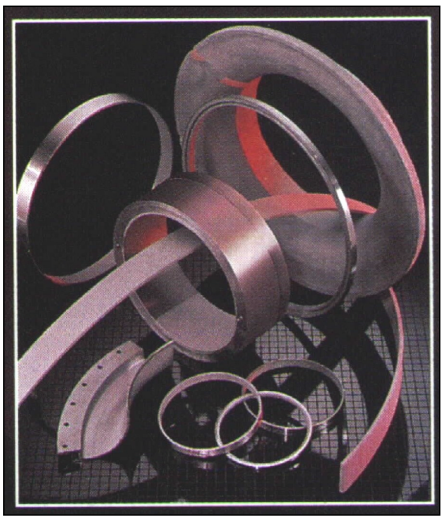
ABRADABLE SEAL DEVELOPMENTS AT TECHNETICS

Doug Chappel and Harold Howe
Technetics Corporation
Indianapolis, Indiana

Technetics
CORPORATION

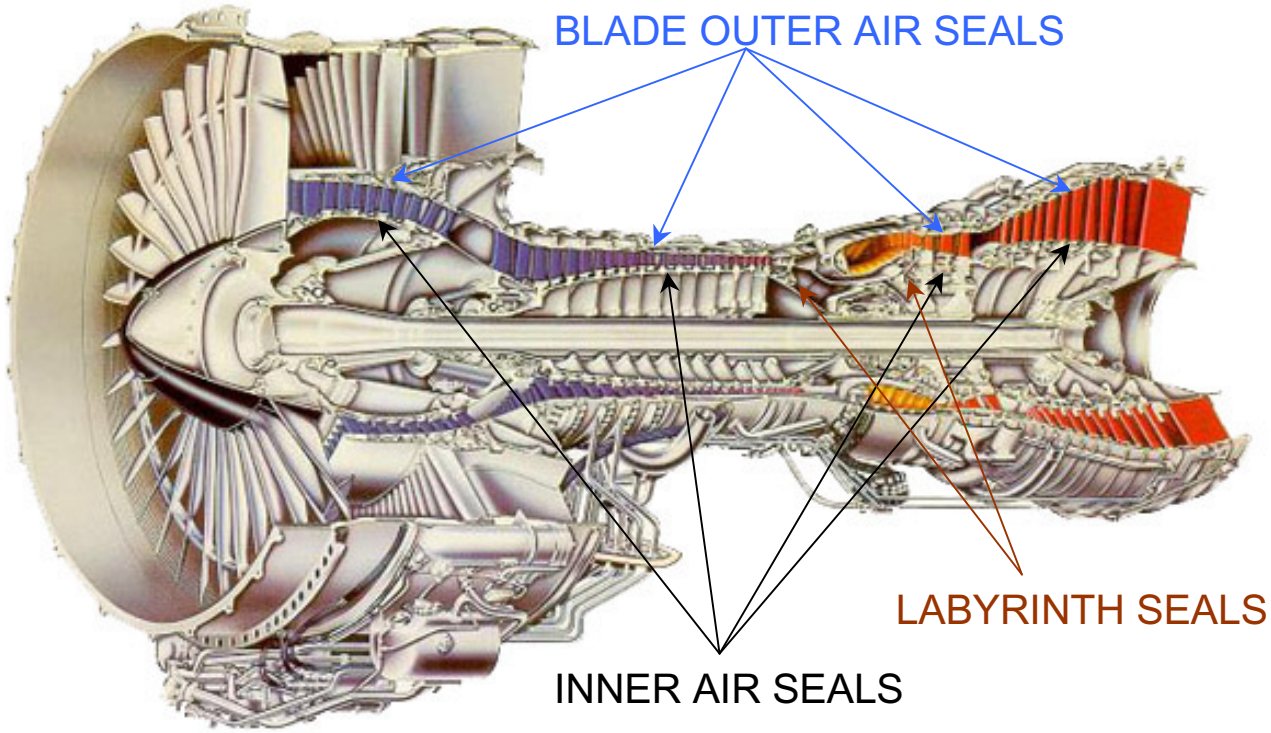


Abradable Seal Developments At Technetics

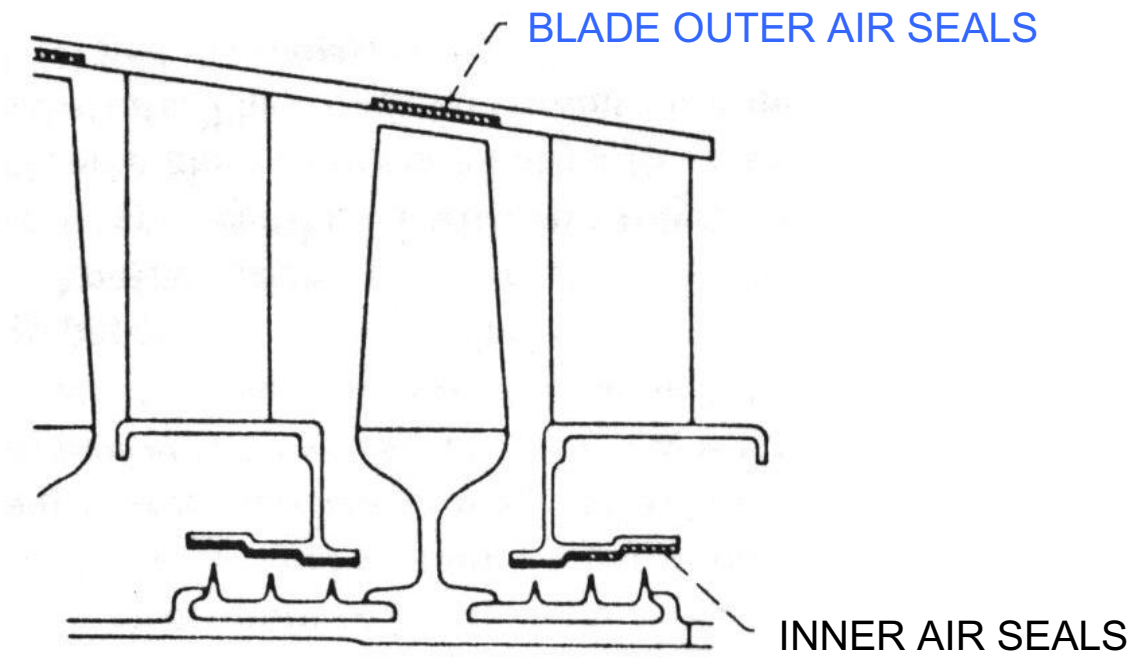
Doug Chappel
Harold Howe

NASA Seal / Secondary Air System Workshop
October 25, 2000

Typical Abradable Seal Applications

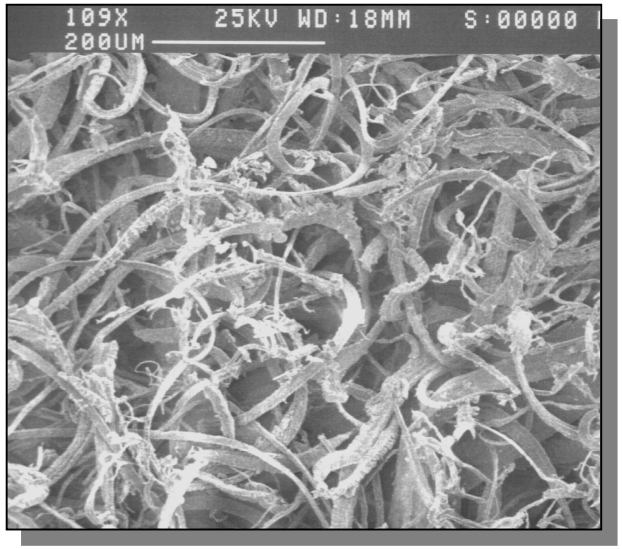


Typical Abradable Seal Applications



What Is Feltmetal®?

Micron Size Fiber Sinter Bonded Into A Continuous Felt



- Typically Hast-X or FeCrAlY
- Density Range 10 – 50%
- UTS Range 500 – 3000 psi

Key Requirements For Abradable Seal Materials

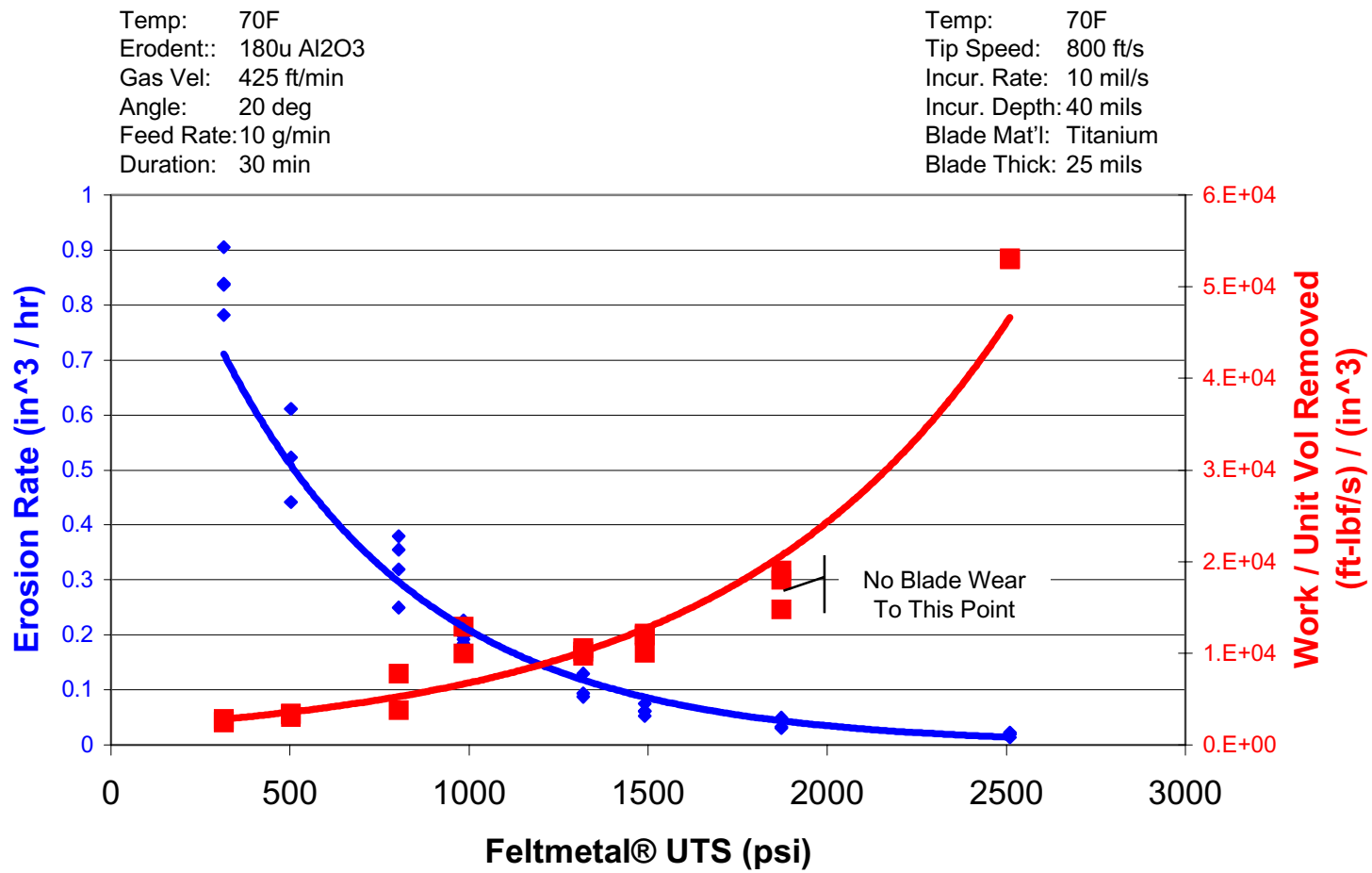
- Clean Cutting With Minimal Blade Wear
- Erosion Resistance
- Operating Life

Performance Is Application Specific

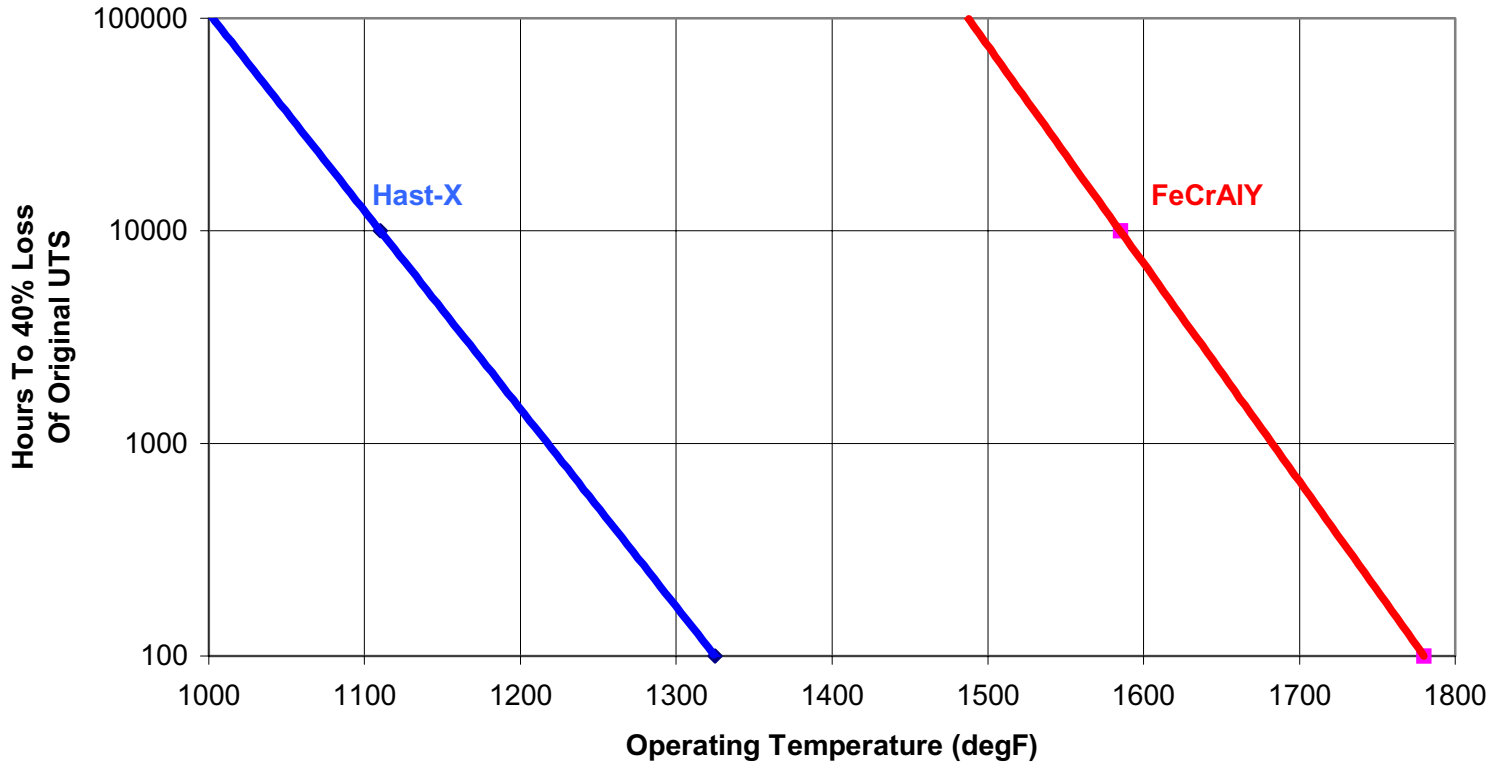
Typical GT Compressor	AERO	UTILITY
Max Tip Speed	1400 fps	1200 fps
Max Temp	1300 F	1200 F
Incursion Rate	10 mil/sec	0.1 mil / sec
Incursion Depth	20 mils	40+ mils
Blade Material	Ni, Ti	Steel
Blade Thickness	25 mils	Up to 300 mils

Erosion And Abradability Are Conflicting Properties

Felt Tensile Strength Is The Driving Material Property



Material Selection Based On Operating Environment

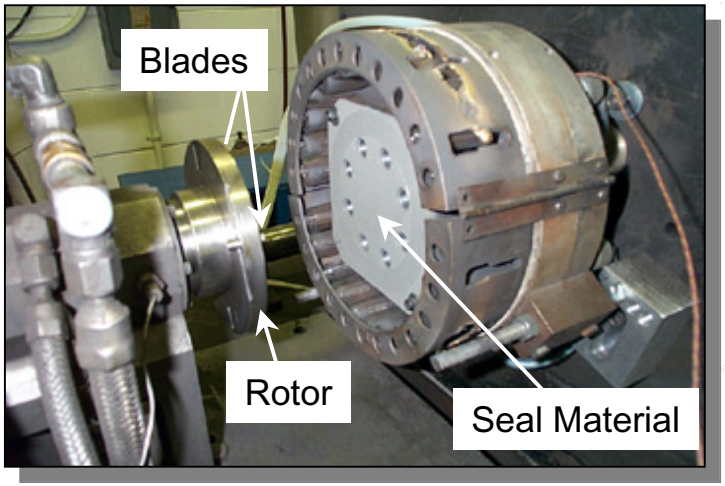


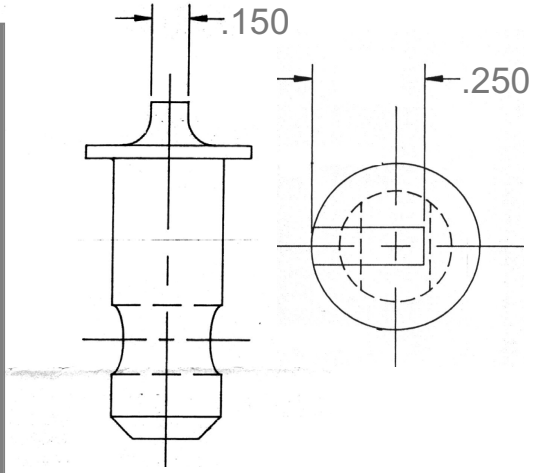
Majority Of Available Literature Has Aero Focus And Experimental Evaluations Run On Disparate Test Rigs

Title	Author(s)	Organization	Date
Advanced Seal Technology	Mahler	P&W	1972
Development Of Abradable Gas Path Seals	Shiembob	P&W	1974
Continued Development Of Abradable Gas Path Seals	Shiembob	P&W	1975
Aerodynamic Performance Of Conventional And Advanced Design Labyrinth Seals With Solid-Smooth Abradable And Honeycomb Lands	Stocker, Cox, Holle	Detriot Diesel Allison	1977
Friction And Wear Of Sintered Fibermetal Abradable Seal Materials	Bill, Shiembob	AVRADCOM, P&W	1977
Development Of Improved Abradable Compressor Gas Path Seals	Erickson, Jarvi	Technetics	1977
Friction And Wear Of Several Compressor Gas-Path Seal Materials	Bill, Wisander	AVRADCOM	1978
Some Cosideration Of The Performance Of Two Honeycomb Gas Path Seal	Bill, Shiembob	AVRADCOM, P&W	1980
Rub Energetics Of Compressor Blade Tip Seals	Laverty	P&W	1982
Improved Compressor Performance Using Recessed Clearance (Trenches) Over Rotor	Beacher, Wisler	GEAE	1986
NiCrAl / Bentonite Thermal Spray Powder For High Temperature Abradable Seals	Clegg, Mehta	-	1987
The Wear Mechanisms Occurring In Abradable Seals Of Gas Turbines	Borel, Nicell, Schlapfer, Schmid	Sulzer Plasma-Teknik	1989
Thermally Sprayed Coating Systems For Surface Protection And Clearance Control Applications In Aero Engines	Rhys-Jones	-	1990
The Selection And Performance Of Thermal Sprayed Abradable Seal Coatings For Gas Turbine Engines	Novinski	Metco	1990
Basic Characteristics Of Different Abradable Coatings	Oka, Nakahira, Noritoh	-	1990
A High Performance Alternative To NiCrAl / Bentonite For Gas Turbine Abradable Seals	Dorfman, Novinski, Kushner, Rotolico	-	1992
Advances In Abradable Coatings For Gas Turbine	Nicoll, Schmid	Sulzer Innotec	1994
A Review Of Clearance Control Wear Mechanisms For Low Temp Aluminum Silicon Alloys	Dorfman, Ghasripoor, Russo, Schmid	Sulzer Metco/Innotec	1997
Abradables Improve Gas Turbine Efficiency	Ghasripoor, Schmid, Dorfman	Sulzer Innotec	1997
Optimizing The Performance Of Plasma Sprayed Clearance Control Coatings Up To 850C	Ghasripoor, Schmid, Dorfman, Wei, Correa, Tilkaran	Sulzer Metco/Innotec	1998
Abradable Coatings For Gas Path Seals In Turbine Engines	Pritchard, Rush, Kiela	VAC AERO	1998
CABC Family Of Sprayed Abradable Materials	Wolfla	Chromalloy	1999

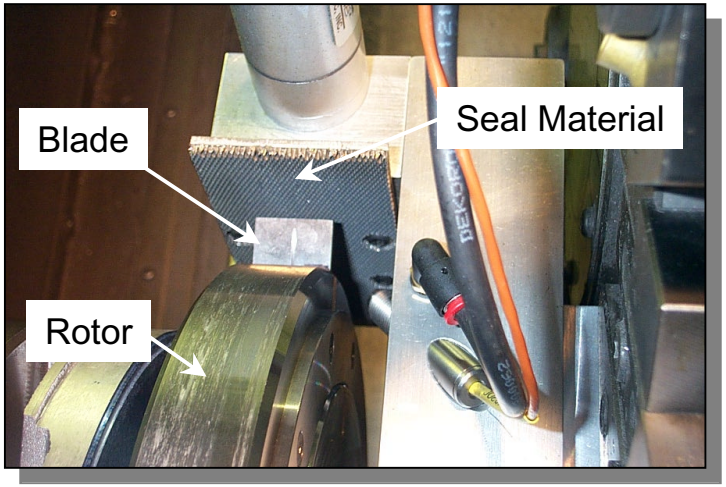
Initial Goal: Quantify Feltmetal® Performance For Utility Gas Turbine Type Applications

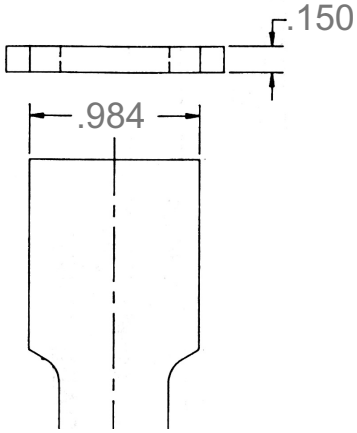
High Speed Rub Rig



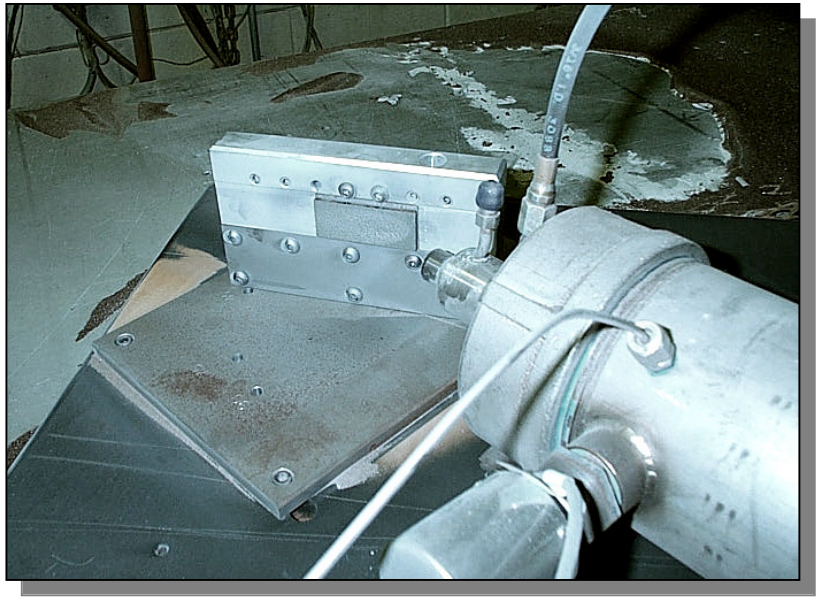


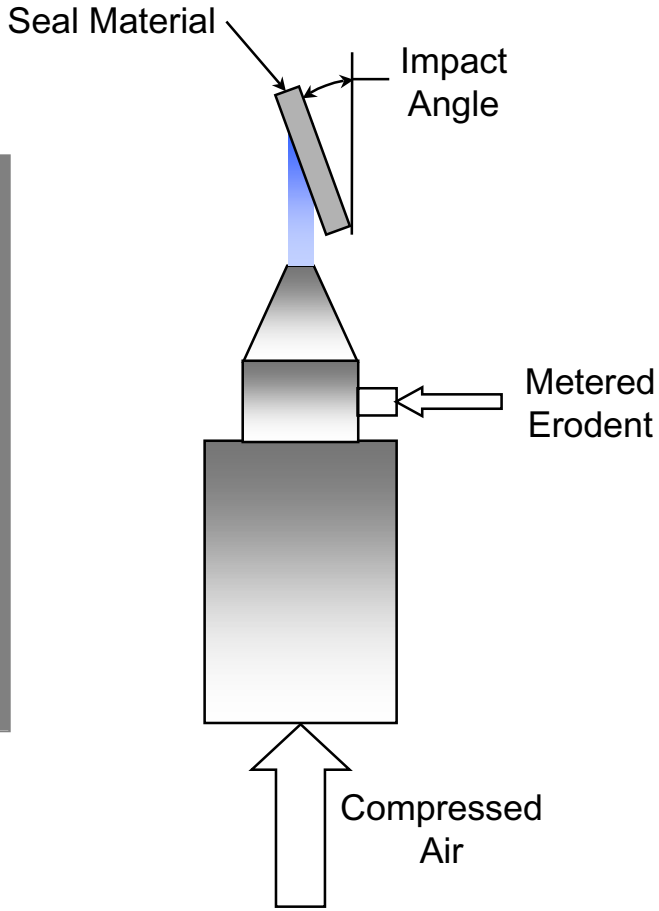
Low Speed Rub Rig





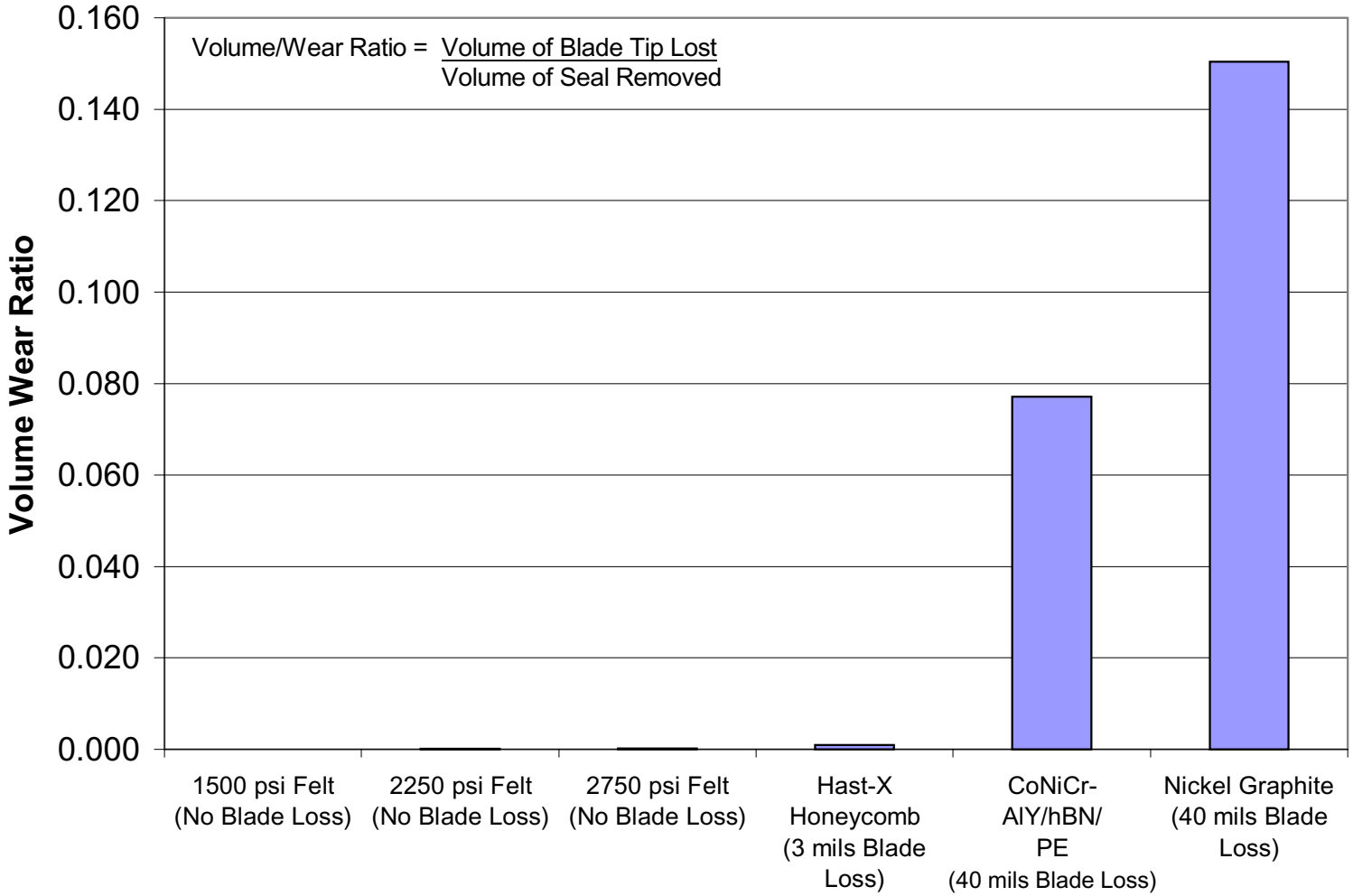
Erosion Test Rig





High Speed Abradability Test Results

Temp: 70F
Tip Speed: 900 ft/s
Incur. Rate: 0.11 mil/s
Incur. Depth: 40 mils
Blade Mat'l: 403 SS
Blade Thick: 150 mils



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Tip Speed:	900 ft/s
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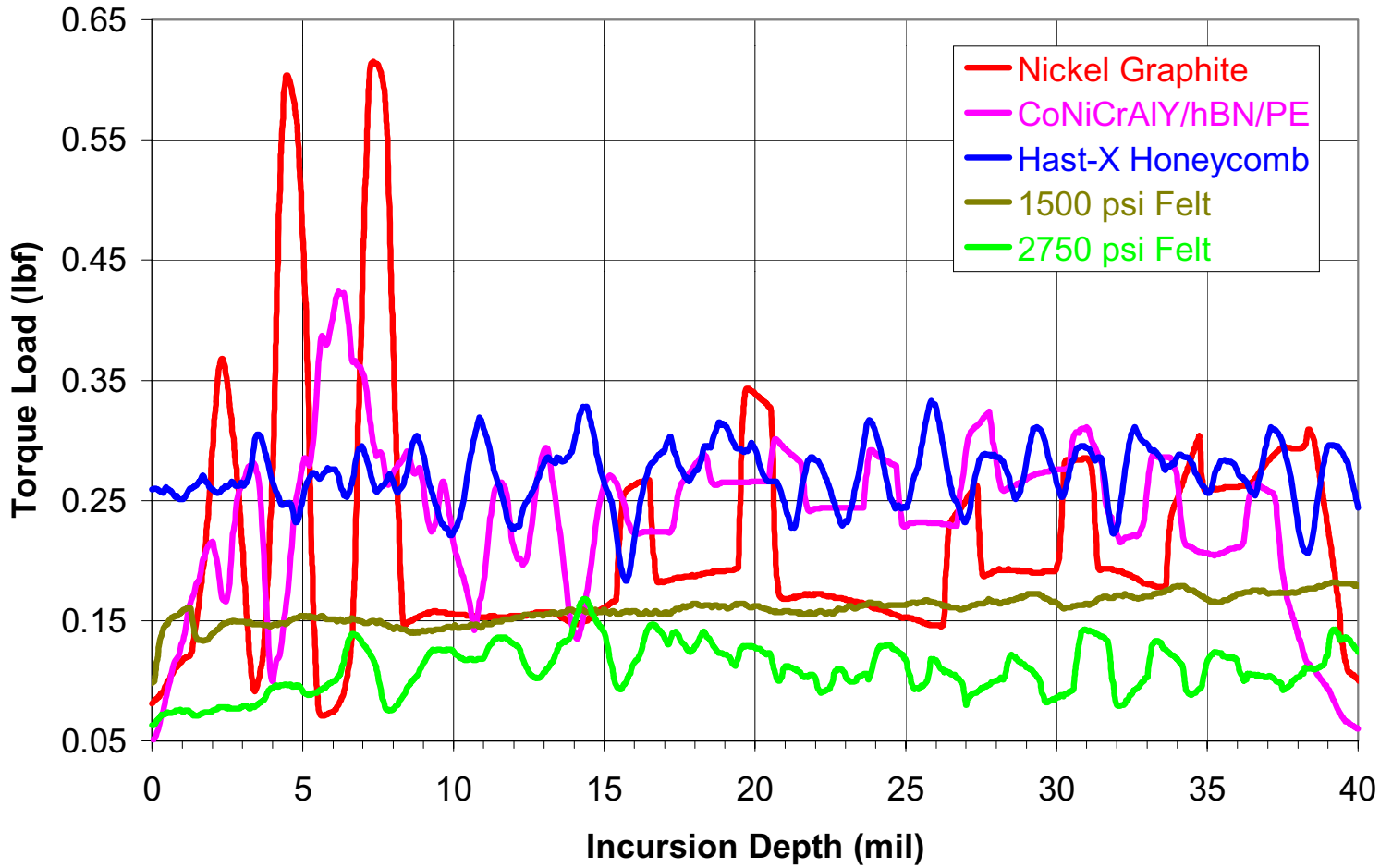
Incur. Depth:	40 mils
Blade Mat'l:	403 SS
Blade Thick:	150 mils

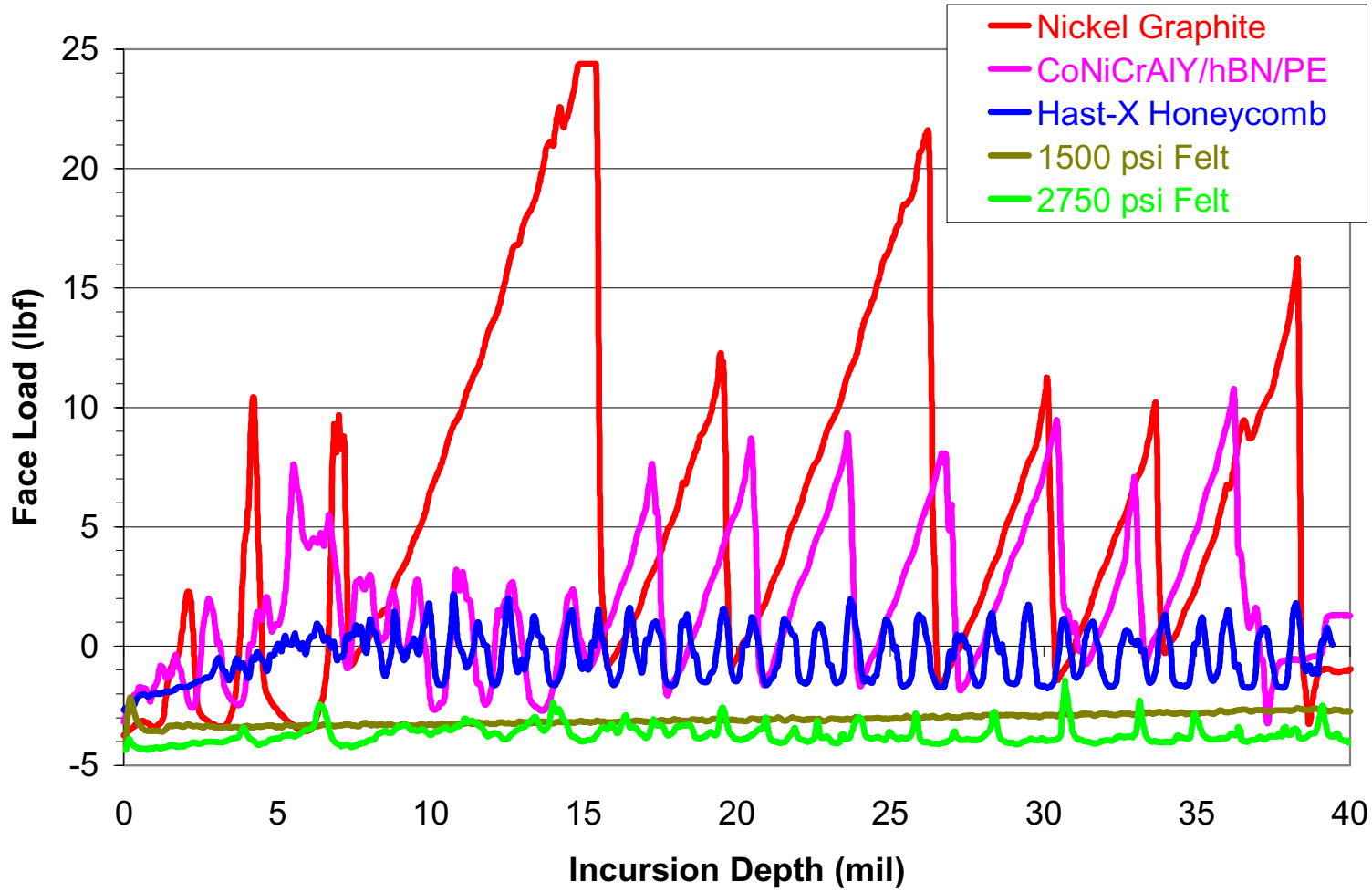
Circumferential Torque Imparted To Seal Material



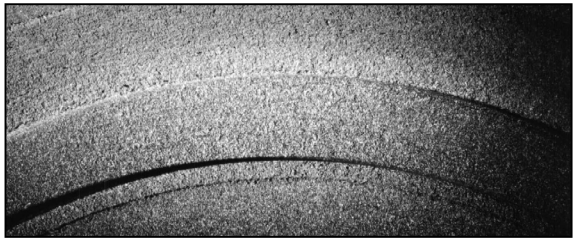
High Speed Abradability Test Results

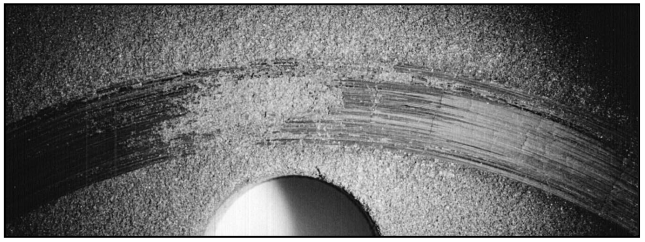
Temp:	70F
Tip Speed:	900 ft/s
Incur. Rate:	0.11 mil/s
Incur. Depth:	40 mils
Blade Mat'l:	403 SS
Blade Thick:	150 mils

Axial Face Load Imparted To Seal Material

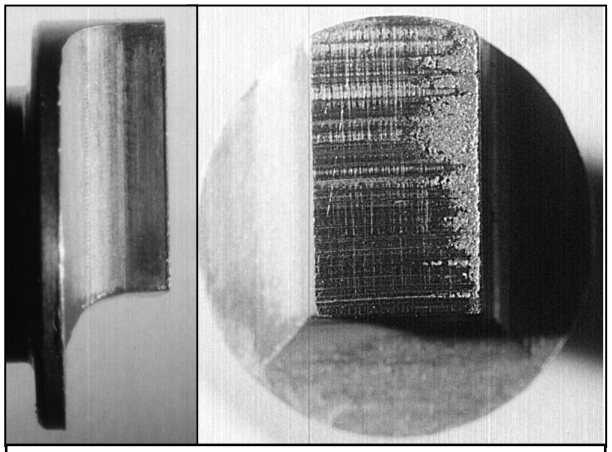


1500 psi Felt
Rub Track

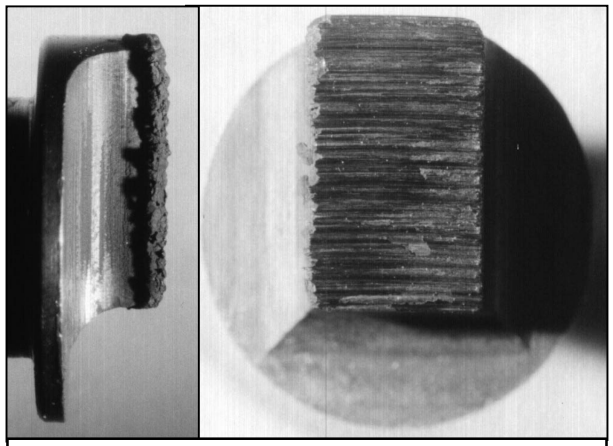




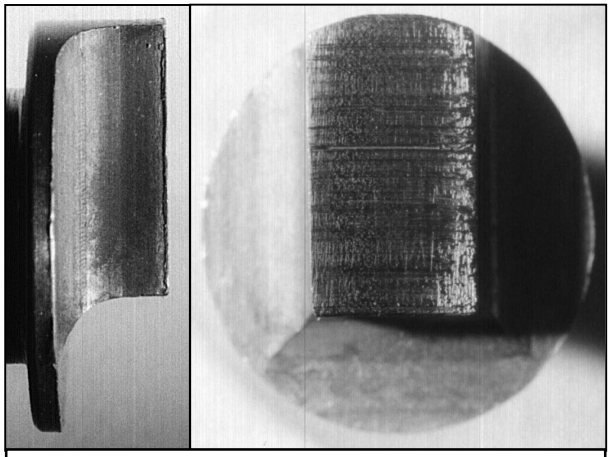
NiGr
Rub Track



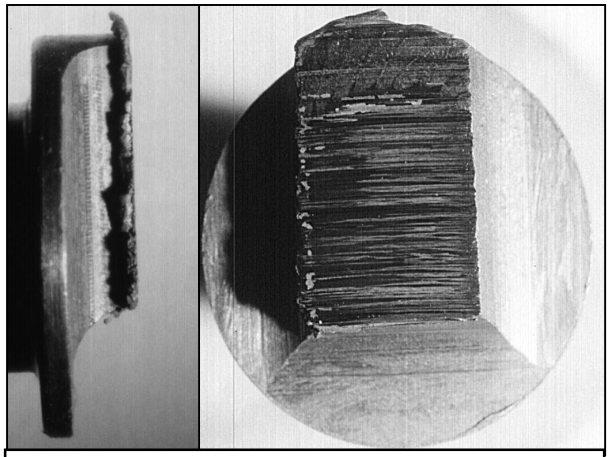
1500 psi Felt



Hast-X Honeycomb



2750 psi Felt

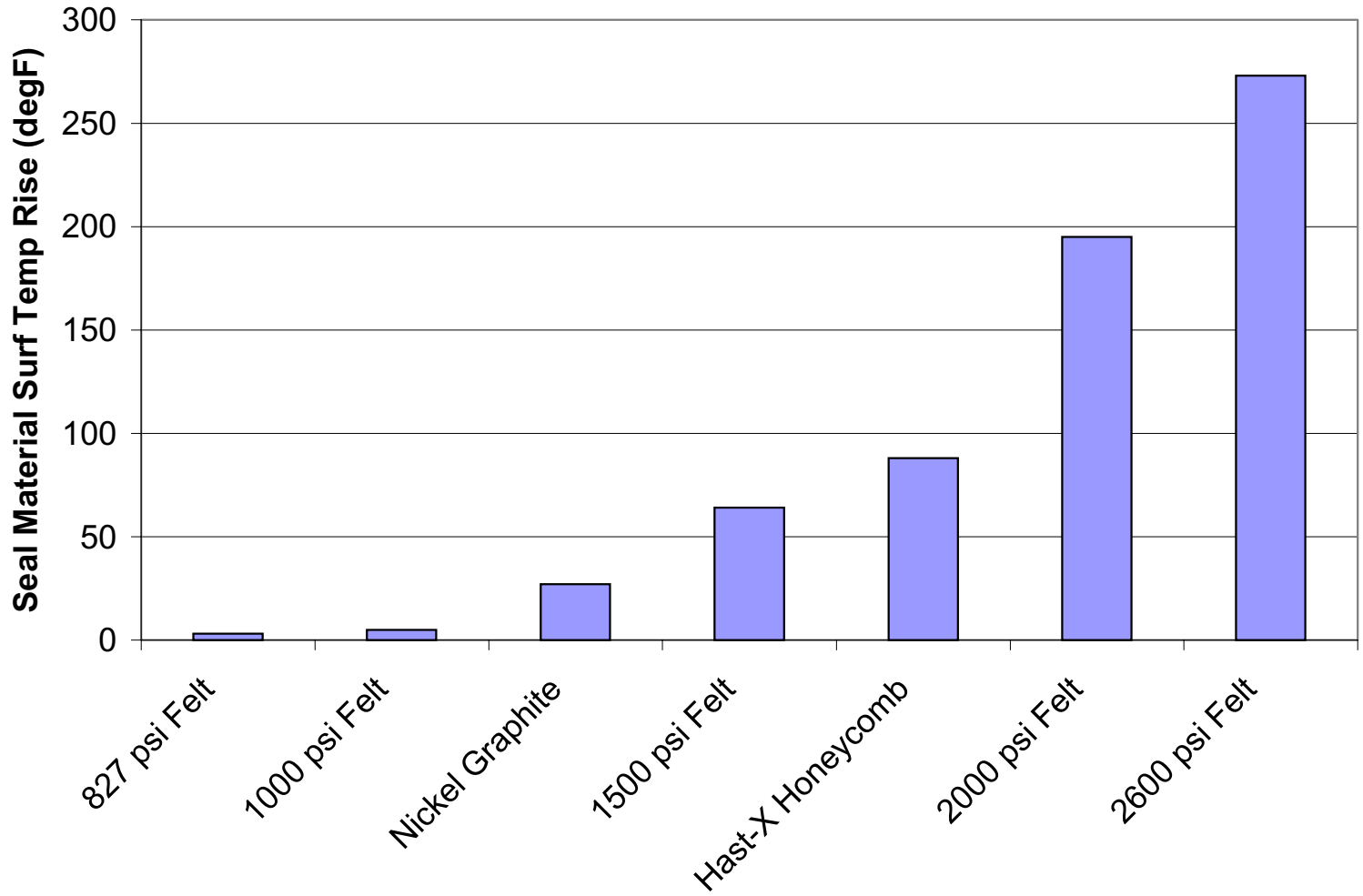


Nickel Graphite

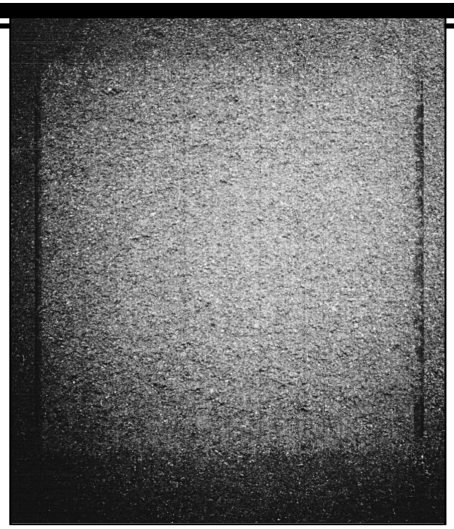
Low Speed Abradability Test Results

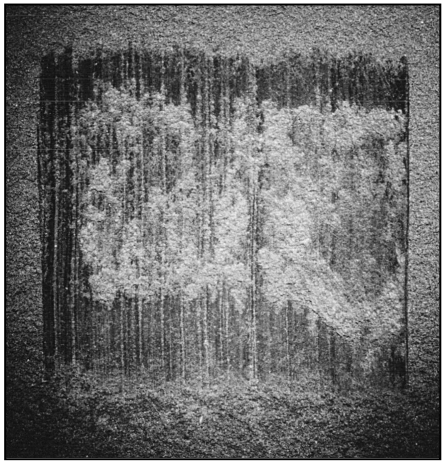
Temp:	80F
Tip Speed:	155 ft/s
Incur. Rate:	0.1 mil/s
Incur. Depth:	40 mils
Blade Mat'l:	403 SS
Blade Thick:	150 mils

Blade Temperature Rise Not Quantified

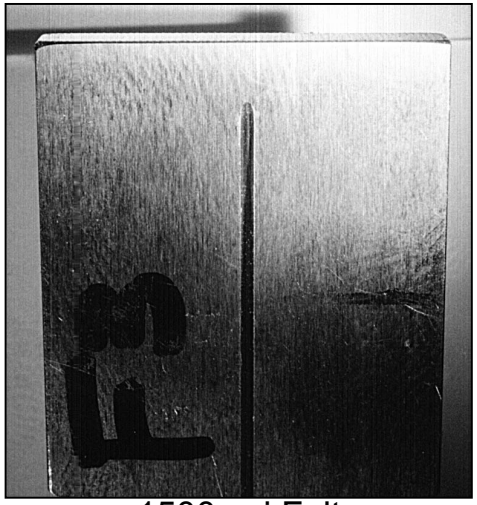


Rub Tracks

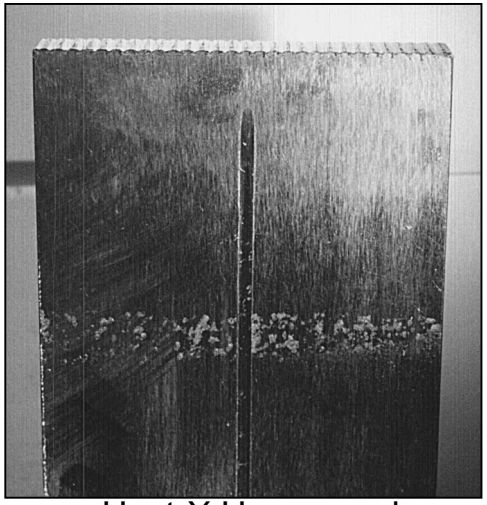




Blades



1500 psi Felt

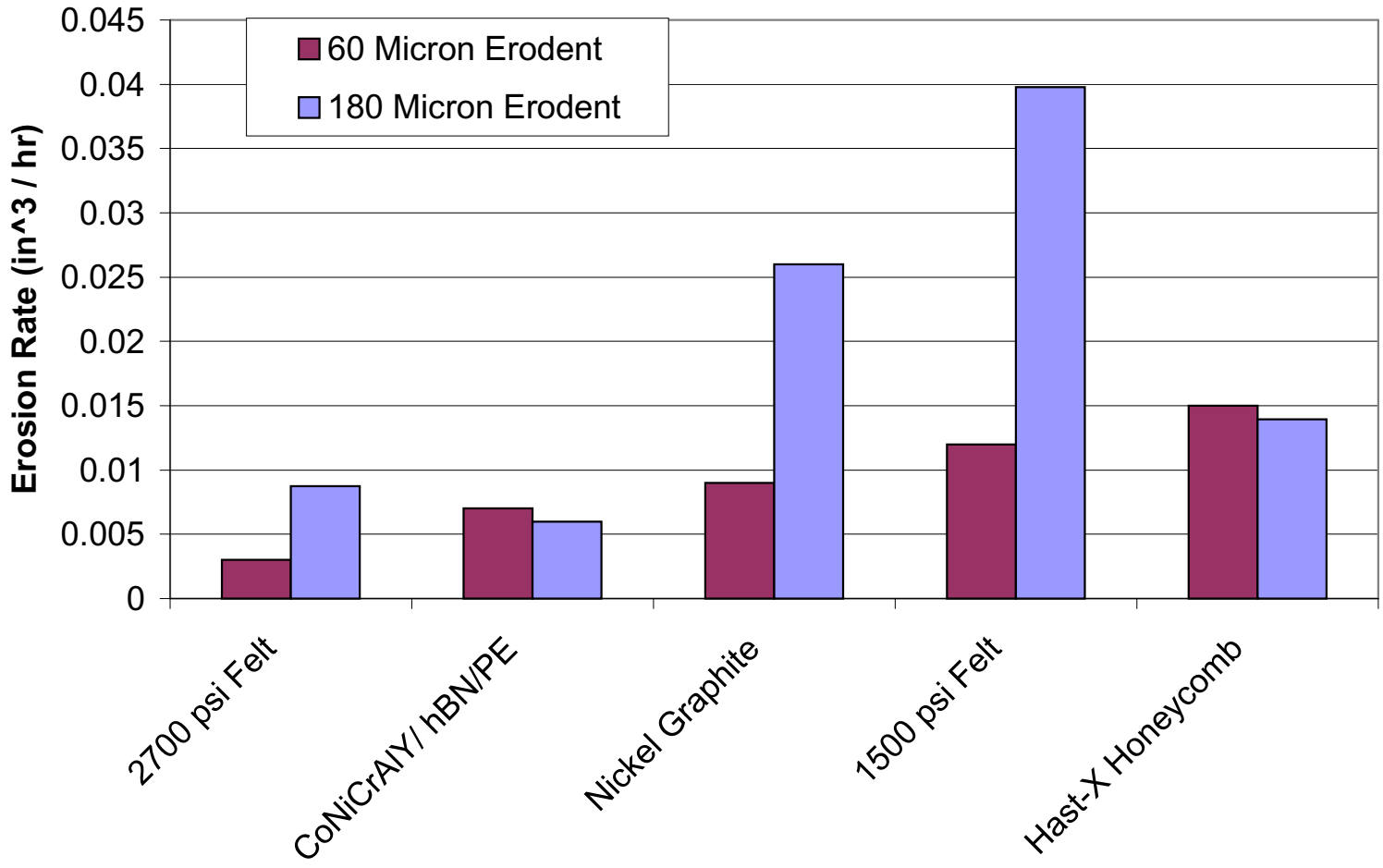


Hast-X Honeycomb

Nickel Graphite

Erosion Test Results

Temp:	70F
Erodent::	Al2O3
Gas Vel:	425 ft/min
Angle:	20 deg
Feed Rate:	10 g/min
Duration:	30 min



Conclusions

- Abradable Materials Are Promising For Use In Industrial Gas Turbines
- Feltmetal® Can Be Tailored To Meet Specific Application Requirements

Future Work

- Low Speed Rub Blade Temperature
- Continued Parametric Testing
  (Temp, Materials, Erodent Size, etc)
- Knife Edge Geometries
- Establish Industry Standards For Erosion And Abradability Testing