CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

Thermoplastics • Thermosets
Fluoropolymers • Elastomers

ISO 9001:2008 CERTIFIED

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MATERIALS OF CONSTRUCTION

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Note: Properties of plastics and elastomers vary because different compounds of the same material are used for different products and components. The following materials descriptions are of a general nature. Chemline should be consulted for material recommendations on specific applications.

THERMOPLASTICS

Most plastics are made from synthetic resins (polymers) through the process of polymerization. Two main types of plastics are thermoplastics and thermosets. Thermoplastic products are injection moulded or extruded from compound material processed under heat and pressure.

PVC (Polyvinyl Chloride)

The largest selection of Chemline valves and controls are moulded in PVC. This rigid gray colour material is unplasticized polyvinyl chloride. PVC is formed by the polymerization of the vinyl chloride monomer. Unplasticized PVC or PVC-U has excellent mechanical and chemical resistance properties at low cost. The working temperature range of PVC valves is 0 to 60°C (30 to 140°F). Vinyl is plasticized PVC. The added plasticizer produces a flexibile material for such products as tubing, but offers poor chemical resistance.

The PVC used for Chemline valves is identified by cell classification number 12454-A as per ASTM Standard D 1784. Suffix "A" refers to the highest chemical resistance rating. Most other PVC valves as well as pipe and fittings have only a "B" chemical resistance rating. The special PVC "A" compound used in Chemline valves resists attack of most acids, strong alkalais, salts and many other chemicals. High chemical resistance of this material allows its application on aggressive services such as 98% H2 SO4, dry chlorine and low pressure wet chlorine gas. PVC is attacked by chlorinated hydrocarbons, ketones, esters and some aromatic compounds. It can be used on solutions containing up to 1000 ppm solvents.

Chemline PVC valves are non-toxic. They meet CSA standard B137.0 for toxicity and NSF/ANSI Standard 61 for contact with drinking water. They are resistant to damaging effects of sunlight and weathering, thus painting is not necessary.

CPVC (Chlorinated Polyvinyl Chloride)

CPVC is PVC that has been chlorinated via a free radical chlorination reaction. It is similar to PVC in chemical resistance. Mechanically it is more ductile than PVC. It's main difference is higher working temperature ratings and is therefore used where temperatures are too high for PVC or when an extra margin of safety is required. Valves are suitable for applications from 0 to 95°C (30 to 200°F).

The CPVC compound used for Chemline valves is classified as 23567-A as per ASTM D 1784. The suffix "A" denotes conformance to the highest chemical resistance rating. Most other CPVC valves as well as pipe and fittings have only a "B" chemical resistance rating. The compound is non-toxic, conforming to CSA toxicity standard B137.0.

PP (Pigmented Polypropylene)

Polypropylene (PP) is a thermoplastic polyolefin made from the olefin propylene. A more modern term for polyolefin is polyalkene. Chemline offers piping systems, valves and controls normally in pigmented PP. The addition of grey-beige pigment prevents degradation due to ultraviolet light penetration.

PP is used in a wide variety of applications from acids and alkali's to organic solvents as well as pure water. PP is one of the best materials to use for systems exposed to varying pH levels, as many plastics do not handle both acids and bases well. It is excellent on acids such hydrochloric and phosphoric acid but unsuitable on strong acids like concentrated nitric, also chlorinated hydrocarbons, aromatic compounds and high concentrations of free chlorine.

PP is ductile at ambient temperature and has good impact strength. It also has good thermal stability up to 90°C (194°F) , higher than that of other thermoplastics such as PVC and HDPE. It is light weight. The specific gravity is 0.91 compared to 1.4 for PVC. It's abrasion resistance is good, much better than that of PVC. This is a feature of Chemline PVC butterfly valves which have PP discs as standard.

Chemline PP pipe and fittings weld together very well using either butt or socket fusion. The pressure losses in PP piping systems are lower than metal because of the smooth inside surfaces of the pipes. This property also minimizes or eliminates deposits or bacterial growth. PP is a poor conductor of heat, i.e. is a good insulator. Chilled or hot water systems in PP often require no insulation.

PP is very inert and relatively inexpensive, thus popular for high purity water systems. The standard pigmented material is normally used.

Special grades include U-PP (unpigmented, natural) translucent material sometimes preferred for pure water systems, pigmented black for the highest resistance to UV light, flame retardant grades to meet building code requirements, and electro-conductive grades for volatile media.

Polypropylene is available in two grades:

- Homopolymer (PP-H) made from Type I resin conforming to ASTM D 4101, produced from 100% propylene monomer. PP-H is the most widely utilized. It offers a high strength to weight ratio and is stiffer and stronger than the copolymer grade. Piping is normally PP-H. a few Chemline valves are also PP-H. The working temperature range of PP-H back pressure valves for example is 10 to 70°C (50 to 158°F).
- Random Copolymer (PP-R) made from Type II resin produced from 94% propylene with 6% ethylene. PP-R is a bit softer but has better impact strength, is tougher and more durable than PP-H. Copolymer polypropylene has better stress crack resistance and low temperature toughness than homopolymer at the expense of small reductions in other properties. Most Chemline valves and all the pipe fittings are PP-R. PP-R pipe is also available. The working temperature range of Chemline's PP-R ball valves is –20 to 80°C (–4 to 176°F) and up to 90°C (194°F) for diaphragm valves.

U-PP (Unpigmented Polypropylene)

U-PP is produced from high-purity virgin random copolymer. Chemline offers PP pipe, fittings and valves in unpigmented PP.
U-PP shows excellent purity levels when tested in standard static leach tests (better than high-purity PVC) and has a superior surface quality, i.e. smoothness (Ra=0.4 to 1.5 µm), making it a popular choice for high-purity water systems. It is suitable as piping for high purity water systems, compliant with USP Class VI for pharmaceutical high purity applications. It is also approved by the FDA for contact with food. The disadvantage of U-PP is it will degrade if exposed to UV light (sun light).

PVDF (Polyvinylidene Fluoride)

PVDF also known as "Kynar®", is a highly inert and pure thermoplastic fluoropolymer. It has many superior properties as a thermoplastic.

PVDF has excellent chemical resistance against halogens such as chlorine and bromine, strong acids such as hydrofluoric and nitric acids, organic solvents and oils. PVDF is not resistant to hot bases.

PVDF has much higher abrasion resistance than other thermoplastics. Chemline's butterfly valves with optional PVDF discs offer extended life on abrasive applications.

PVDF (Polyvinylidene Fluoride)
It has remarkable strength over the largest working temperature range. The working temperature range of PVDF ball valves is –40 to 100°C (–40 to 212°F) and up to 120°C (250°F) for diaphragm valves with a PVDF bonnet. PVDF's impact strength is over twice that of PVC. The valves and piping will withstand mechanical abuse at sub-freezing temperatures.

PVDF is a pure polymer without UV stabilizers, thermo stabilizers, softeners, lubricants or flame-retardant additives. It the preferred choice of piping material for ultra-pure water and high purity chemicals in the semiconductor industry. PVDF is non-toxic, imparts no odours or tastes into the fluid. It is compliant with USP Class VI for pharmaceutical high purity applications and conforms with FDA regulations as outlined in Title 21, Chapter 1, Part 177-2510 (contact with food) as well as with ROHS. The Canadian Food Inspection Agency recognizes Chemline's PVDF for use in any food application by "Letter of No-Objection".

Gas permeability of PVDF is extremely low. A PVDF gas permeability barrier is available on most Chemline diaphragm valves. It is a backing to the PTFE diaphragm and has proven to increase the life of diaphragm valves on chlorine and strong acid services.

PVDF offers excellent fire protection without flame-retardant additives (V-O rating according to the UL-94 vertical flame test) and during combustion has only a slight amount of smoke development. It has high resistance to the damaging effects of UV (sun light) and gamma radiation.

ECTFE (Halar®)
ECTFE is a durable copolymer of ethylene and chlorotrifluoroethylene (CTFE). Chemline offers butt fusion metric pipe and fittings in ECTFE, commonly known as "Halar®". ECTFE shares with PVDF excellent properties such as high chemical resistance, wide application temperature range, good UV resistance (i.e. unaffected by sunlight long term), excellent abrasion resistance, smooth inner surfaces (low pressure losses, resistant to deposits or bacterial buildup), excellent insulating properties and low permeability. It is extremely inert and the material is natural, without any additives or pigment. It is suitable as piping for high purity water systems, compliant with USP Class VI for pharmaceutical high purity applications.

ECTFE has a working temperature range up to 95°C (200°F). Pressure ratings are higher than for PP but lower than for PVDF.

ECTFE has excellent chemical resistance (i.e. not subject to chemically induced stress cracking) against halogens such as chlorine and bromine, strong acids such as hydrofluoric and nitric acids, organic solvents and oils. ECTFE surpasses PVDF in resistance to strong bases and is the best material for handling sodium hypochlorite even at high temperatures. ECTFE is not resistant to hot amines, sodium or potassium.

ECTFE offers excellent fire protection without addition of flame-retardant additives. It has a V-O rating according to the UL-94 vertical flame test.

PE (Polyetheylene)
Polyethylene is the polyolefin produced by polymerizing the olefin ethylene. The ball in a Chemline Cavity Free ball valve is made of PE. They withstand abrasion better than PVC.

PSU (Polysulfone)
Polysulfone is a thermoplastic polymer containing a sulfonyl functional group (-SO2-) attached to two carbon atoms. It is offered as a tube material for Chemline variable area flow meters. It offers high impact strength, high dimensional stability and good optical transparency, all important for accuracy and easy reading of the flow meters. Working temperature range of the PSU flow meters is 0 to 90°C (32 to 194°F) depending on end and nut materials. While the standard PVC tube flow meters are not recommended for gases, PSU ones are. It is also more suitable for high purity water applications. The chemical resistance is good generally, but lower than that of PVC.

PA (Polyamide)
Polyamide is a polymer containing monomers of amides. There are a number of polyamide families. Polyamide is a tube material for Chemline variable area flow meters. It offers high impact strength, high dimensional stability and excellent optical transparency. The special grade to PA used for flow meters has very low water absorption rate. These properties are all important for accuracy and easy reading of the flow meters. PA tube flow meters may be used on pressurized gases, whereas PVC cannot be. Working temperature range of the flow meters is 0 to 75°C (32 to 167°F) depending on end and nut materials. This is higher than for PVC. Chemical resistance is relatively poor compared to PVC, so applications generally are water or only mildly corrosive chemicals.

THERMOSETS

Thermosets are polymers that irreversibly cure. The curing process transforms the resin into a larger molecular weight plastic by a cross-linking process. The process is initiated through heat, generally above 200°C (392°F), through a chemical reaction (two-part epoxy is an example), or irradiation. Due to the three dimensional network of bonds (cross-linking), thermoset materials are generally stronger than thermoplastic materials and have higher temperature ratings.

PDCPD (Polydicyclopentadiene)
PDCPD is a polyolefin thermoset polymer which is formed through the polymerisation of dicyclopentadiene (DCPD). It is used for Chemline butterfly valve bodies from 16" to 48" sizes and air release valves. Reaction Injection Moulding (RIM) is the manufacturing process. PDCPD has excellent corrosion resistance, similar to that of PP and high tensile strength which translates to high valve working pressures. PDCPD body butterfly valves offer higher working pressures than those with PP bodies at the same price. For example a 20" or 24" Type 75 butterfly valve at 30°C (86°F) is 110 psi rated with PDCPD body and 50 psi rated with PP body. Impact strength and dimensional stability is also high.

FRP
Fiberglass reinforced plastic (FRP) is a composite material made from glass reinforcement in a thermoset polymer, usually vinyl ester resin. Chemline FRP damper butterfly valves are made from high elongation vinyl ester for high resistance to impact and thermal shock. Special additives to the FRP can be provided for extremely high abrasion resistance in dirty corrosive gas handing applications. Fire retardants are always incorporated for the Chemline damper butterflies.

GRP (Glass Reinforced Plastic)
GRP is another term for FRP. Flange rings on large Chemline Cavity Free ball valves are GRP.

VE-CF
VE-CF is a proprietary composite thermoset material. It is composed of vinyl ester filled with 10% carbon fiber and 10% glass fiber. It is the body material of Chemline's ChemValve TFM (PTFE) lined butterfly valves. VE-CF has high temperature rating of 130°C (266°F), and high tensile strength for high valve working pressures. It has high impact strength even at low temperatures. All these properties mean durability and safety in severe and difficult chemical applications.

Materials of Construction

FLUOROPOLYMERS

Fluoropolymers are fluorocarbon based polymers with multiple strong carbon-fluorine bonds. They are characterized by a high resistance to solvents, acids, and bases. They have high application temperature ranges.

PTFE (Polytetrafluoroethylene)
PTFE is almost totally insoluble and chemically inert. It has high temperature resistance. Ball seats of PTFE have natural lubricity. Chemline diaphragm valves with PTFE diaphragms and PTFE bonded EPDM flange gaskets are suitable for the most severe chemical resistance applications.

PTFE's weakness is that during the forming process the powder raw material cannot flow, so the finished material is left with some microporosity. This allows it to "cold flow" or creep under conditions of pressure and temperature. The microporsity also reduces the polymer's permeation resistance. Chemline PTFE diaphragms are supplied standard with PVDF gas barriers to avoid permeation problems which may reduce the diaphragm life. Newer fluoroplymers such as PFA and TFM were developed to overcome PTFE's weak properties.

PFA (Perfluoralkoxy)
Perfluoralkoxy (PFA) is a fully fluorinated polymer with the same chemical resistance and high temperature performance as PTFE. The big difference is that it is melt process able. PFA can be extruded to make pipe or tubing, or injection molded for tube fittings. It has much lower porosity than PTFE and is translucent instead of opaque white. Mechanically it is stronger. The threads in a moulded PFA tube fitting are vastly superior in durability and strength compared to the threads machined on a comparable PTFE fitting. Application temperature is to150°C (300°F). Chemline recommends PFA as the best choice of fluoropolymer tubing. Like PTFE and TFM the PFA fluoropolymer is made from tetrafluoroethylene (TFE) and perfluoropropylvinyl ether (PPVE) monomer units. However, it is polymerized with a higher percentage of the PPVE comonomer; as much as 3 to 4% compared to <1% for TFM PTFE. This increases polymer-chain entanglement at lower molecular weight levels and makes it melt process able.

FEP (Fluorinated Ethylene Propylene)
FEP is a melt-process able fully fluorinated polymer with similar chemical resistance as PTFE and PFA and similar low porosity and translucency as PFA. FEP is a copolymer of hexafluoropropylene and tetrafluoroethylene (TFE) resin. FEP is less expensive than PFA tubing but the temperature rating is not as high and mechanical properties not as good. Convoluted FEP is usually chosen for the outer tubing of dual containment PFA tube systems. FEP is not used for moulding fittings.

TFM (modified PTFE)
TFM is a modified form of PTFE. It's chemical and temperature resistance is the same as standard PTFE but TFM can be welded together, or to PFA parts. Also porosity is lower, tensile strength is higher, and cold flow is less. The seats of the ChemValve, all-fluoropolymer lined butterfly valves are made of TFM.

It is a tetrafluoroethylene (TFE) polymerized with less than <1% perfluoropropylvinyl ether (PPVE) to produce a slightly higher density molecular structure with side chain branching. This branching increases polymer-chain entanglement, slightly lowers molecular weight, and reduces voids as well as warpage of the material under pressure.

Compared to standard PTFE, TFM PTFE has higher permeation resistance which means better resistance to aggressive chemical, less "cold flow" or "creep" which means longer life for a butterfly valve seat for example and smoother surfaces which translates to better abrasion resistance and lower particle generation in high purity services.

ELASTOMERS

EPDM (Ethylene Propylene Diene Monomer)
EPDM is a type of synthetic rubber, a cost effective elastomer used as the standard seal material for most Chemline valves. E=ethylene, P=propylene, D=diene and M refers to M-class according to ASTM D-1418. The M class includes rubbers having a saturated chain of the polymethylene type. EPDM has excellent chemical resistance on the great majority of applications including acids, alkalis, salts and many others at temperatures up to 90°C (194°F). EPDM is weak on organic compounds and cannot be used on fats and petroleum oils.

Chemline valves seals of EPDM meet CSA standard B137.0 for non-toxicity.

FKM or FPM ("Viton®" Fluorocarbon Rubber)
FKM (or FPM) is a fluoroelastomer, polymerized from vinylidene fluoride (VDF) and hexafluoropropylene (HPF). Other FKM types include other additional monomers. "Viton®" is more expensive than EPDM so is usually chosen as an alternate elastomer when required. It is a durable material, offering excellent seal life in valves. Resistance to mineral acids, oils and many aliphatic and aromatic hydrocarbons is excellent. FKM/FPM is weak on sodium hydroxide. It is usually offered as a standard seal material for PVDF valves because EPDM's temperature rating is lower than that of PVDF, whereas FKM's maximum temperatures match or exceed those of PVDF.

- FKM-C is a special formulation with higher resistance to chlorine services. A butterfly or diaphragm valve with FKM-C seat or diaphragm can work in services where usually only expensive all-PTFE lined valves can. Elastomer seated valves usually have longer cycle life than those with PTFE seals.
- FKM-F offers better chemical resistance on inorganic acids than standard FKM. The Chemline chemical resistance guide shows ratings for hydrochloric, nitric and sulphuric acids. A butterfly or diaphragm valve with FKM-F seat or diaphragm can work in services where only all-PTFE lined valves are normally selected. Elastomer seated valves usually have longer cycle life than those with PTFE seals.

CPE (Chlorinated Polyethylene)
CPE is a high performance synthetic rubber material renown for long life in outdoor membrane applications (pools, fountains, roofs, etc.). As a seal material for Chemline valves it has found to be superior to all other elastomers on sodium hypochlorite. It resists hypochlorite up to full strength (13%). Ball valves supplied with CPE seals are very price competitive on this service.

NITRILE (Acrylonitrile-Butadiene Copolymer, abv. NBR)
Nitrile (formerly referred to as Buna-N) has high chemical resistance to oil and petroleum but is weak on oxidizing media i.e. acids. Nitrile has excellent abrasion resistance and is less expensive than FKM/FPM. It is often chosen as a seat material for Chemline butterfly valves in landfill applications and for abrasive slurry applications. It is an excellent alternative to FKM/FPM (Viton®) for petroleum based services.

Aflas®
Aflas® is a copolymer of tetrafluoroethylene and propylene (TFE/P). It offers excellent chemical resistance to strong acids and bases and excellent oil resistance. It is used as an alternate o-ring material in Chemline valves where higher chemical resistance than FKM/FPM is required. It has high heat resistance making it a good choice for PVDF ball valves seals.

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