

2.1 Polyethylene

Polyethylene is a basic, high volume thermoplastic with uses ranging from packaging film to pipe.

High density polyethylene pipe (sp. gr. 0.95) has a higher tensile strength than LDPE (sp. gr. 0.915), and so is the preferred grade for chemical plant service. HDPE possesses good chemical resistance to chlorinated water, sodium hypochlorite, sodium hydroxide, hydrochloric acid, and sulphuric acid. However it has a relatively low temperature rating that limits most practical application to 150°F or less. 180°F max has been quoted for cell effluent service.

Because of HDPE's resistance to solvents, HDPE joints must be fusion welded rather than solvent welded.

Driscopipe is a tough HDPE pipe finding increased use within Dow. At this time OCD is using Driscopipe to carry 30% hydrochloric acid and sodium carbonate. A nominal six mile long Driscopipe carries cell effluent from salt dome storage caverns back to the Texas plants. This is a 10 inch line. A buried 6" free-standing PE line costs in the order of \$25/ft installed. A buried 3" PE line costs around \$10/ft installed.

HDPE "slip liners" are also finding widespread use in Dow. These "slip liners" can be inserted into old leaking pipelines at a considerable savings over the cost of running a new line. Texas is operating the following PE slip-lined systems:

- 7,000 ft of 10" line on weak alkalinity (#13 line) between Plants A & B. (1981 installation)
- 30,000 ft of 10" on same line as above (1983 installation)
- 30,000 ft of 8" line in cell effluent service (#12 line, recently completed).

Note that slip liners can be installed in one of two forms: as a loose fitting liner where the annular space between the steel pipe and the liner is grouted; or as a close tolerance liner that does not require grout. Approximate cost data (for long pipelines) is:

- new 8" line, close tolerance slip liner: \$9.25/ft installed
- new 8" line, grouted slip liner: \$11.50/ft installed
- old 10" line, grouted slip liner: \$21/ft installed

We have not used PE in salt slurry service, although there is a feeling that it would perform satisfactorily.

The experience with HDPE pipe is not all good. One plant reported a sizeable acid spill due to failure of a weld joint in a 6" line.

2.2 Polypropylene

Polypropylene is another basic thermoplastic with uses ranging from molded automobile parts to fibers. Its chemical resistance is similar to that of PE.

PP is a relatively brittle material. It cannot be solvent welded, and it does not form a strong chemical bond to Derakane like PVC does. Consequently PP's use in C/A is restricted primarily to Dow Plastic Lined Pipe where it affords excellent resistance to acids (sulphuric and hydrochloric) and alkalies. PP is not suitable for services where free chlorine is present. Refer to appendix K for information on the chemical resistance of thermoplastics. Refer also to the section on Pipe Specs for services where PP lined pipe is in use.

Some interesting facts regarding PP lined pipe:

- PP degrades in sunlight. Keep PP lined pipe ends protected from sunlight during storage intervals.

- PP liners are known to stress crack in weak sulphuric acid. Do not use PP in sulphuric acid service at concentrations below 50%.

- PP fittings are known to crack in hydrochloric acid that contains added chlorides such as NaCl or FeCl₃. We do not often encounter such acid, so PP is widely used to convey hydrochloric acid.

- PP is widely used to convey salt slurries such as salt column underflows.

- PP lined pipe becomes susceptible to mechanical damage at temperatures below 40°F. When handling PP pipe at temperatures lower than this, use caution. It might be appropriate to heat trace PP lines in colder climates - consult your lined pipe representative. Note that most problems have been in the 10" and 12" sizes.

2.3 Polybutylene

Polybutylene might be thought of as a high performance polyethylene. The chemical resistance of Polybutylene is similar to that of polyethylene, but PB has improved mechanical properties including higher temperature ratings and considerable resistance to abrasion. PB pipe is available as "stand-alone" or as a slip lining.

In 1982 Texas installed 25,000 ft of 8" PB slip-lined pipe to carry sodium carbonate to Chlorine 6. There were only a few fusion weld problems with this line. In 1983 another 30,000 ft of 8" PB slip-lining was installed at Texas (carb to the brine wells) and this time there were more problems with fusion welds. In 1984 OCD tried to install PB slip lining into a 6" line, and wound up abandoning the line when it repeatedly failed hydrotest. Failures were occurring at the fusion weld joints.

Other companies reportedly have had problems joining PB pipe. This pipe is no longer being specified in Texas.

2.4 PVC

PVC is a well known material of construction in chlorine plants. It has excellent resistance to acids and alkalies, and has been used in such services as:

- weak sulphuric acid storage tank lining
- weak acid drying tower lining
- chlorine scrubber lining
- general purpose small diameter piping
- tower packing

PVC may be bonded by solvent welding. As this implies, PVC is readily attacked by many solvents. Note that PVC is generally restricted to use at temperatures below 150°F. Higher operating temperatures are permitted in PVC lined FRP vessels where the FRP backing material lends mechanical support. Some experiences regarding PVC are:

- PVC has often been chosen as the packing material for chlorine drying towers and scrubbers. Almost invariably there are problems with this choice: either RCIs (from upstream FRP pipe, HCl, or graphite anodes) attack the PVC packing causing it to soften, or temperature excursions cause the packing to flatten to the point of restricting flow. Refer to the appendix M for recommended packing materials.

- PVC lining has been used in continuous service chlorine scrubbers. Here, heat of reaction has caused the lining to crack. Current thinking is that continuous chlorine scrubbers ought to be constructed of titanium, or as a minimum be installed with a CPVC lining. Intermittently operated scrubbers may be constructed of solid FRP (DER 470).

- PVC liners are in use in brine chill towers and weak sulphuric drying towers. Attack by organics can and will occur in this service. There are many plies of PVC used in liner fabrication, and the experience is that blistering of the plies occurs at a slow enough pace that use of PVC is not precluded. Periodic inspection is, however, warranted. (Similar attack has been observed on internal PVC piping and distributors).

2.5 CPVC

Chlorinated polyvinyl chloride essentially is a high temperature form of PVC. The chemical resistance of CPVC and PVC are nearly the same, but CPVC is suitable for service up to 210°F. CPVC is used in C/A in such services as:

- lining material in FRP chlorine scrubbers.
- trays in weak sulphuric drying towers.
- substitute (at 1.5 times the cost) for PVC packing in chlorine towers and scrubbers.

Some interesting facts concerning CPVC are:

- CPVC shares the basic characteristics of PVC: it may be solvent welded, threaded, or fusion welded; it does not stand up well to solvents, but is good in wet chlorine, hydrochloric acid, sulphuric acid (below 90%), and caustic; it does not stand up well to abrasion.

- CPVC liners over FRP, unlike PVC liners, must be stress relieved.

It is recommended that continuous use chlorine scrubbers be constructed of titanium, but CPVC lined FRP is acceptable. There are some who contend that CPVC trays are preferable to PVC trays in weak sulphuric drying towers. With good temperature and level readout, the improved mechanical characteristics of CPVC are not needed in this service.

2.6 Kynar

The generic name for Kynar is polyvinylidene fluoride. Kynar is a readily machinable thermoplastic with a chemical resistance that approaches that of teflon. Note that Kynar, while possessing superior resistance to many chemicals, runs a distant second to teflon. For example, the Dow Plastic Lined Piping catalog lists kynar lined pipe suitable to a maximum of only 200°F in caustic service. Teflon is good to 300°F and beyond.

Kynar may be joined by threading or by fusion welding. Kynar is relatively brittle and difficult to bend, which explains why kynar, at half the cost of teflon, is not used more often as a tank lining. Welding Kynar is said to be easy, but it also is very easy to make a bad Kynar weld that is not readily noticeable.

Kynar is used in Dow C/A in the following services:

- Hydrochloric and Sulphuric Acid service.
- Alkaline hypochlorite service.
- Instrument piping in aggressive service in Cl₂ plants.
- Tower packing in chlorine plants.

Note that the high cost of Kynar encourages use of less expensive materials such as Polypropylene. Where PP cannot stand up to service conditions (see pipe specs) we go to Kynar and then as a last resort, teflon.

Kynar liners are known to have cracked in continuous use Cl₂ scrubbers. There is some thought that cracking occurred because stress relieving was not performed. Regardless, titanium is strongly recommended for continuous use scrubbers, with CPVC lined FRP the alternate.

2.7 Teflon

Teflon is by far the most chemically resistant thermoplastic in use today. The word "teflon" now encompasses a family of products, all of which share superb chemical resistance:

- FEP (fluorinated ethylene propylene). This translucent material is the most dense of the teflons (2.15 sp gr). It is much more flexible than other thermoplastics such as HDPE, PP, Tefzel, and PVC, but has a relative low temperature rating of about 350°F.

- PTFE (polytetrafluorethylene). This opaque, white material is noted for possessing the lowest coefficient of friction of any solid. Its temperature rating is around 400 to 450°F.

- PFA (perfluoroalkoxy). This is a relatively new teflon. It is noted for its high mechanical strength at elevated temperatures (relative to FEP and PTFE). The max temperature rating is 500 to 550°F.

- Tefzel (ETFE) (ethylenetetrafluoroethylene). This teflon is used primarily for structural shapes. Most of the time, if not always, it incorporates glass fiber reinforcement. Its chemical resistance is not as good as FEP, PTFE, and PFA.

Teflon is a well-known material in C/A. Uses range from acid area gaskets to caustic pump packing. Teflon has a tendency to cold-flow, and for this reason solid teflon gaskets are not recommended where high compressive force and high pressure are encountered.

Dow Lined Plastic Pipe is available in both PTFE and FEP. As far as C/A use is concerned, these products may be used interchangeably up to their temperature limits. (Note: teflon is not suitable for use around molten alkali metals, and a few other chemicals not found in C/A.)

Teflon is known for its permeability to gases. Dow teflon lined pipe is constructed with grooved passages to allow permeated vapors to vent. There have been very few instances of corrosion occurring in Dow teflon lined pipe due to permeation, and in fact the Plastic Lined Piping folks say the problem is very unlikely to be a concern except with Bromine (Kynar is recommended in lieu of teflon for this service.) While no corrosion problems would result, it is probably best not to use teflon in freon service.