Description

Image

Image caption

(1) Hot Isostatic Presses Laboratory unit © EPSI (2) Hot Isostatic Presses - Large Production Units © EPSI (3) Blades of an aircraft turbine engine © Blickpixel at Pixabay [Public domain]

The process

In HOT ISOSTATIC PRESSING a powder is sealed in a deformable metal container (the 'can') and then subjected to a high temperature at high pressure (1100C, 200MPa) in a pressure vessel, inside which there is a furnace surrounding the container in which the powder is loaded. Argon is used as the pressurizing medium. In the 'SINTER-HIP' process, a variation of HIPing, the initial sintering of the compacts and their subsequent densification are done sequentially in the same vessel. The main advantage of HIPing is its ability to produce components which are 100% dense and having uniform isotropic properties, but it is expensive, limiting its use to those applications in which the integrity of the material is of prime importance (e.g. turbine disks and blades).

Process schematic

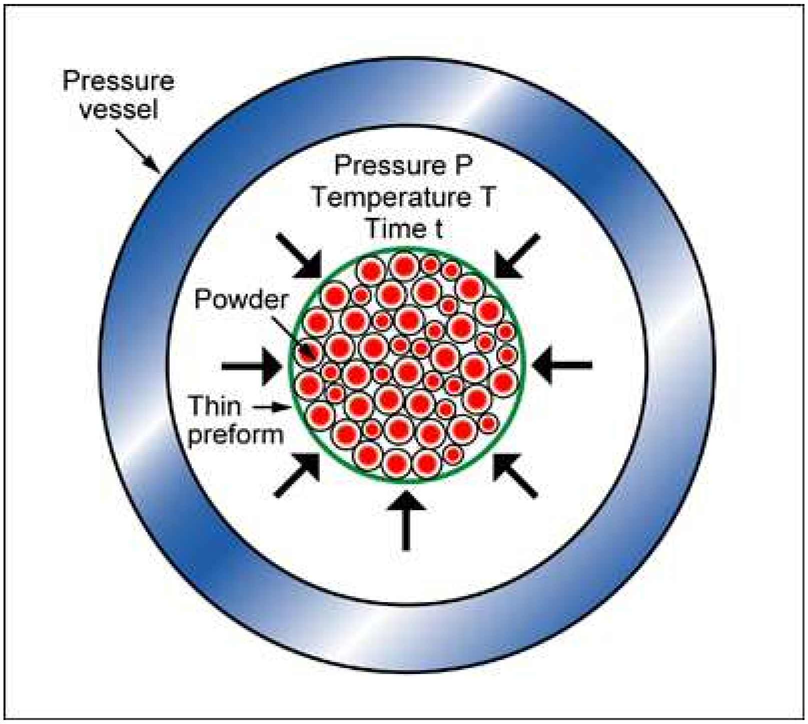


Figure caption

Hot isostatic pressing (HIPing).

Tradenames

HIP; CAP process; CERACON

Material compatibility

Ceramics	✓
Metals - ferrous	✓
Metals - non-ferrous	✓

Shape

Solid 3-D	✓

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	very			
Labor intensity	high			
Economic batch size (units)	1	-	1e4	

Physical and quality attributes

Mass range	0.22	-	661	lb
Range of section thickness	197	-	1.97e4	mil
Tolerance	19.7	-	39.4	mil
Roughness	0.0787	-	0.248	mil
Surface roughness (A=v. smooth)	B			

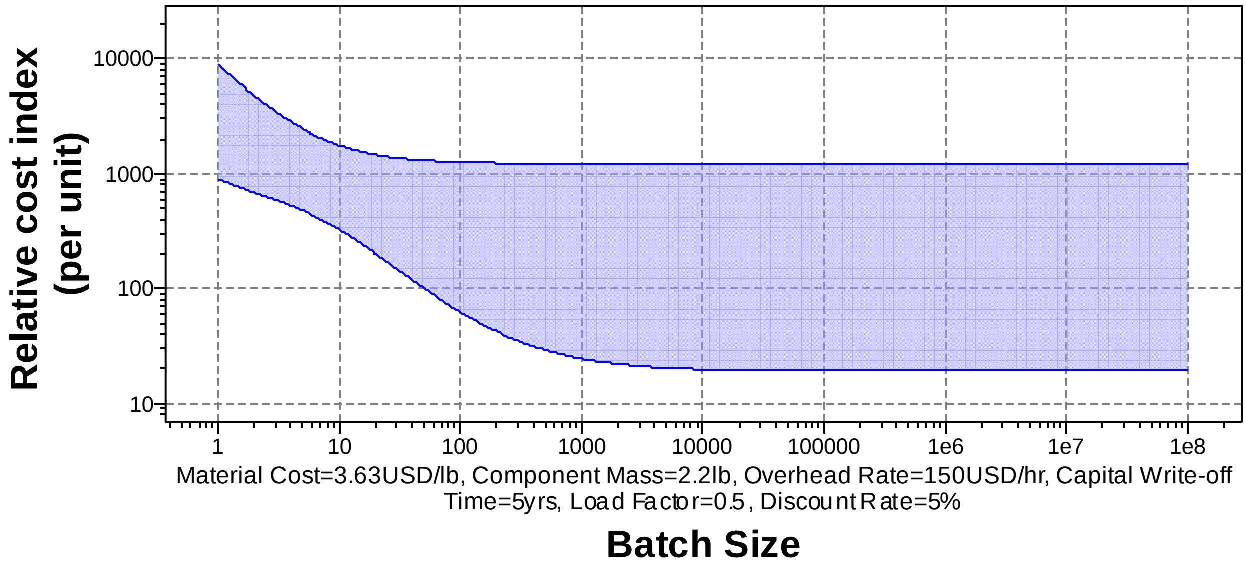
Process characteristics

Primary shaping processes	✓
Discrete	✓

Cost model and defaults

Relative cost index (per unit)	24.6	-	1.22e3

Parameters: Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	3.28e5	-	3.28e6	USD
Material utilization fraction	0.8	-	0.9	
Production rate (units)	0.2	-	50	/hr
Tooling cost	328	-	8.2e3	USD
Tool life (units)	300	-	3e3	

Supporting information

Design guidelines

HIPing has some shape limitations - sidewalls must be parallel; undercuts and screw threads are not possible. Cylindrical billets are the most cost effective product form.

Technical notes

Most metals and ceramics can be consolidated by HIPing.

Typical uses

Production of tool steel and tungsten carbide cutting tools such as hobs and shaper cutters. Making superalloy components such as superalloy blades for high temperature gas turbines for the aerospace industry.

The economics

Capital costs are high (but lower than conventional injection molding), but tooling costs are low due to the low injection pressures. Energy consumption is also lower than conventional injection molding. The cycle time is largely controlled by cure time and open mold time (part ejection maybe difficult with thermosets).

The environment

Fine powders can be pyrophoric and carcinogenic.

Links

MaterialUniverse