

COLLAPSE

WHAT IS THE MINIMAL WALL THICKNESS REQUIRED TO RESIST COLLAPSE DUE TO AN EXTERNAL HYDROSTATIC PRESSURE IN A WATER DEPTH OF 2,000?

In addition to the above considerations, it can also be of interest to note that a pipeline with 0.531-inch can safely resist external pressure collapse at 2,000 ft water depth, even if there is total depressurization of the pipeline. Following API 111, section 4.3.2.1 and equations 9 through 12, the following is obtained for the collapse pressure, Pc:

PLASTIC COLLAPSE

$$P_y = 2 \cdot SMYS \cdot \left(\frac{t}{D} \right)$$

$$P_y = 2 \cdot 60,000 (0.531/18.00)$$

$$P_y = 3,540 \text{ psi}$$

ELASTIC COLLAPSE

$$P_e = 2 \cdot E \cdot \frac{\left(\frac{t}{D} \right)^3}{(1-\nu^2)}$$

$$P_e = 2 \cdot 29,000,000 \cdot (0.531/18.00)^3 / (1-0.3^2) \text{ psi}$$

$$P_e = 58,000,000 \cdot 2.567 \cdot 10^{-5} / (1-0.09) \text{ psi}$$

$$P_e = 1,489 / 0.91 \text{ psi}$$

$$P_e = 1,636.0 \text{ psi}$$

PIPE COLLAPSE CAPACITY

$$P_c = \frac{P_y \cdot P_e}{\sqrt{P_y^2 + P_e^2}}$$

$$P_c = 3,540 \cdot 1,636 / \sqrt{3,540^2 + 1,636^2} \text{ psi}$$

$P_c = 5,791,440 / 3,900$

$P_c = 1,485 \text{ psi}$

SAMPLE

Using the API 1111 section 4.3.2.1 collapse safety factor of 0.6,

MAXIMUM ALLOWABLE EXTERNAL WATER PRESSURE IS

$$Po\text{-max} = 0.6 * Pc$$

$$Po\text{-max} = 0.6 * 1,485 \text{ psi}$$

$$Po\text{-max} = 891 \text{ psi}$$

Since the above pressure $Po\text{-max}$ is greater than the external water pressure of 889 psi, the above demonstrates:

THIS ANSWER OF 0.531 IS THE ABSOLUTE MINIMUM WALL THICKNESS FOR THE PIPELINE TO SAFELY OPERATE IN 2,000 FEET OF WATER WITHOUT ANY FEAR OF COLLAPSE.