# Sinter-HIP Advantages


*Life cycle from powder to sinter-HIPed product.*

## What is Sinter-HIP?

Sinter-HIP is a method of thermal consolidation for cemented carbide wherein the simultaneous application of heat and pressure fully consolidates the carbide during the sintering process. It results in a product that contains little or no porosity, thereby producing a component that is as close to full theoretical density as possible.

## Hot Isostatic Pressing (HIP) Results in Superior Reliability

Some companies sinter-HIP large parts only. At General Carbide, we sinter-HIP all parts in **one of five furnaces** to ensure the highest metallurgical quality. Subjecting our preforms to sinter-HIPing improves nominal transverse rupture strength, ranging from 400,000-560,000 psi. The result is parts or components that have little or no porosity and offer superior reliability in a variety of applications, including:

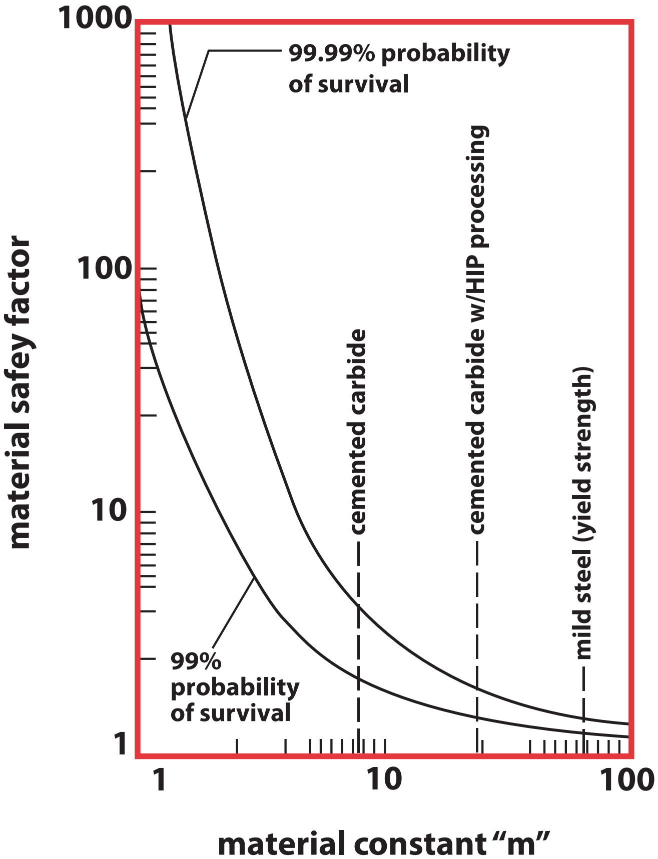
- Automotive
- Aerospace
- Heavy Equipment
- Industrial
- Oil & Gas

Beyond excellent transverse rupture strength, the key features of sinter-HIPed carbide preforms include outstanding:

- Compressive Strength (> 600,000 psi)
- Torsional Strength
- Improved Resistance to Deflection, Corrosion & Wear
- Higher Fracture Toughness

# The Theory Behind the Practice

**MATERIAL SAFETY FACTOR VS. WEIBULL MATERIAL CONSTANT, "m"**




*This graph shows that to achieve a 99.99% probability of survival, a smaller material safety factor is needed if cemented carbide is processed by sinter-HIP.*

**Ernst Hjalmar Waloddi Weibull (1887-1979) was a French-born Swedish engineer, scientist and mathematician. In addition to publishing a paper on distribution of material flaws, Weibull published many papers on material strength fatigue and rupture in solids. He also wrote a book on fatigue analysis.*

*The American Society of Mechanical Engineers awarded Dr. Weibull its Gold Medal in 1972. He received The Great Gold Medal from the Royal Swedish Academy of Engineering Sciences in 1978.*

According to **Weibull's* Statistical Strength Theory**, the strength of a brittle material is subject to the presence of a flaw of random size and random distribution located in the area of highest stress. Therefore, a stress concentration of micron size may exist in a particular area of the material and will weaken it. This phenomenon is likely to cause a scatter plot in rupture strength values and the material may fail at stress levels below specification or published strength values.

Weibull's Theory also considers that a size effect exists, meaning the larger the part, the more likely the part will contain pits or other flaws, according to the following equation:

$$\frac{\sigma_1}{\sigma_2} = \left[\frac{V_2}{V_1}\right]^{\frac{1}{m}}$$

The strength depends upon specimen volume and will decrease as the volume increases. However, the size effect decreases as the value of "m" (the Weibull "m" material constant) increases.

Sinter-HIPing raises the value of the material constant ("m"), thereby reducing the probability of voids, which increases the probability that the material will perform as specified.

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