cavity filled or cavity filler seats are designed to fill the gaps between the ball and the valve body minimizing any media flowing through the body.

Standard seats allow media to flow though the valve cavity.



Cavity Filled or Cavity Filler seats are designed to fill the gaps between the ball and the valve body



Note: *Each application has different requirements and may use the standard or the cavity filled seats. For example, ASME – BPE prefers utilizing standard seats over cavity filled for pharmaceutical applications, while most Food and Beverage applications require cavity filled seats.*

What do I need to know?

Because the selection is vast for fluid handling applications, there are certain details that are critical to determine the right solution.

- Media
- Temperature
- Pressure
- Valve materials of construction
- Installation *(Inside or Outside)*
- End connection
- Manual or automated

In Closing

A process control scheme will likely be developed for very specific outputs, rates and materials. It may also need to address pressure and temperature conditions and hazardous area locations. With many options, classifications and control solutions available today it is always a good idea to work with a highly experienced automation supplier.

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