DETERMINING THE D.O.T. GAS STORAGE CYLINDER DERATING FACTOR FOR A.S.M.E. SERVICE

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The American Society of Mechanical Engineer's Boiler and Pressure Vessel Code[1] (A.S.M.E. Code) and the Department of Transportation Specifications[2] (D.O.T. Specs.) have differing requirements for constructing and rating pressure vessels. Because the laboratory may in some instances be unwilling to maintain its cylinders to the more stringent requirements of the D.O.T. Specs., a derating factor may be applied to lower the maximum allowable pressure to the A.S.M.E. Code value. This memo details the determination of that derating factor.

The A.S.M.E. Code uses a factor of safety of working stress (σ_{ASME}) to ultimate tensile stress (σ_{ULT}) of 4 to 1 or:

$$\sigma_{ASME} = .25 \times \sigma_{ULT}$$

The working stress is used in the following equation to obtain the maximum allowable working pressure.[3]

$$P_{ASME} = \frac{\sigma_{ASME} \times t}{(R + .6t)}$$

Where

P_{ASME} = maximum allowable A.S.M.E. working pressure (psi)

R = inside radius (inches)

t = thickness (inches)

The D.O.T. allows a much lower factor of safety for its working stress to ultimate strength because of the stringent retesting procedures required.[4] The working stress (σ_{DOT}) to ultimate tensile stress relation for 3AA vessels[5] rated above 900 psi

is:

$$\sigma_{DOT} = .67 \times \frac{3}{5} \times \sigma_{ULT} = .402 \times \sigma_{ULT}$$

These standards use a different and less conservative equation to determine maximum allowable working pressure:

$$P_{DOT} = \frac{\sigma_{DOT}((R + t)^2 - R^2)}{1.3\ (R + t)^2 + 0.4\ R^2}$$

Where

P_{DOT} = maximum allowable D.O.T. working pressure (psi)

Thus, the ratio of allowable pressures may be derived by substitution:

$$\frac{P_{ASME}}{P_{DOT}} = \frac{.622 \times t \times (1.3\ (R + t)^2 + 0.4(R)^2}{((R + t)^2 - R^2) \times (R + .6t)}$$

For a 8" i.d., .35 wall cylinder this factor computes to .55 or 55%.

FOOTNOTES

[1] A.S.M.E. BOILER AND PRESSURE VESSEL CODE, Section VIII, "Rules for Construction of Pressure Vessels," Division 1, 1977 Edition.

[2] Department of Transportation, Title 49, par. 178.36 et al. of Subpart C, "Specifications for Cylinders."

[3] Ibid 1, Sec. VIII, par. UG-27 (c)

[4] Ibid 2, Title 49, par. 173.34, "Qualification, Maintenance and Use of Cylinders."

[5] Ibid 2, par. 178.37-10 (b) and (c)