AMERITHERM INC.™

Calculations For Shrink Fitting

The amount that a particular metal will expand can be calculated using the coefficient of thermal expansion:

$$\delta = \alpha L(\Delta t)$$

δ = Total deformation desired (in or mm)
α = Coefficient of thermal expansion (in/in °F or mm/mm °C)
L = Nominal length of the part being heated (the diameter for a cylinder) (in or mm)
Δt = Temperature difference (°F or °C)

The coefficient of thermal expansion (α) for a particular metal can be found in Table 1.
The amount of holding stress developed once contraction of the outer hole has occurred can be calculated:

$$S_t = \frac{E * \Delta D}{4 * a}\left(1 + \frac{a^2}{b^2}\right) \qquad S_r = \frac{E * \Delta D}{4 * a}\left(1 - \frac{a^2}{b^2}\right)$$

- S_t and S_r = Tangential and radial stresses developed between the collar and the shaft.
- 'a' and 'b' = Internal and external radii of the collar
- E = Elastic modulus

ΔD = Change of inner diameter of hole.

Table 1: Coefficient of Thermal Expansion and Elastic Modulus

Material	Coefficient of thermal expansion, α In/in °F	mm/mm °C	Elastic Modulus (E) psi (at 70°F)
Steel:			
AISI 1020	6.5×10^{-6}	11.7×10^{-6}	30×10^{6}
AISI 1050	6.1×10^{-6}	11.0×10^{-6}	29×10^{6}
AISI 4140	6.2×10^{-6}	11.2×10^{-6}	
Stainless Steel:			
AISI 301	9.4×10^{-6}	16.9×10^{-6}	28.0×10^{6}
AISI 430	5.8×10^{-6}	10.4×10^{-6}	29.0×10^{6}
Aluminum:			
2014	12.8×10^{-6}	23.0×10^{-6}	10.5×10^{6}
6061	13.0×10^{-6}	23.4×10^{-6}	
Bronze:	10.0×10^{-6}	18.0×10^{-6}	17×10^{6}

* The elastic of modulus will decrease as temperature increases. At 1000°F, E, will be 22×10^{6} for steel.

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