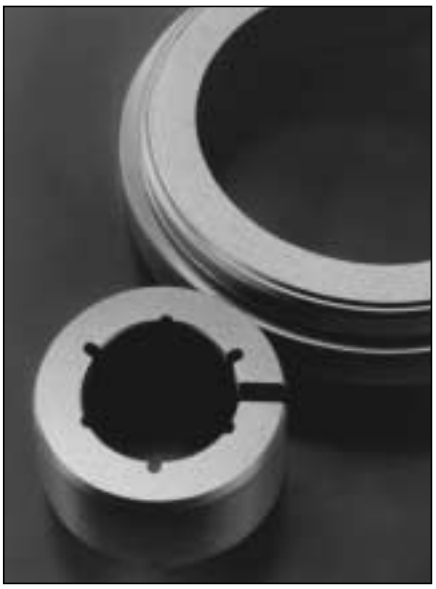
# Hexoloy® SP Silicon Carbide

## Technical Data

CARBORUNDUM

### Product Description

Hexoloy® SP SiC is a sintered alpha silicon carbide material designed specifically for optimum performance in sliding contact applications such as mechanical seal faces and product lubricated bearings. This material improves upon the exceptional friction properties of Hexoloy® SA SiC (sintered alpha SiC) through the addition of spherical pores. These pores are discrete, non-interconnecting and dispersed in a controlled manner throughout the body of the material. The spherical pores act as fluid or lubricant reservoirs helping to promote the retention of a fluid film at the interface of sliding component surfaces. This "pore" based lubrication mechanism allows Hexoloy® SP SiC to outperform conventional reaction-bonded and sintered silicon carbides in a wide variety of service conditions.



### Performance Testing

*Corrosion Resistance.* Unlike reaction-bonded silicon carbides and tungsten carbides, Hexoloy® SP SiC contains no free silicon phase or metallic binder subject to corrosive attack. This material is a fine grain, single phase SiC product produced via pressureless sintering of submicron silicon carbide powder. As a result of this homogenous SiC composition, it exhibits the same outstanding corrosion resistance as does its forerunner Hexoloy® SA SiC. Superior performance is assured across a nearly universal range of environments including both strong acids and bases. Hexoloy® SP SiC's corrosion resistance exceeds that of all reaction-bonded SiC's, tungsten carbides and aluminum oxides.

### Corrosion Test Results in Liquids

| Test Environment* | | Corrosive Weight Loss (mg/cm²yr)** | | | |
|---|---|---|---|---|---|
| Conc. Reagent (Wt%) | Temp. (°C) | Hexoloy® SP (No Free Si) | Reaction Bonded SiC (12% Si) | Tungsten Carbide (6% Co) | Aluminum Oxide (99%) |
| 98% $H_2SO_4$ | 100 | 1.8 | 55.0 | >1000 | 65.0 |
| 50% NaOH | 100 | 2.5 | >1000 | 5.0 | 75.0 |
| 53% HF | 25 | <0.2 | 7.9 | 8.0 | 20.0 |
| 85% $H_3PO_4$ | 100 | <0.2 | 8.8 | 55.0 | >1000 |
| 70% $HNO_3$ | 100 | <0.2 | 0.5 | >1000 | 7.0 |
| 45% KOH | 100 | <0.2 | >1000 | 3.0 | 60.0 |
| 25% HCl | 70 | <0.2 | 0.9 | 85.0 | 72.0 |
| 10% HF plus 57% $HNO_3$ | 25 | <0.2 | >1000 | >1000 | 16.0 |

***Test Time:** 125 to 300 hours of submersive testing, continuously stirred.

****Corrosion Weight Loss Guide:**

| | |
|---|---|
| >1000 mg/cm² yr | Completely destroyed within days. |
| 100 to 999 mg/cm² yr | Not recommended for service greater than a month |
| 50 to 100 mg/cm² yr | Not recommended for service greater than one year |
| 10 to 49 mg/cm² yr | Caution recommended, based on the specific application. |
| 0.3 to 9.9 mg/cm² yr | Recommended for long term service |
| <2 mg/cm² yr | Recommended for long term service; no corrosion, other than as a result of surface cleaning, was evidenced. |

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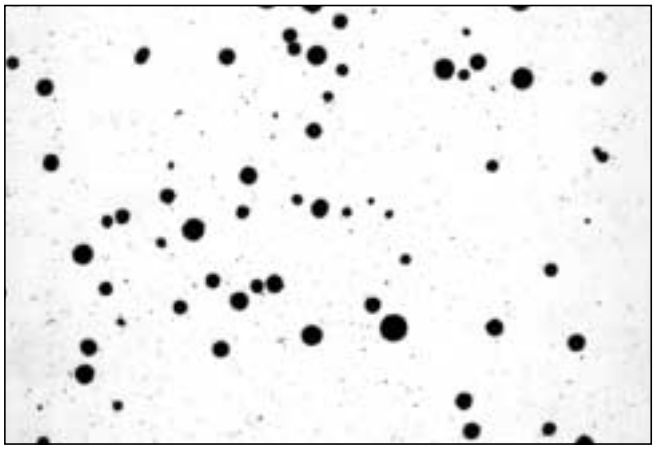
## Performance Testing

*Seal Face Testing*. Seal face performance tests comparing Hexoloy® SP SiC with conventional fine grained reaction-bonded SiC and sintered SiC were conducted on a high pressure test rig. All of the SiC materials were tested running against identical phenolic resin impregnated carbon-graphites. Maximum tested PV (pressure-velocity) exceeded 1 million psi ft/min. Hexoloy® SP demonstrated consistently superior results compared to reaction-bonded and sintered SiC in terms of both carbon-graphite and silicon carbide wear. Additionally, self-mated testing of this material shows excellent service potential for those applications which can benefit from a hardface versus hardface mechanical face seal combination.

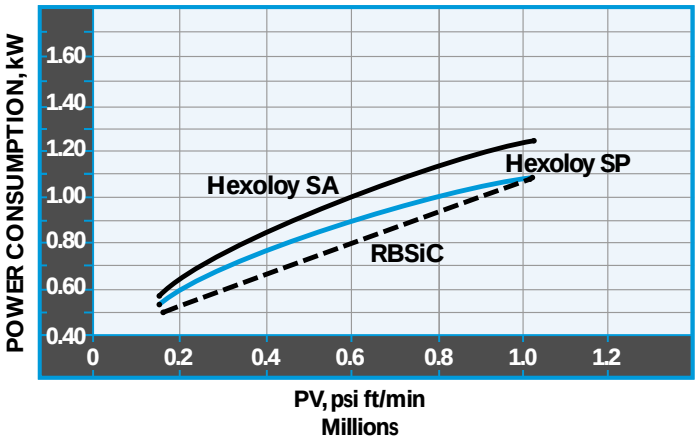
## Test Conditions

| Item | Value(s) |
|---|---|
| Hydraulic Pressure (Test Pressures) | 10, 25, 50, 75, 125 bar<br>147, 367, 735, 1102, 1837 PSI |
| Speed | 3000 RPM, 9.4 m/s<br>3000 RPM, 31 ft/s |
| PV | 55-364 bar m/s<br>157,000-1,250,000 psi ft/min |
| Temperature | 60°C<br>140°F |
| Duration | 48 hours (per pressure step) |
| Seal Diameter | 75mm (O.D.)<br>2.953 In. (O.D.) |
| Wear Track Diameter | 59.5mm<br>2.343 in. |

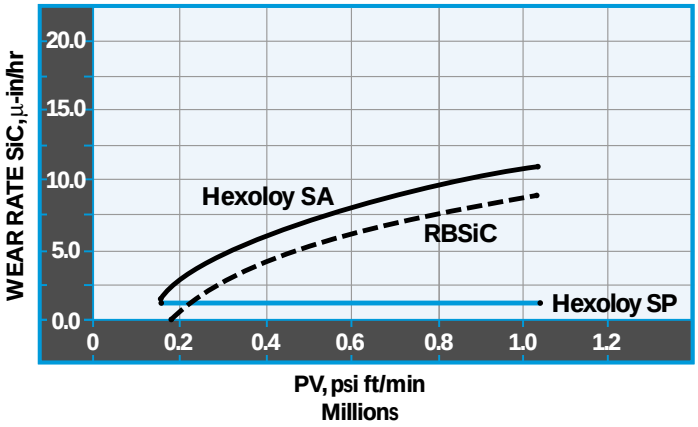


This photomicrograph shows the typical appearance of pores at a magnification of 50X.

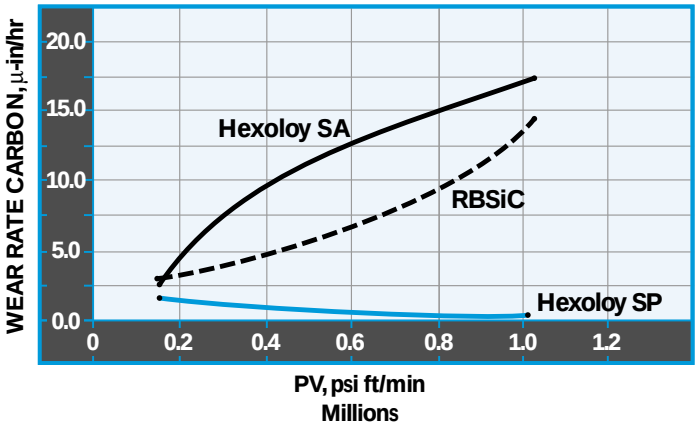
## Power Consumption




## Wear Rate: SiC




## Wear Rate: Carbon



## Applications

### Industrial Seal Faces

Hexoloy® SP SiC offers mechanical seal manufacturers and users a material they can broadly standardize on without sacrifice. Universal corrosion resistance combined with excellent tribological characteristics makes Hexoloy® SP SiC the superior choice for a wide range of industrial seal face applications:

- Chemical processing
- Waste water
- Mining
- Marine
- Refining
- Paper and pulp
- Nuclear
- Appliance

### Automotive Water Pump Seal Faces

In highly silicated coolants Hexoloy® SP SiC has demonstrated improvement in service life over the excellent performance of Hexoloy® SA for both automotive and truck application. Hexoloy SP is used commercially in automotive SiC versus hard carbon seal designs, and has shown superior results in SiC versus SiC hard-face designs for diesel truck applications.

### Pump Bearings

Seal-less pumps equipped with Hexoloy® SP SiC sleeve and thrust bearings have been able to run dry during process upset conditions up to twice as long as have pumps equipped with conventional sintered and reaction-bonded SiC's. Hexoloy® SP SiC is the one bearing material available today which can handle the full spectrum of application demands from suspended abrasives to hydrofluoric acids to light-hydrocarbons.

Typical sealface and bearing components currently fabricated in Hexoloy® SP SiC.

### Relative Ranking of Commonly Used Seal Face Materials

| Key Material Attributes | Hexoloy SP SiC | Sintered SiC | Reaction-Bonded SiC | Tungsten Carbide | Aluminum Oxide |
|---|---|---|---|---|---|
| 1. Running Capability Versus Carbon-Graphite | Superior | Excellent | Excellent | Good | Fair |
| 2. Running Capability Versus Itself | Superior | Fair-Good | Fair-Good | Poor | Poor |
| 3. Universal Corrosion Resistance | Superior | Superior | Fair | Fair | Fair |
| 4. Good Thermal Management | Superior | Excellent | Excellent | Fair-Good | Poor |
| 5. Abrasive Wear Resistance (Slurry Applications) | Superior | Superior | Good | Good | Fair |
| 6. Economics (Hi-Volume Moldable) | Excellent | Excellent | Fair | Fair | Excellent |

## Hexoloy® SP SiC Typical Physical Properties

| Property | Units | Typical Value |
|---|---|---|
| **Composition*** | – | SiC |
| **Grain Size** | µm | 4-10 |
| **Density** | $g/cm^3$ | 3.04 |
| **Hardness (Knoop)**** | $kg/mm^2$ | 2800 |
| **Flexural Strength 4 pt @ RT***** | MPa<br>$x10^3$ $lb/in^2$ | 240<br>35 |
| **Modulus of Elasticity @ RT** | GPa<br>$x10^6$ $lb/in^2$ | 400<br>58 |
| **Weibull Modulus** (2 parameter) | | 19 |
| **Poisson Ratio** | | 0.14 |
| **Fracture Toughness @ RT**<br>**Double Torsion & SENB** | MPa x $m^{1/2}$<br>$x10^3$ $lb/in^2$ x $in^{1/2}$ | 4.3<br>3.9 |
| **Coefficient of Thermal Expansion**<br>**RT to 700˚C** | $x10^{-6}$ mm/mmK<br>$x10^{-6}$ in/in ˚F | 4.2<br>2.3 |
| **Mean Specific Heat @ RT** | J/gmK | 0.59 |
| **Thermal Conductivity @ RT** | W/mK<br>Btu/ft h ˚F | 110<br>64 |
| **Pore Volume Fraction** | % | 4.0-6.0 |
| **Pore Size (Typical)** | µm | 50 |

***Composition code:** Si = free silicon metal; C = free graphite; SiC = silicon carbide

****Test Bar Size:** 3 x 4 x 45 mm (0.118" x 0.157" x 1.772")

**Knoop 0.1 kg load

## Design Considerations

Successful application of engineered ceramic materials such as Hexoloy® SP SiC is heavily dependent on proper design criteria. Among the many aspects of product design requiring careful consideration are:

- Physical Properties
- Tribological Performance
- Process Capability/Economics
- Attachment or Drive Method
- Geometric Shape
- Effect of Tolerances on Cost
- Surface Finish Requirements

Saint-Gobain Ceramics application engineers can assist you with the design of cost-effective high performance components for your specific need.



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