Book 2: Chapter 3 - Pressure Rating Design

Pressure rated DriscoPlex™ polyethylene pipe and fittings are manufactured from materials that have been evaluated for long-term performance under mechanical stress.

Pipe Pressure Ratings

Pipe has a simple cylindrical shape. Formulas 3-1 and 3-2 relate the allowable long-term hoop tensile stress to internal pressure. DriscoPlex™ OD controlled pressure pipes are pressure rated using Formula 3-1. ID controlled pressure pipes are pressure rated using Formula 3-2.

$$P = \frac{2\,HDB\,f_E\,f_T}{(DR - 1)} \qquad \textbf{(3-1)}$$

$$P = \frac{2\,HDB\,f_E\,f_T}{(IDR + 1)} \qquad \textbf{(3-2)}$$

Formula (3-1) and (3-2) terms are:

P = Internal Pressure, psi
HDB = Hydrostatic Design Basis at 73°F, psi
f_E = Environmental Design Factor, Table 3-1
f_T = Service Temperature Design Factor, Table 3-2
DR = OD Controlled Pipe Dimension Ratio

$$DR = \frac{OD}{t} \qquad \textbf{(3-3)}$$

OD = OD-Controlled Pipe Outside Diameter, in.
t = Pipe Minimum Wall Thickness, in.
IDR = ID Controlled Pipe Dimension Ratio

$$IDR = \frac{ID}{t} \qquad \textbf{(3-4)}$$

ID = ID-Controlled Pipe Inside Diameter, in.

Thermoplastic pipes are commonly produced in accordance with a dimension ratio system. The dimension ratio, DR or IDR, is the ratio of the wall thickness to the respective pipe diameter. As diameters change, the pressure rating is the same for the same material, dimension ratio and application.

The terms “DR” and “IDR” are used with outside diameter controlled and inside diameter controlled pipe respectively. Certain dimension ratios that meet an ASTM-specified number series are “standardized dimension ratios” that is SDR or SIDR. Standardized dimension ratios are: 41, 32.5, 26, 21, 17, 13.5, 11, 9, and 7.3. From one SDR or SIDR to the next, there is about a 25% difference in minimum wall thickness.

In Formulas 3-1 and 3-2, the HDB at 73°F (23°C) is always used. Materials that are suitable for use at higher temperatures will also have elevated temperature HDB’s. Two design factors, f_E and f_T, relate environmental conditions and service temperature conditions to the product. See Tables 3-1 and 3-2

Occasionally, the HDS, the Hydrostatic Design Stress, may be used. The HDS is application-specific. It is the HDB times the appropriate environmental design factor (Formula 3-5).

$$HDS = HDB \times f_E \quad \textbf{(3-4)}$$

The ASTM Standard Thermoplastic Material Designation Code uses the HDS for water service as part of the code. See "Material Designation Code" in Book 1, Chapter 4.

Table 3-1 Environmental Design Factors, f_E

Application	f_E
Fluids such as potable and process water, benign chemicals, dry natural gas (non-federally regulated), brine, CO_2, H_2S, wastewater, sewage, glycol/anti-freeze solutions	0.50
Dry natural gas (Federally regulated under CFR Title 49, Part 192),	0.32
Fluids such as solvating/permeating chemicals in pipe or soil (typically hydrocarbons) in 2% or greater concentrations, natural or other fuel-gas liquid condensates, crude oil, fuel oil, gasoline, diesel, kerosene, hydrocarbon fuels	0.25

Table 3-2 Service Temperature Design Factors, f_T

Service Temperature	*f_T for PE 3408*	*f_T for PE 2406*
40°F (4°C)	1.20	1.10
60°F (16°C)	1.08	1.04
73°F (23°C)	1.00	1.00
100°F (38°C)	0.78	0.92
120°F (49°C)	0.63	0.86
140°F (60°C)	0.50	0.80

Table 3-1 and 3-2 design factors are applicable to Performance Pipe polyethylene materials. They may not be applicable to materials from other manufacturers.

Fitting Pressure Ratings

Like pipe, fittings for pressure service are pressure-rated using long-term internal pressure tests. Fittings however, have complicated geometries and are subject to additional stresses and stress concentrations due to their shape and rigidity. The usual practice in fitting pressure rating is to rate fittings as equivalent to system pipe of a particular DR.

Pressure-rated fittings must have added wall thickness where stresses are concentrated, and around holes for directional outlets. Thus the fitting body wall must be thicker than the outlet wall where it joins to system pipe. Saddle fittings have collars around the base to compensate for the material that is removed by cutting the saddle outlet hole through the main pipe wall.

Molded fittings usually have an enlarged body that provides the necessary wall thickness. But in fabricated fittings, heavier wall pipe sections must be used. This places the additional material thickness inside the fitting. *Fabricated fittings made from pipe segments that are the same DR as the system pipe must be pressure-rated at least one SDR higher than system pipe of the same DR.* For example, a fabricated tee or elbow made from segments of DR 11 pipe is pressure rated the same as DR 13.5 system pipe.