Compound Cylinder Strain Based Analysis of SRS

Geometry and Material Properties of SRS

Young's Modulus of PTFE liner Material $E_1 := 56.6\ ksi$
Thickness of PTFE liner $t_1 := 0.0015\ in$
Yield Strength of PTFE liner $\sigma_{1y} := 2.9\ ksi$

Young's Modulus of Nylon 12 Material $E_2 := 220.3\ ksi$
Thickness of Nylon Jacket $t_2 := 0.008\ in$
Poisson Ration of Nylon $\nu_2 := 0.45$
Yield Strength of Nylon Tube $\sigma_{2y} := 6.35\ ksi$

Inner radius of the tube $R := 0.1205\ in$

Theory of Compound Cylinders :

Derivation of Equation for Effective stress in a cylinder when subjected to a radial strain:

Tangential or hoop stress of thin cylinder, $\sigma_h = \frac{P \cdot R}{t}$ --------Eq 1

where P= Internal Pressure
R= Inner Radius
t= thickness of cylinder

By Hooke's law, $\varepsilon_r = \frac{\sigma_h}{E}$

$$\frac{\delta_r}{R} = \frac{\sigma_h}{E}$$ --------Eq 2

where ε_r =Radial Strain

σ_h =Hoop/tangential stress

E= Youngs modulus

From Equations 1 and 2, Radial displacement of cylinder $\delta_r = \frac{P \cdot R^2}{t \cdot E}$

Effective Stress in SRS due to Radial Strain

When a THV is extruded into the SRS, the radial displacement of the SRS is observed to be 0.0075". Since PTFE liner, Nylon are bonded together, the radial displacements of these 2 tubes are equivalent.

$$\delta_{PTFE} := 0.0075\ in$$
$$\delta_{Nylon} := 0.0075\ in$$

The internal pressure acting on PTFE liner when it is subjected to the given radial displacement is

$$P_i := \frac{\delta_{PTFE} \cdot t_1 \cdot E_1}{R^2}$$
$$P_i = 0.044\ ksi$$

The hoop stress in PTFE liner

$$\sigma_{hPTFE} := P_i \cdot \frac{R}{t_1}$$
$$\sigma_{hPTFE} = 3.523\ ksi$$

The internal pressure acting on the Nylon when it is subjected to the given radial displacement is

$$P_{iNylon} := \frac{\delta_{Nylon} \cdot t_2 \cdot E_2}{R^2}$$
$$P_{iNylon} = 0.91\ ksi$$

The hoop stress in Nylon

$$\sigma_{hNylon} := P_{iNylon} \cdot \frac{R}{t_2}$$
$$\sigma_{hNylon} = 13.712\ ksi$$

The Factor of Safety for SRS Nylon when THV subjects it to 0.0075" radial displacement $f_{nylon} := \frac{\sigma_{2y}}{\sigma_{hNylon}}$

$$f_{nylon} = 0.463$$

The Factor of Safety for SRS PTFE liner when THV subjects it to 0.0075" radial displacement $f_{PTFE} := \frac{\sigma_{1y}}{\sigma_{hPTFE}}$

$$f_{PTFE} = 0.823$$