Description

Process schematic

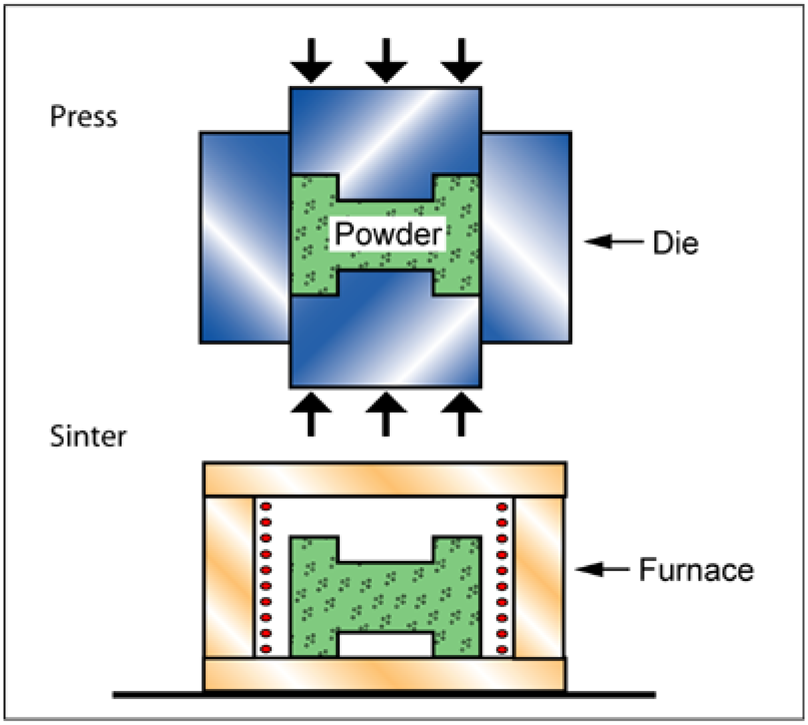


Figure caption

Powder pressing and sintering.

The process

Powder methods have particular value in shaping difficult materials -- ceramics and refractory metals, for instance - that are too brittle to deform and have high melting temperatures so cannot be easily cast. In POWDER PRESSING AND SINTERING, the loose powder is packed in a shaped mold of steel, graphite or ceramic in which it is sintered at a temperature, typically, of 2/3 of the melting temperature of the powder. In pressing and sintering, the powder is first compressed in a cold die, giving it just sufficient strength to be handled, allowing it to be sintered as a free-standing body. Better densification, strength and ductility are given by hot pressing, which combines compaction and sintering into one operation. The powder is heated in a graphite or ceramic die under sufficient pressure to compact the powder to nearly full density. The process is mainly used for components that are too large for regular cold pressing and sintering. Its use is limited by the cost of dies, the difficulty in heating and atmospheric control and the length of time required for a cycle. Vacuum hot pressing is used for powders that are particularly sensitive to contamination by oxygen or nitrogen (titanium is an example).

Material compatibility

Ceramics	✔
Metals - ferrous	✔
Metals - non-ferrous	✔

Shape

Circular prismatic	✔
Non-circular prismatic	✔
Solid 3-D	✔

Hollow 3-D	✔

Economic compatibility

Relative tooling cost	medium			
Relative equipment cost	medium			
Labor intensity	low			
Economic batch size (units)	5e3	-	5e6	

Physical and quality attributes

Mass range	0.022	-	11	lb
Range of section thickness	59.1	-	315	mil
Tolerance	0.984	-	39.4	mil
Roughness	0.0394	-	0.394	mil
Surface roughness (A=v. smooth)	B			

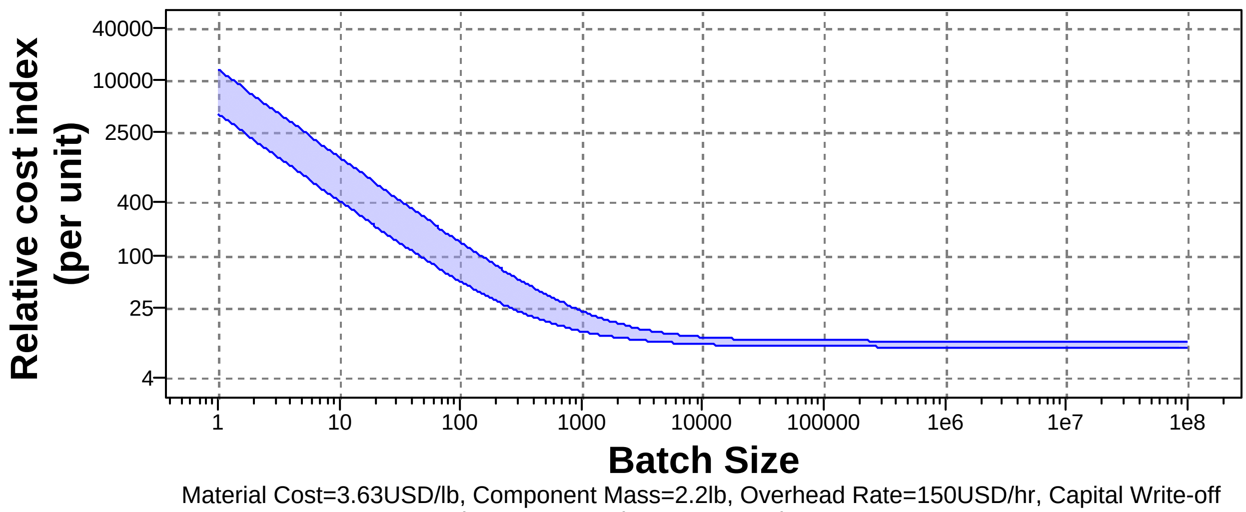
Process characteristics

Primary shaping processes	✔
Discrete	✔

Cost model and defaults

Relative cost index (per unit)	* 13.6	-	23.3	

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



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

Capital cost	* 5.74e4	-	3.28e5	USD
Material utilization fraction	* 0.9	-	0.97	
Production rate (units)	* 120	-	1.2e3	/hr
Tooling cost	* 4.1e3	-	1.31e4	USD

Tool life (units)	* 1e4 - 5e4

Supporting information

Design guidelines

Powder methods give great freedom of choice of materials (particularly as powders of different materials can be mixed to give composites) but they are limited in the shapes that can be made. Side walls must, in general, be parallel, undercuts at right angles to the pressing direction, and screw threads, lateral holes and re-entrant grooves cannot be molded at easily. There is considerable shrinkage (up to 35%) on sintering - the dimensional changes must be allowed for. Powder extrusion is limited to simple circular, elliptical or rectangular cross sections.

Technical notes

Powder methods are routinely used for brass, bronze, iron-based alloys, stainless steels, cobalt, molybdenum, titanium, tungsten, beryllium, metal matrix composites and ceramics.

Typical uses

Powder sintering: filters, porous bearings and low density ceramics. Pressing and sintering: filters, pump rotors, exhaust flanges, pulley hubs, small gears and cams, tungsten carbide cutting tools, small bearings, electrical and magnetic components. Hot pressing: limited to simple geometric shapes such as extrusion billets and forging blanks.

The economics

Powder methods are material efficient -- there is very little material loss -- but powders are

The environment

Burn-off of binder materials generates toxic fumes. Fine powders can be

Links

MaterialUniverse

Reference