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Mohawk Innovative Technology, Inc.

Advanced Seals for General Aviation Engines

Mohawk Innovative Technology, Inc.

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NASA/GRC
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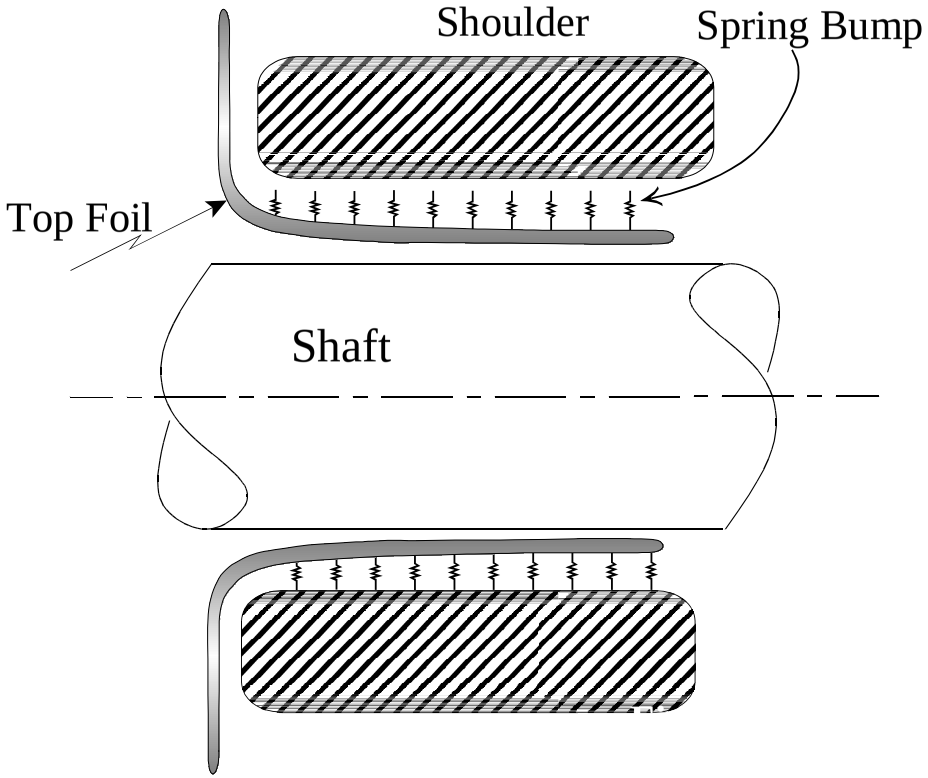
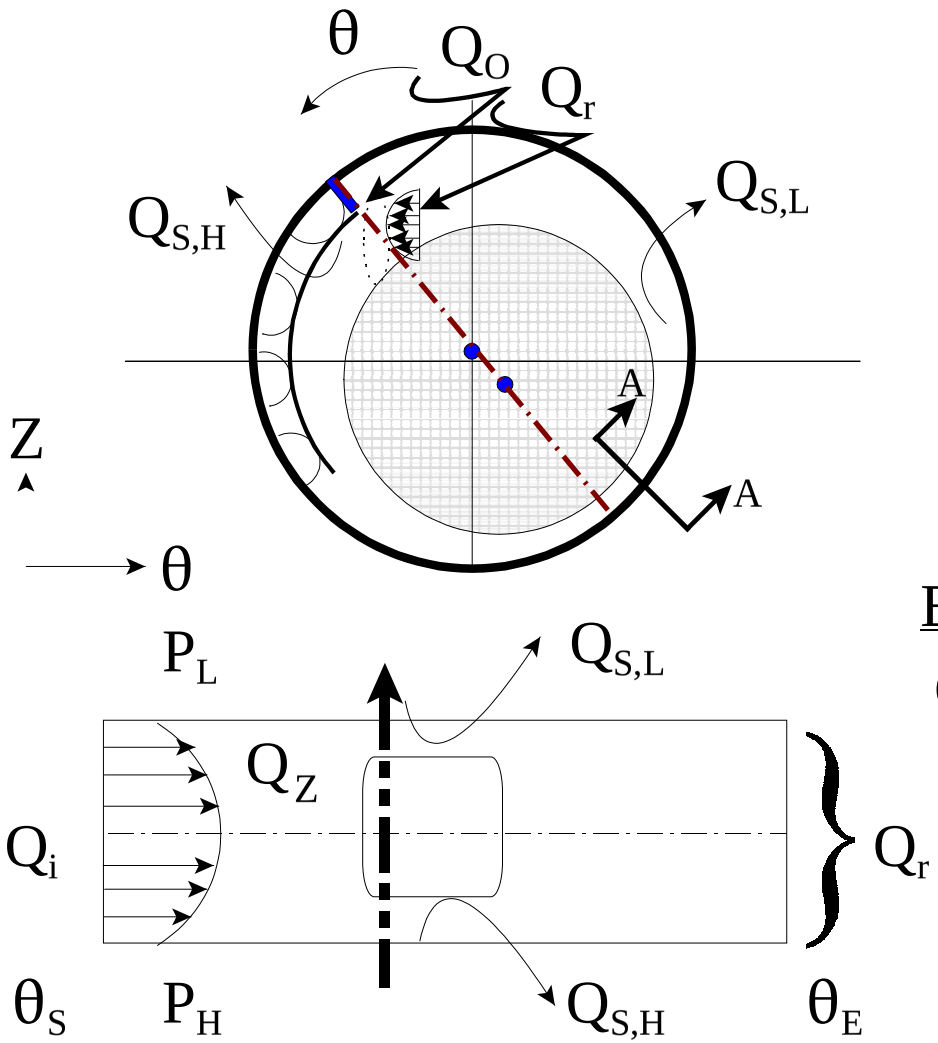
Compliant Foil Seal - Physical Model/prototype



A Simplified Flow Model & Thermal Effects in a Foil Seal



Side Flow

$$Q_S \approx Q_{S,L} + Q_{S,H}$$

$$Q_i \approx Q_r$$

Inlet

$$Q_i \approx Q_O + Q_r$$

$$T_i = f\,(T_O, T_r)$$

Energy Balance Approximation

$$Q_i\,T_i + H_{gen} \approx Q_S T_{S,avg} + Q_r\,T_{max,avg}$$

Governing Equations and Boundary Conditions

Reynolds Equation:

Velocity & Inertia

$$\frac{\partial}{\partial\theta}\left[\bar{P}\,\bar{h}^{3}\frac{\partial\bar{p}}{\partial\theta}\right]+\frac{\partial}{\partial\bar{z}}\left[\bar{P}\,\bar{h}^{3}\frac{\partial\bar{p}}{\partial z}\right]=\Lambda\frac{\partial}{\partial\theta}(\bar{P}\,\bar{h})$$

$\bar{z} = (Z/R)$ $\bar{p} = (P/P_L)$ $\bar{h} = (h/C)$

Film Thickness :

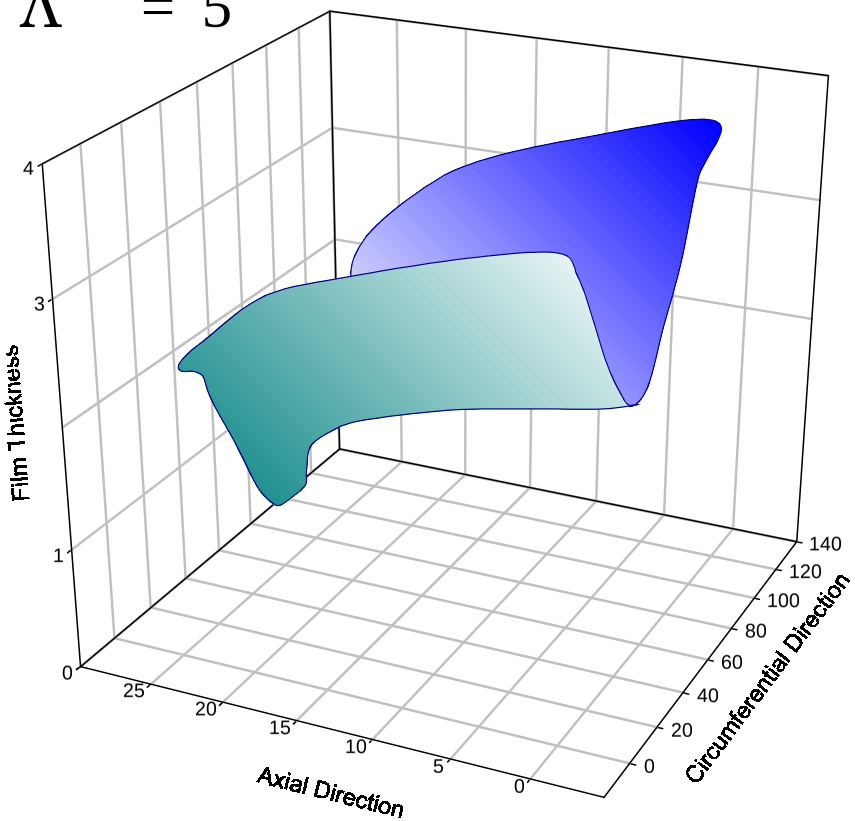
$$\mathbf{h = C + e\,Cos\,(\theta - \theta_0) + \overbrace{\sum K_{ij}\,(p_{eff} - P_N)}^{\text{Compliancy}}}$$

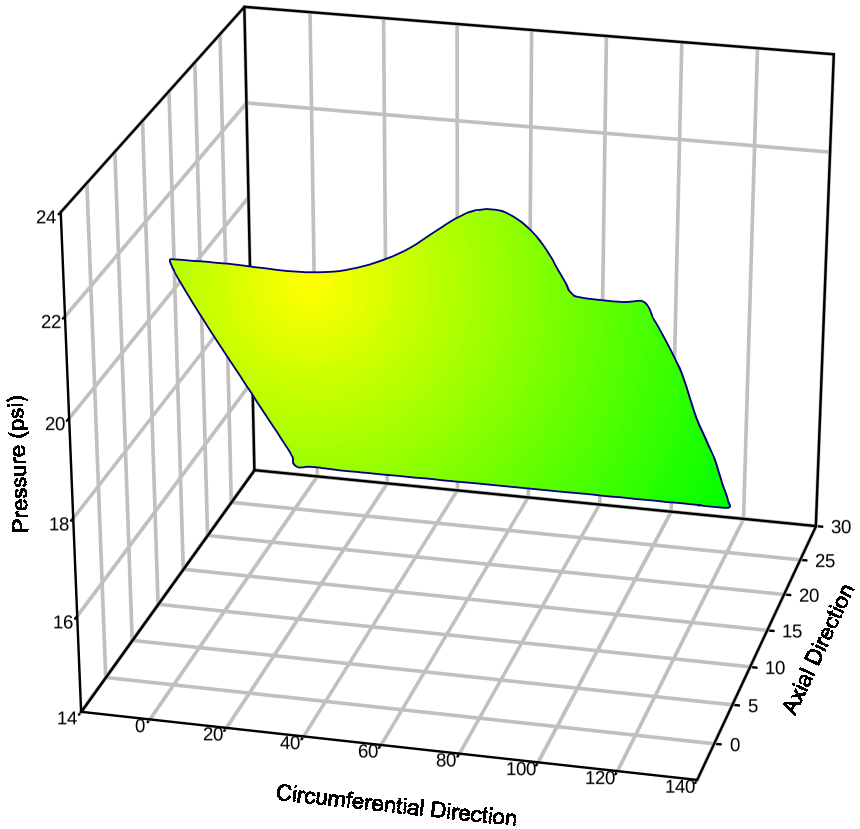
K_{ij} : The combined compliancy coefficeint

P_N: Normalized pressure behind foils

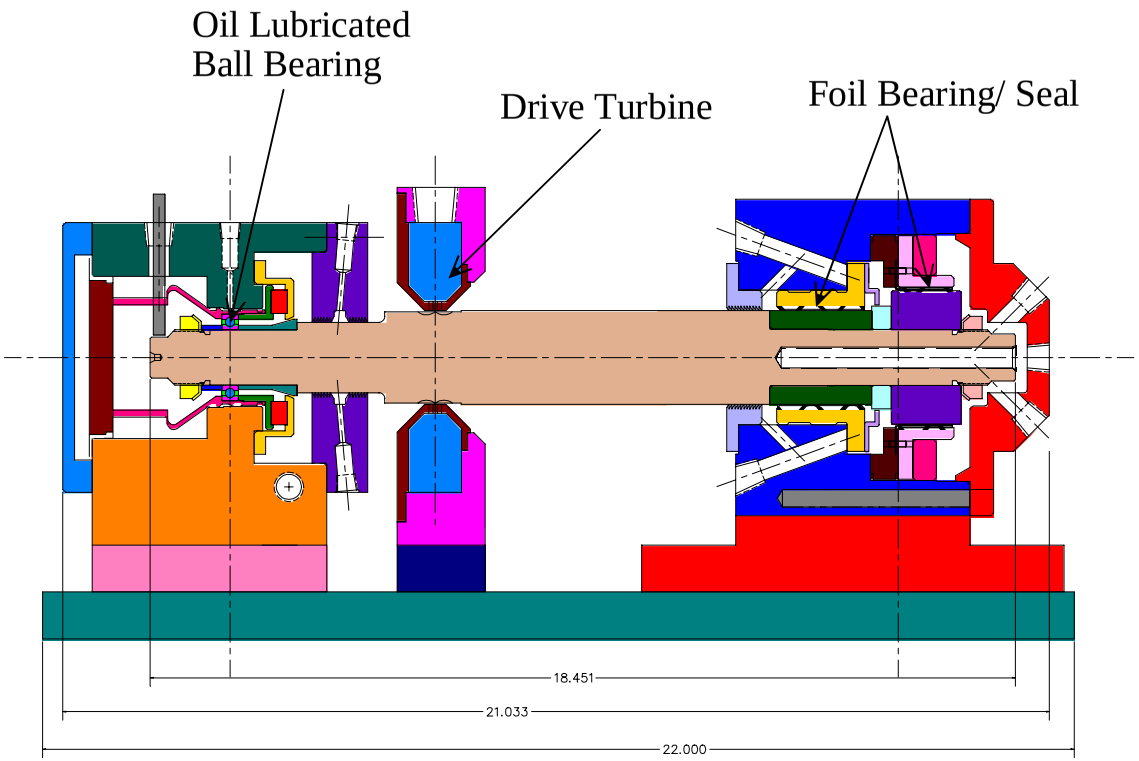
Film Thickness and Pressure Distribution

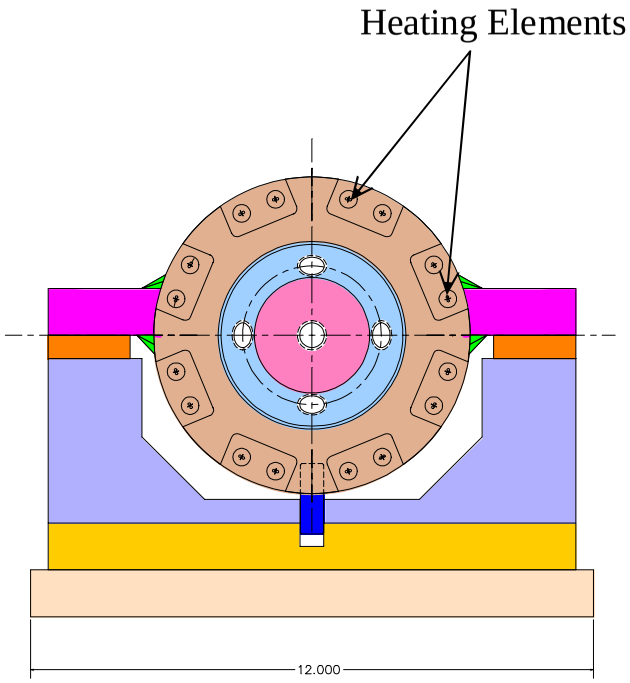
L/D = 0.5
ΔP = 7.5 psi
Λ = 5

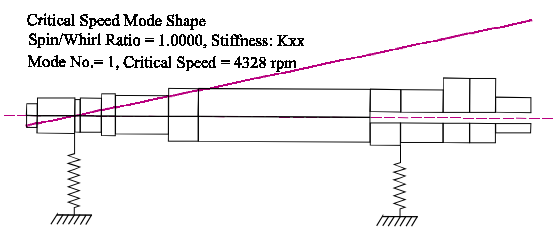


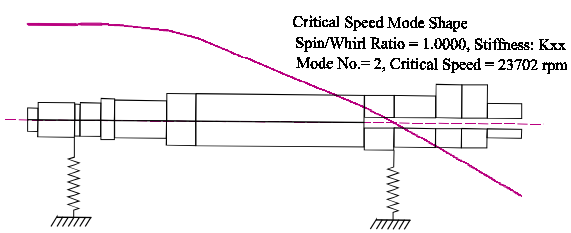


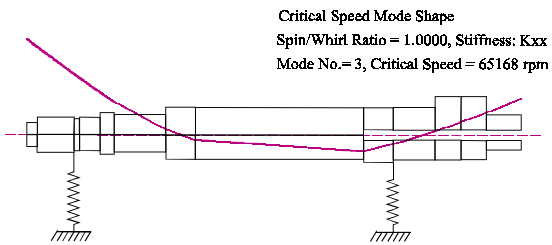
High Temperature Hybrid Bearing/Seal Dynamic Simulator



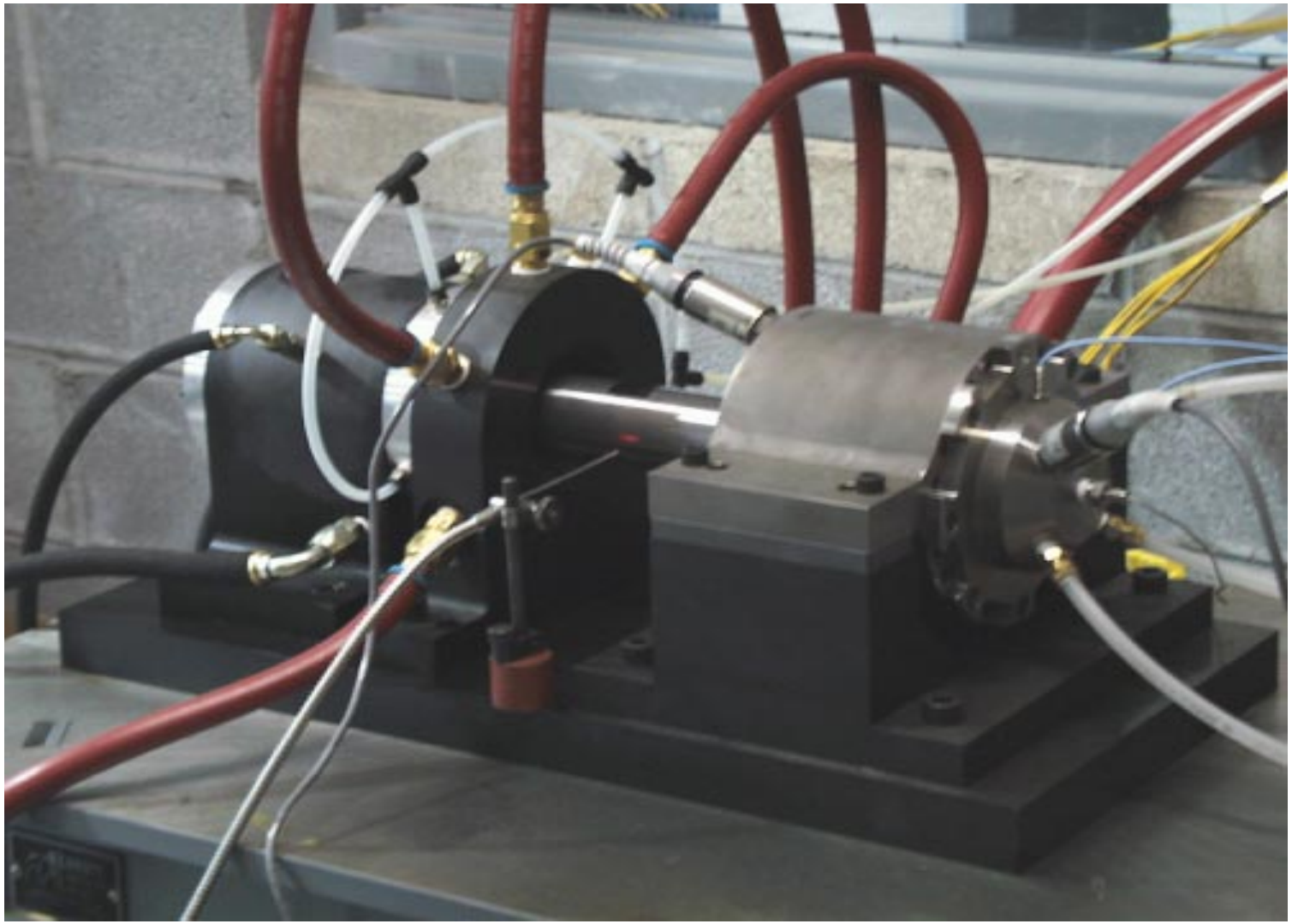






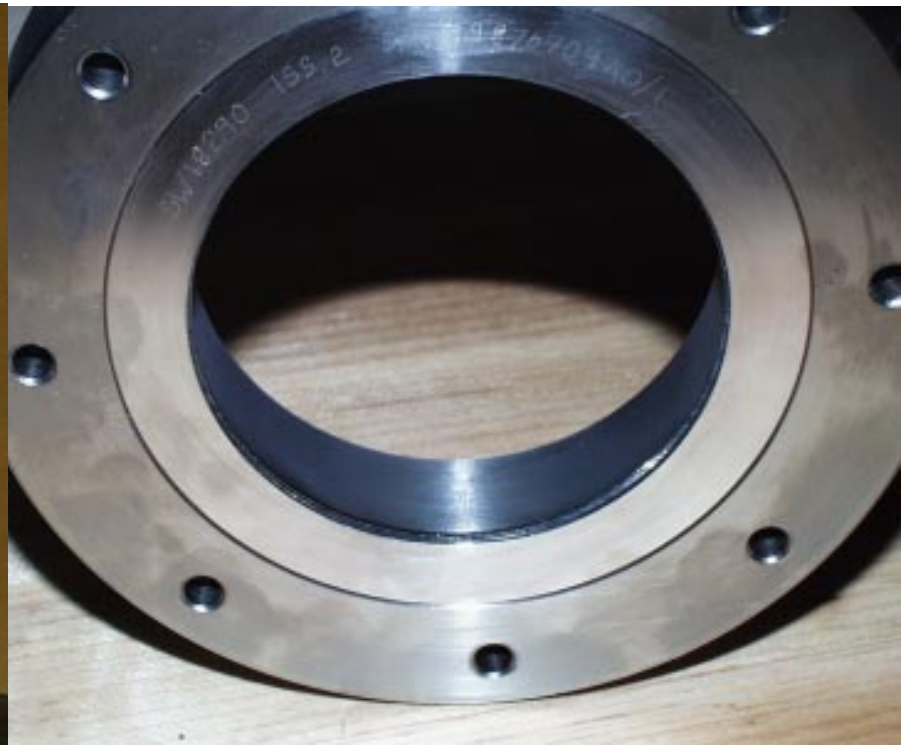


Instrumented Test Apparatus



Seals -Tested

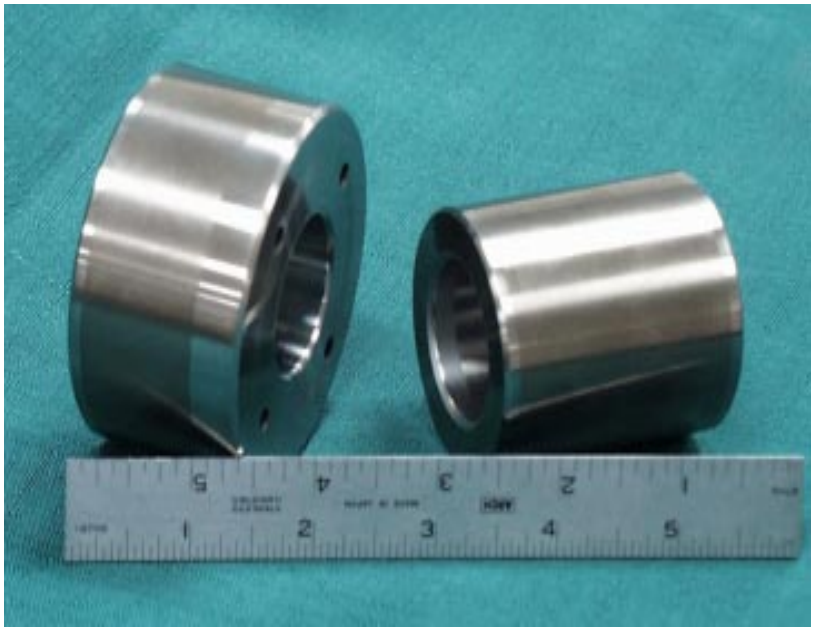
Compliant Foil Seal



Brush Seal

Fabricated by Cross MNFG CO. LTD

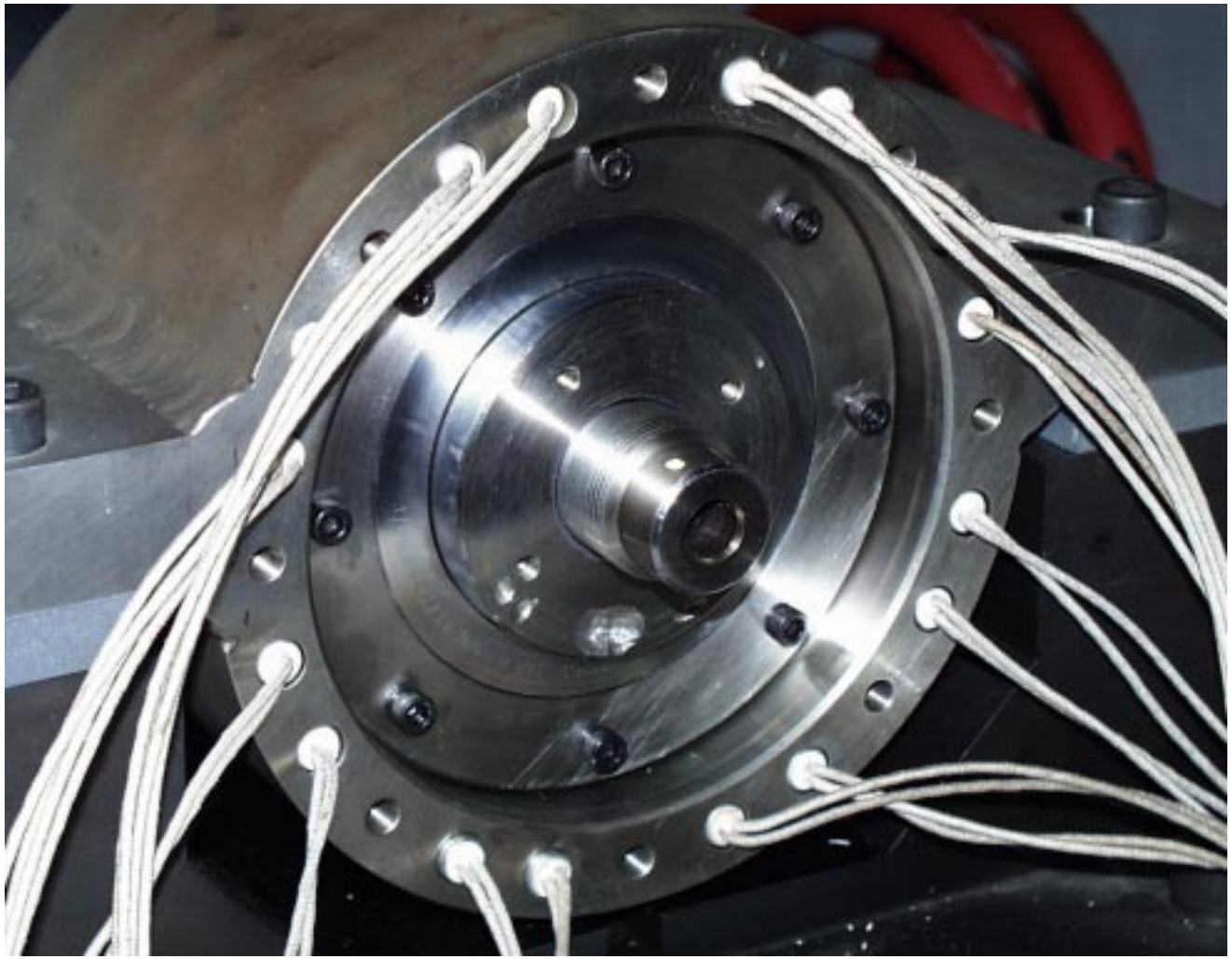
Journals for Compliant Surface Foil Seal/Bearing



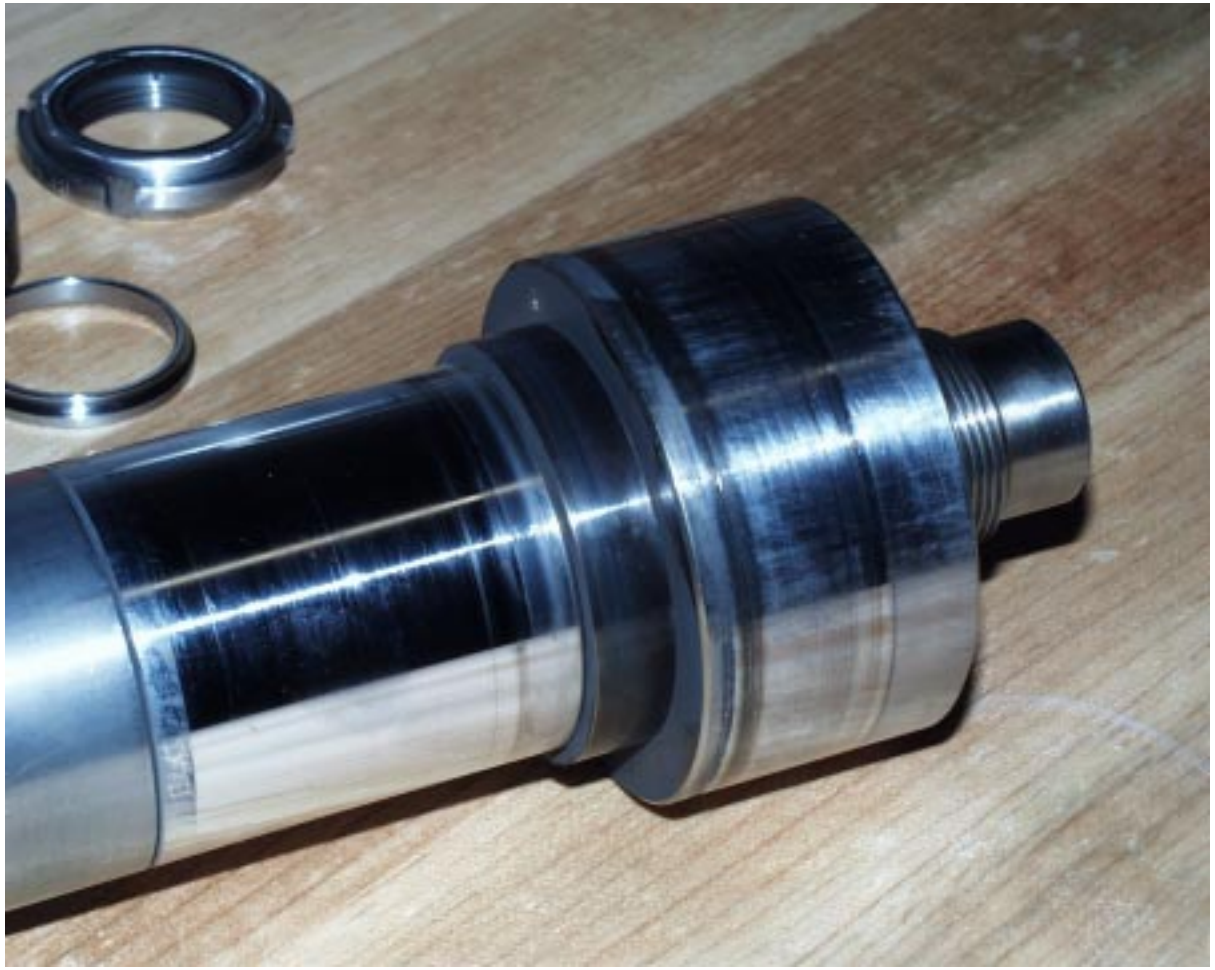
Low Temperature Journals

High Temperature Journals

Mounted Brush Seal

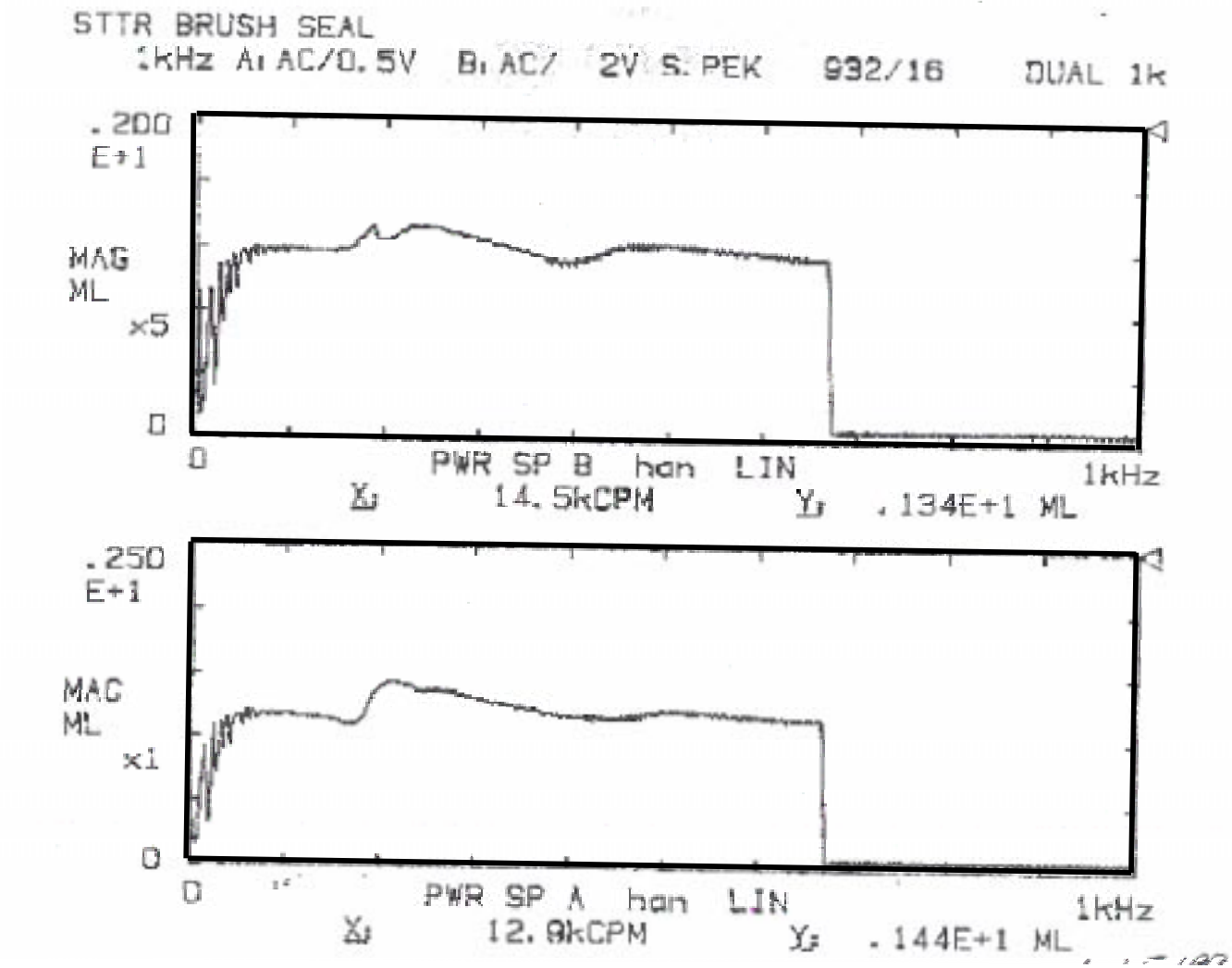


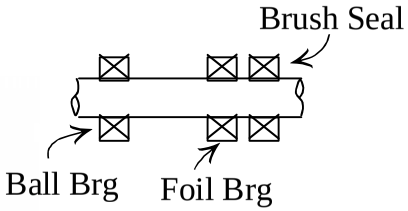
Wear Track from the Brush Seal



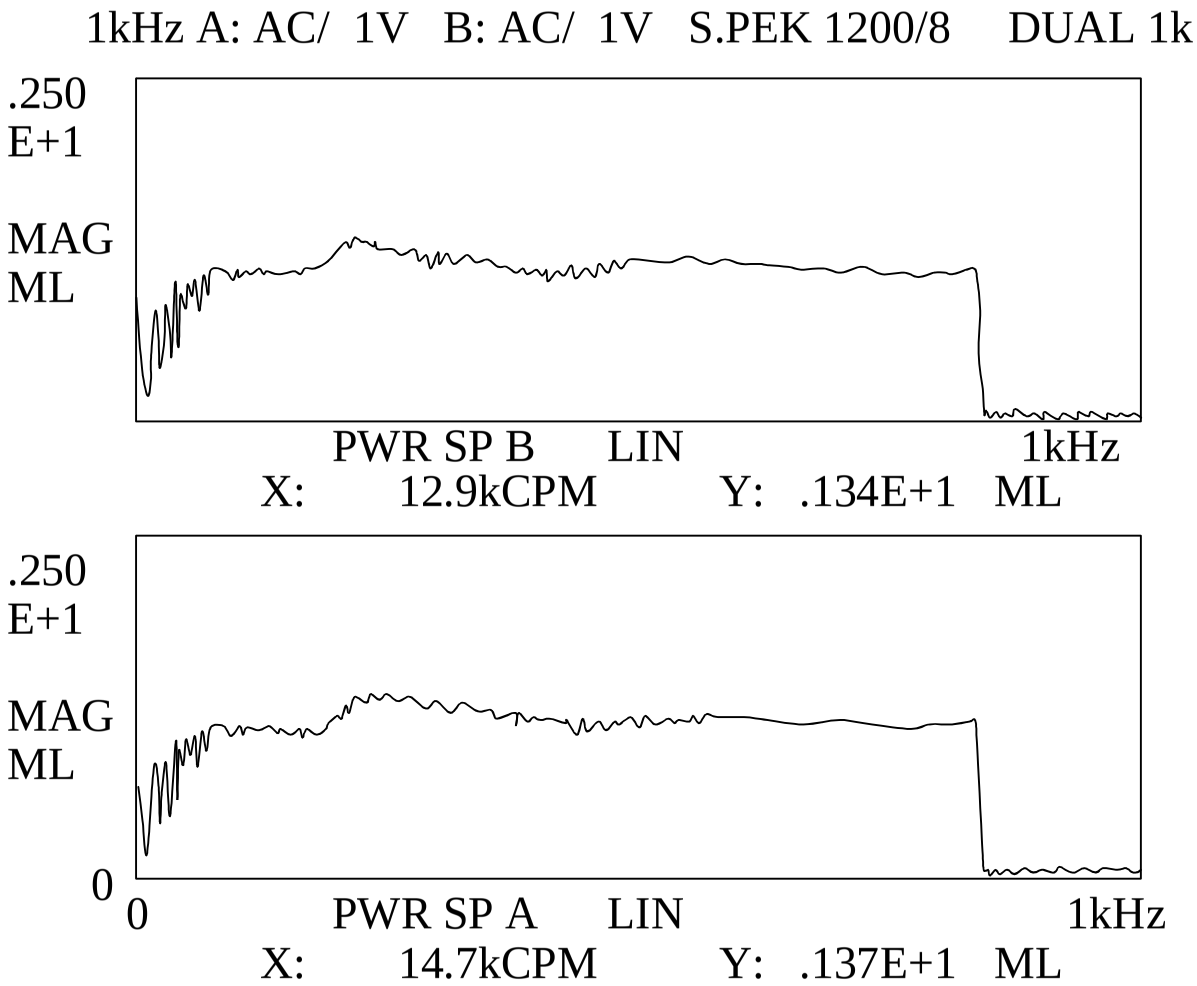
Coastdown on Brush Seal

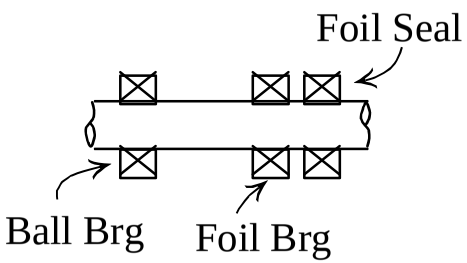
Max. Speed = 41,000 rpm
Max. Orbit size = 1.6 mil





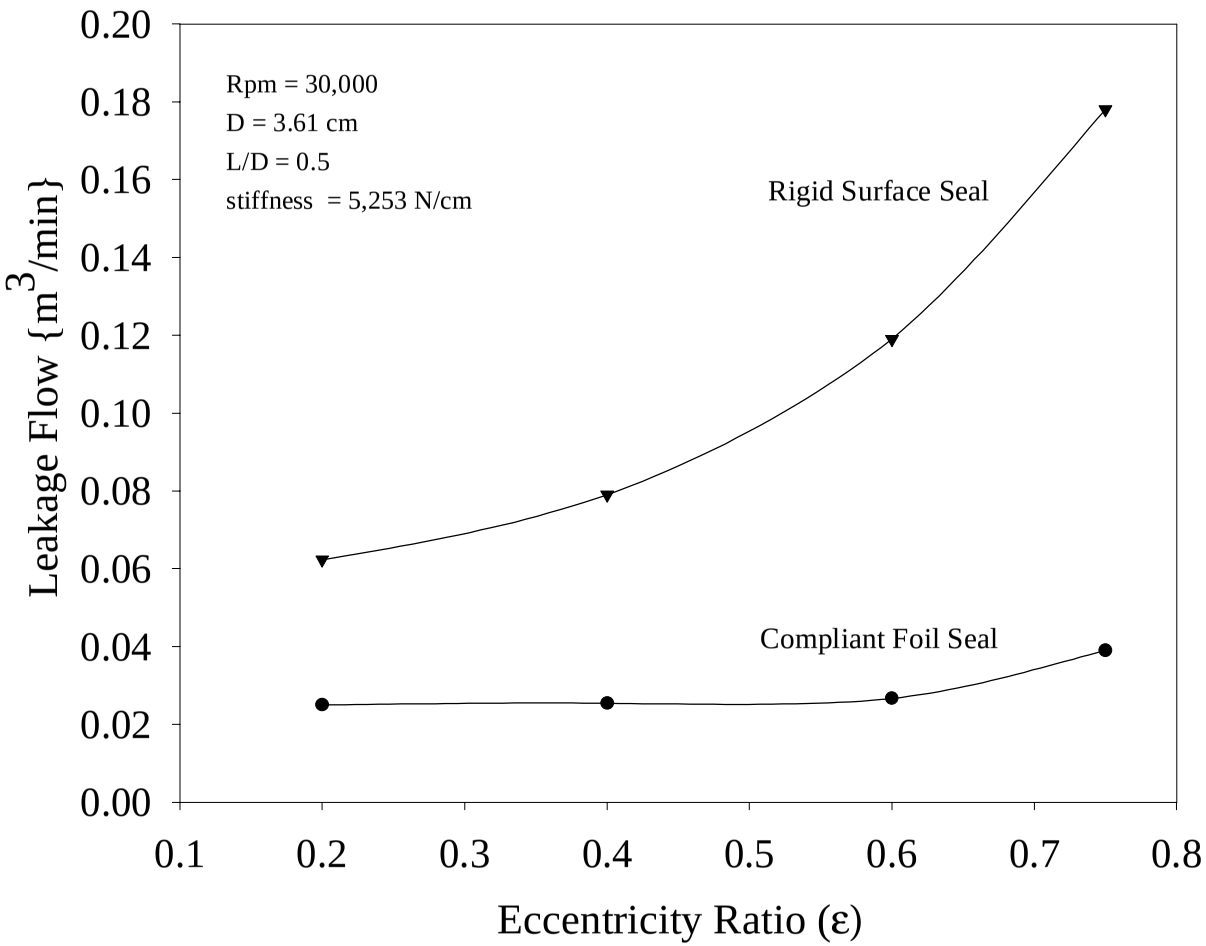
Coast Down at 56,000 rpm



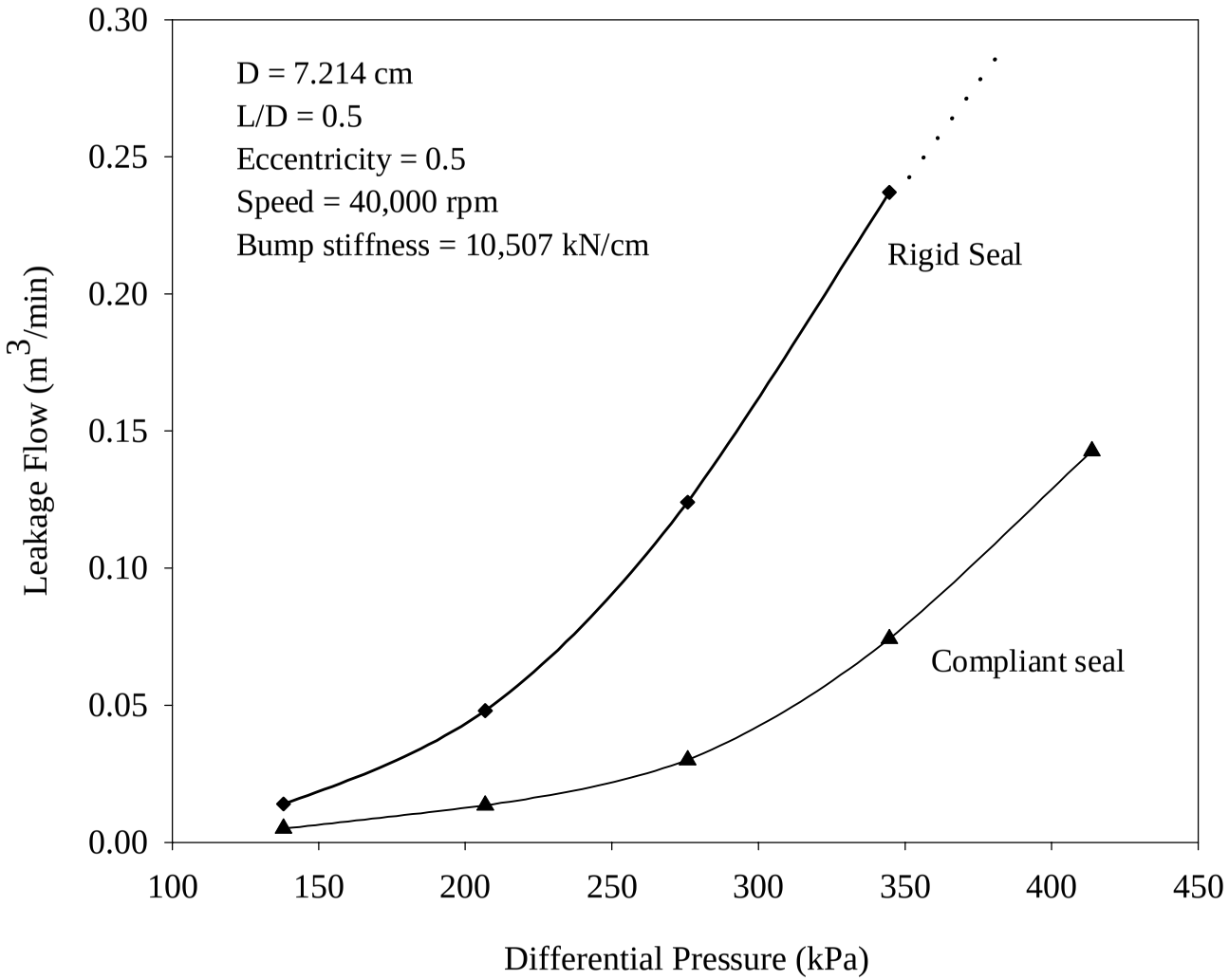


Run : T7R1

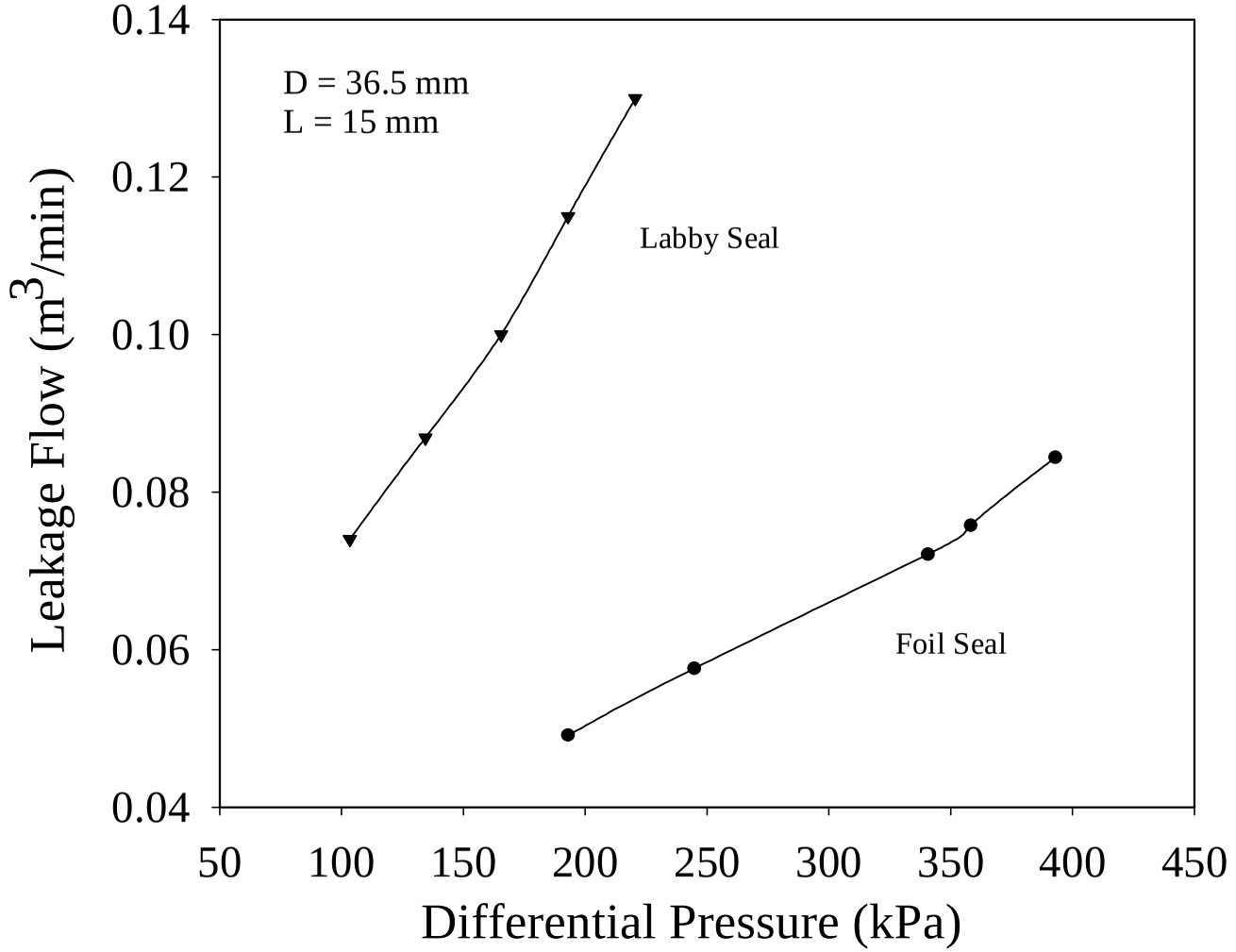
Analysis Prediction for Compliant vs Rigid Surface Seal



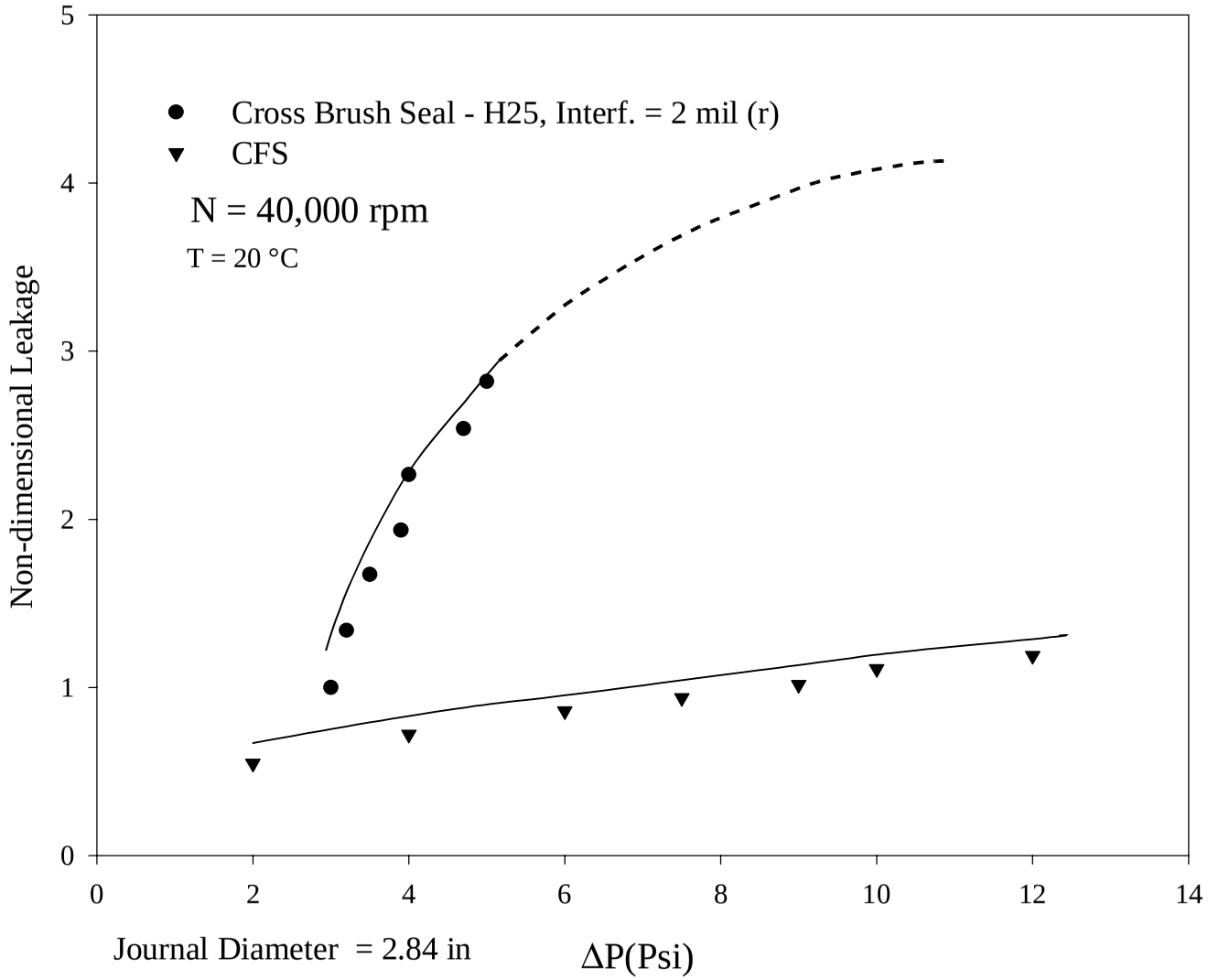
Analysis Prediction for Compliant vs Rigid Surface Seal



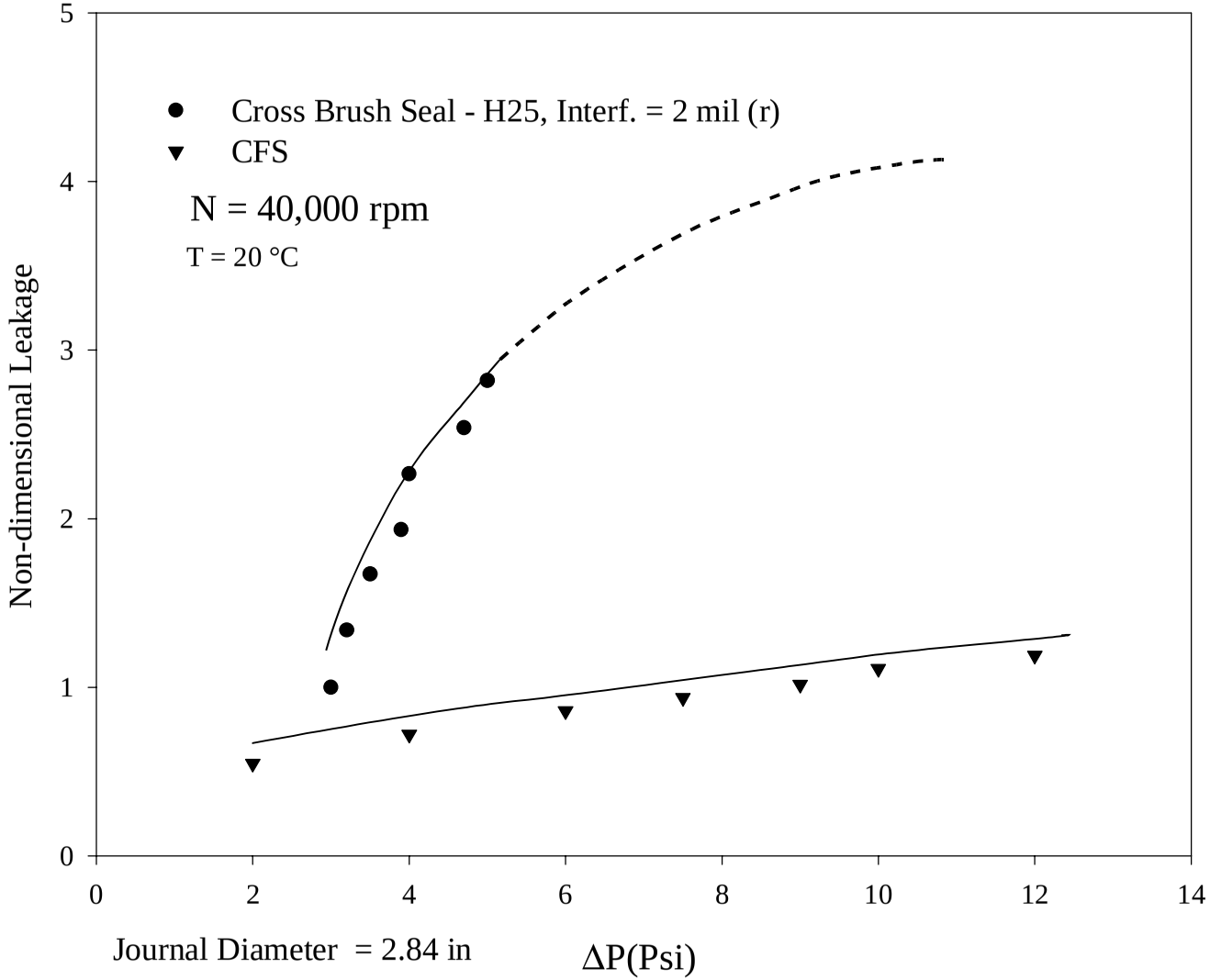
Compliant Seal vs Labby Seal - Static Test



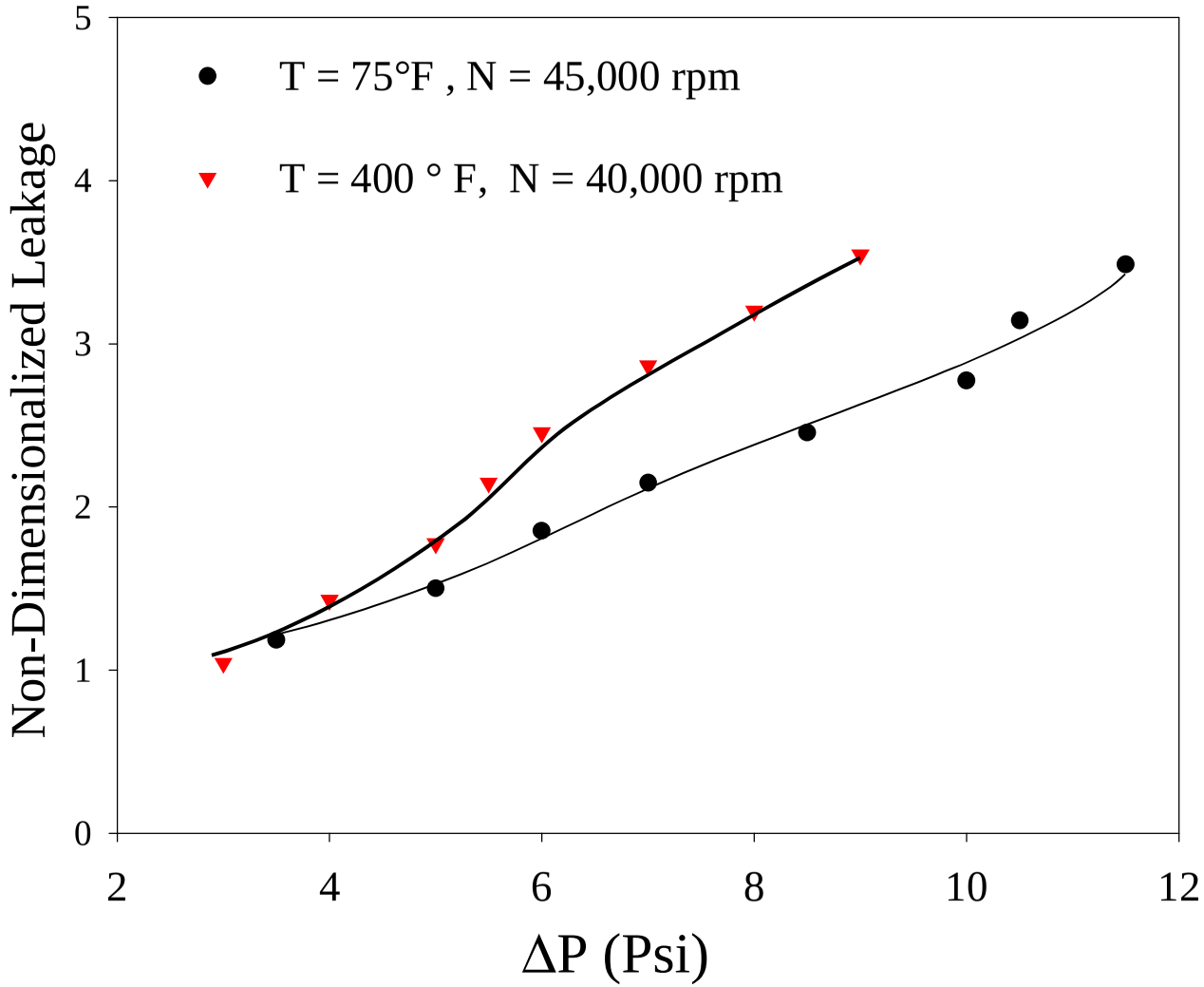
Compliant Foil Seal vs Cross™ Brush Seal



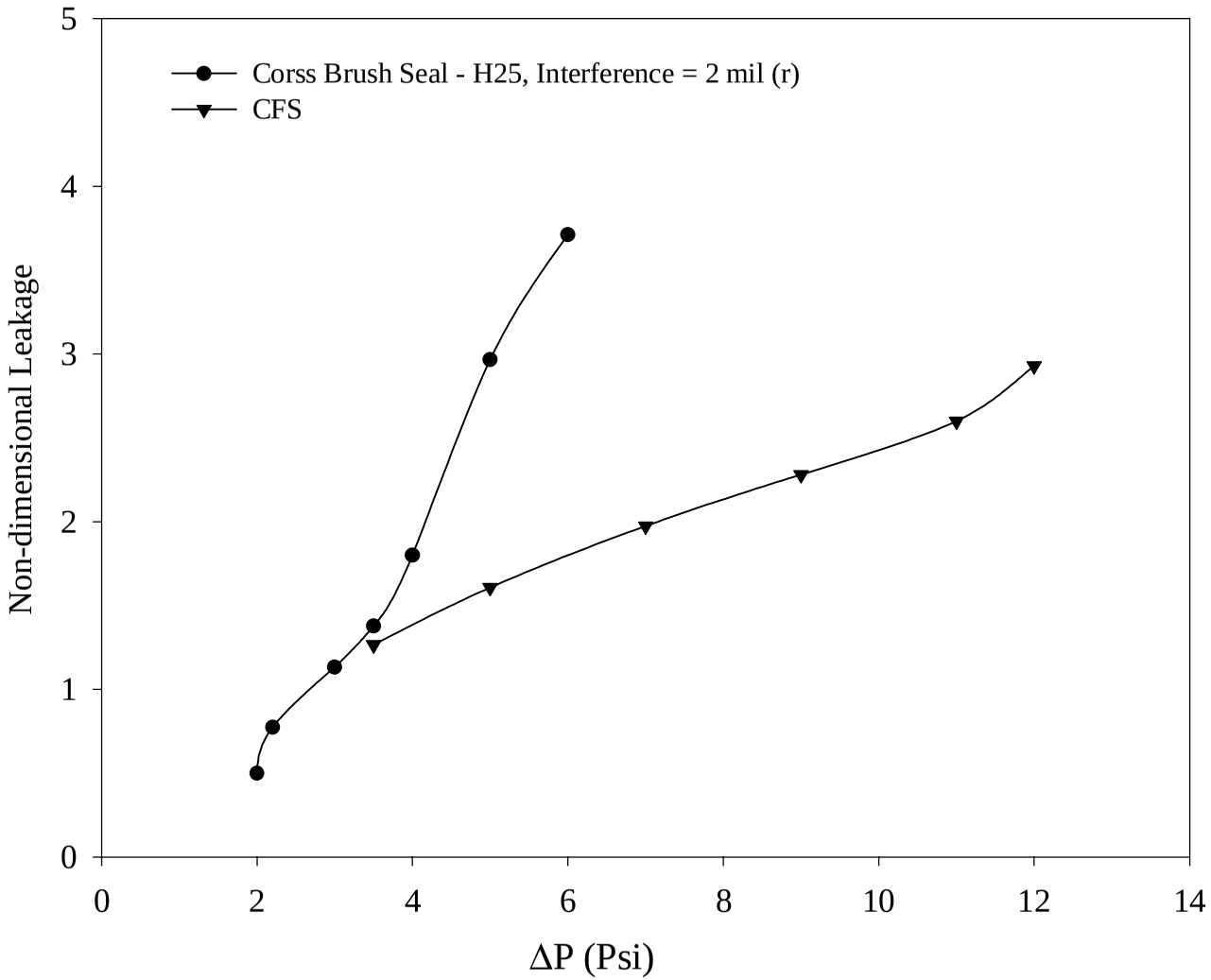
Compliant Foil Seal vs Cross™ Brush Seal



Compliant Seal Performance - Temperature Effect



Compliant Foil Seal vs Cross™ Brush Seal

Static Consition (N = 0 rpm)

Journal Diameter = 2.84 in