

Preliminary of Piping and Pipeline Engineering

Fundamentals

The seven fundamental areas of competence in the mechanical engineering discipline are (1) materials, (2) design, (3) construction, (4) inspection, (5) testing, (6) maintenance, and (7) operations.

In each of the seven fundamental areas, the responsible engineer must make a series of decisions to achieve the optimum and most cost-effective operation. The following checklists summarize the key decision points related to piping and pipeline activities.

Piping Design

1. Internal Pressure

1.1 Pressure Design of Piping

1.1.1 Thin wall approximation

Consider a straight section of pipe filled with a pressurized liquid or gas. The internal pressure generates three principal stresses in the pipe wall: as illustrated in Figure 1-1: a hoop stress σ_h . When the ratio of the pipe diameter to its wall thickness D/t is greater than 20 the pipe may be considered to be thin wall. In this case, the hoop stress is nearly constant through the wall thickness and equal to

$$\sigma_h = \frac{PD}{2t}$$

P = design pressure, psi

D = outside pipe diameter, in

t = pipe wall thickness, in

The longitudinal stress is also constant through the wall and equal to half the hoop stress

$$\sigma_l = \frac{PD}{4t}$$

The radial stress varies through the wall, from P at the inner surface of the pipe to zero on the outer surface.

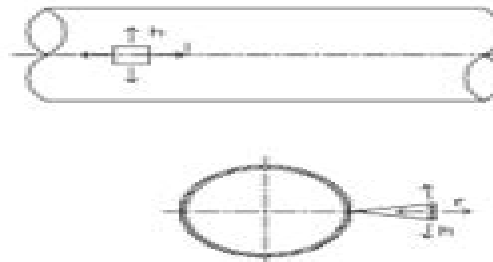


Figure 1-1 : Hoop(h), Longitudinal(l) and Radial(r) Stress Directions

1.1.2 Pipeline design equation

For oil and gas pipelines, the thickness of the pipe wall is obtained by writing that the hoop stress, which is the largest stress in the pipe, must be limited to a certain allowable stress S . Using the thin wall approximation, this condition corresponds to

$$\frac{PD}{2t} < S$$

P = internal design pressure, psi

D = pipe outer diameter, in

t = pipe wall thickness, in

S = allowable stress, psi

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M Mosston



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