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Thermal Expansion (referencing our Plausability Experiment)

Calculating the change in length of Titanium and 4340 steel due to thermal expansion.

$\Delta L = \alpha \Delta T L$ (hyperphysics.phy-astr.gsu.edu)

$\Delta L \approx$ change in length
$\alpha \approx$ coefficient of thermal expansion
$\Delta T \approx$ change in temperature
$L \approx$ initial length

$\Delta T = T_f - T_o$, $L = 3\text{ in} = 0.0762\text{ m}$

$T_o = 68°F = (68-32)\frac{5}{9} = 20°C$

$T_f = 2100°F = (2100-32)\frac{5}{9} = 1148.89°C$

α (4340 steel) $= 12.3 \frac{\mu m}{m\text{-}°C}$ @ 20°C

α (Titanium) $= 8.90 \frac{\mu m}{m\text{-}°C}$ @ 20°C

(matweb.com)

$\Delta L_{4340} = (12.3\times10^{-6}) \frac{m}{\cancel{m}\text{-}\cancel{°C}} (1148.89-20)\cancel{°C}\ (0.0762)\cancel{m} = 0.00106\text{ m} = 1.06\text{ mm}$

$\Delta L_{Ti} = (8.90\times10^{-6}) \frac{m}{\cancel{m}\text{-}\cancel{°C}} (1148.89-20)\cancel{°C}\ (0.0762)\cancel{m} = 0.000766\text{ m} = 0.766\text{ mm}$

The test bilet will expand in two directions, so therefore the detectable expansion is:

$$\frac{\Delta L}{2} = \frac{1.06\text{ mm}}{2} = 0.530\text{ mm} > 0.1\text{ mm}$$

which is greater than the resolution, and therefore thermal expansion will be detected.

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SIGNATURE Kevin L Corning

DATE 2/14/12

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