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Vacuum / External Pressure Applications for PVC Pipe

Applications for PVC pipe can sometimes include vacuum and/or external pressure. An example of a vacuum application could be when a length of PVC pipe is used on the suction end of a pump. Examples of external pressure include pipe submerged in water and some well-casing applications.

In terms of forces acting on the pipe, there is no difference between vacuum and external pressure. In either case, greater pressure exists on the outside of the pipe than on the inside. However, it should be remembered that the maximum external pressure achievable from vacuum alone is the atmospheric pressure, or about 15 lbs/in² at sea level.

The mode of failure for cases of external pressure is wall buckling. The external pressure at which failure occurs is called the Critical Pressure, or P_{cr} . P_{cr} can be calculated for different types of PVC pipe. The following three cases show how this can be done.

Calculations for Critical Pressure

Case 1 *Unsupported, Unburied Pipe With No Diametric Deflection*

Equation 1:

Note: *Applicable for solid wall pipes only. See Equation 2 for profile wall pipes.*

$$P_{cr} = \frac{2E}{0.856 (DR-1)^3}$$

Where:

P_{cr} = Critical Pressure (lbs/in²)

DR = Dimension Ratio of PVC Pipe
= Average OD/Minimum Wall

E = Modulus of Elasticity for PVC Pipe material (lbs/in²)

At 73°F, E has the following values:

PVC Cell Class 12454: 400,000 (lbs/in²)
PVC Cell Class 12364: 440,000 (lbs/in²)

The PVC value for E decreases with increasing temperature. For higher temperatures, multiply the value at 73° by the correction factors in Table 1.

Table 1 *Temperature Corrections for E*

| | | |
|----------|-------------|------|
| At 90°F | Multiply by | 0.93 |
| At 100°F | Multiply by | 0.88 |
| At 110°F | Multiply by | 0.84 |
| At 120°F | Multiply by | 0.79 |
| At 130°F | Multiply by | 0.75 |
| At 140°F | Multiply by | 0.70 |

For profile wall pipes (e.g. PWRib), the equation becomes:

Equation 2:

$$P_{cr} = 0.522 \times (PS)$$

Where:

PS = Pipe Stiffness (lbs/in/in)

Note: Obtain PS from manufacturer's literature or contact the manufacturer.

For temperatures above 73°F, multiply the result from Equation 2 by the appropriate E correction factor from Table 1.

