

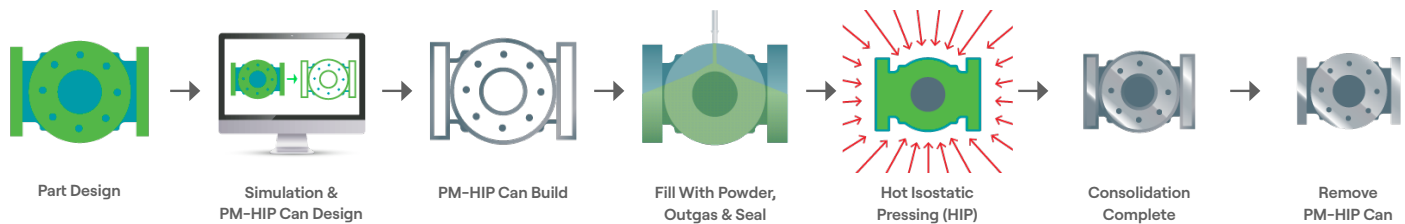


## What is PM-HIP?

PM-HIP, is a highly flexible vetted manufacturing process to produce parts with forge-like isotropic properties.

Ti-6Al-4V	As-HIP PM	PM HIP + Anneal 1290F	Ingot Metallurgy, Anneal Forging	Alloy 706	HIP+HT PM N2 Atomized	HIP+HT PM Ar Atomized	Ingot Metallurgy, HT Forging
0.2% Yield Strength (ksi)	125	128	128	0.2% Yield Strength (ksi)	150	151	142
Tensile Strength (ksi)	136	137	138	Tensile Strength (ksi)	192	195	180
Elongation (%)	17	15	14	Elongation (%)	19	21	17
Reduction of Area (%)	42	40	36	Reduction of Area (%)	25	29	19
Fracture Toughness (ksi(in) <sup>1/2</sup> )	77	67	68				

Parts can be up to 5 feet in diameter and 10+ feet long, ranging in weight from 1lb to 10 tons and can be applied to virtually any material using high-quality, spherical, gas atomized powder. In fact, part size limits are dictated by the current maximum vessel size of the HIP systems used during PM-HIP.



## Advantages of PM-HIP compared to conventional and additive manufacturing methods:

- 1) Significantly reduced manufacturing and delivery times
- 2) Increased material utilization (reduced carbon footprint per component)
- 3) Part consolidation (reduced failure modes and improve inventory management)
- 4) Ability to efficiently support low volume OE & spare parts vs. castings or forgings
- 5) Domestic fabrication of large, complex components including internal cavities
- 6) Reduced weldments, associated failure modes, inspections and heat treatment issues
- 7) Reduced machining and scrap, for improved sustainability
- 8) Multi-materials for increased functionality and reduced costs

	PM-HIP	Castings	Forgings	AM L-PBF	AM-DED
COST (Low Volume)	✓✓	✓	✓	✓	✓✓
PROPERTIES (Isotropic)	✓✓✓	✓✓	✓	✓	✓
LEAD TIME (Low Volume)	✓✓	✓	✓	✓✓✓	✓✓✓
COMPLEXITY	✓✓	✓✓	✓	✓✓✓	✓✓
MODIFICATIONS	✓✓✓	✓	✓	✓✓✓	✓✓✓
SIZE	✓✓✓	✓✓✓	✓✓	✓	✓✓
INSPECTABILITY (UT)	✓✓✓	✓	✓	✓	✓
RANGE OF ALLOYS	✓✓✓	✓✓	✓✓	✓	✓