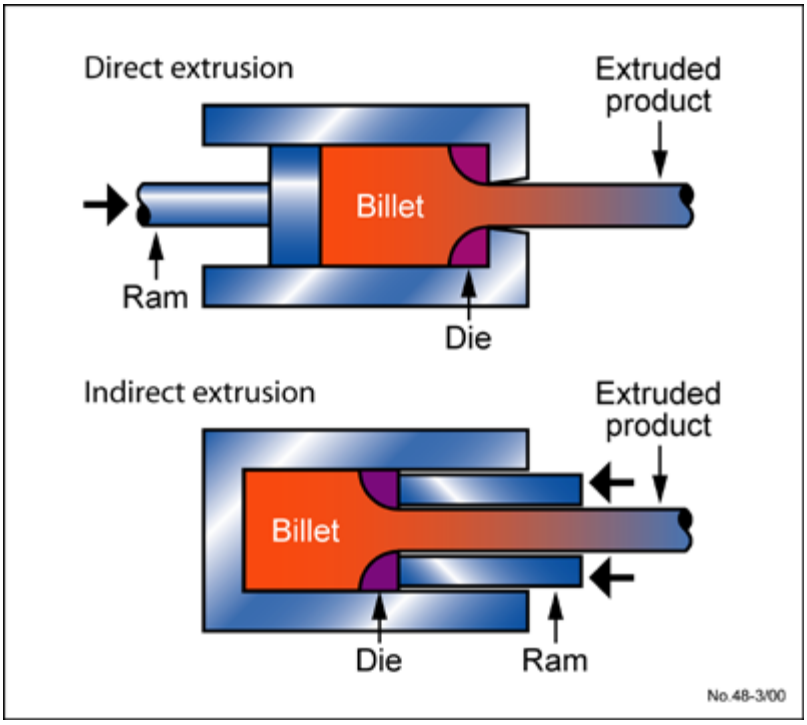
Description

Process schematic



The process

The process of squeezing toothpaste from its tube is one of extrusion. The gooey toothpaste - or the gooey polymer or metal in the industrial process - is forced by pressure to flow through a shaped die, taking up the profile of the die orifice. In co-extrusion two materials are extruded at the same time and bond together - a trick used in toothpaste to create colored stripes in it.

Material compatibility

Ceramics	✓
Metals - non-ferrous	✓

Shape

Circular prismatic	✓
Non-circular prismatic	✓

Economic compatibility

Relative tooling cost	high
Relative equipment cost	high
Labor intensity	low

Physical and quality attributes

Mass range	1	-	1e3	kg
Range of section thickness	1	-	900	mm
Tolerance	0.5	-	1	mm

Roughness	0.8	-	3.2	µm
Surface roughness (A=v. smooth)	B			

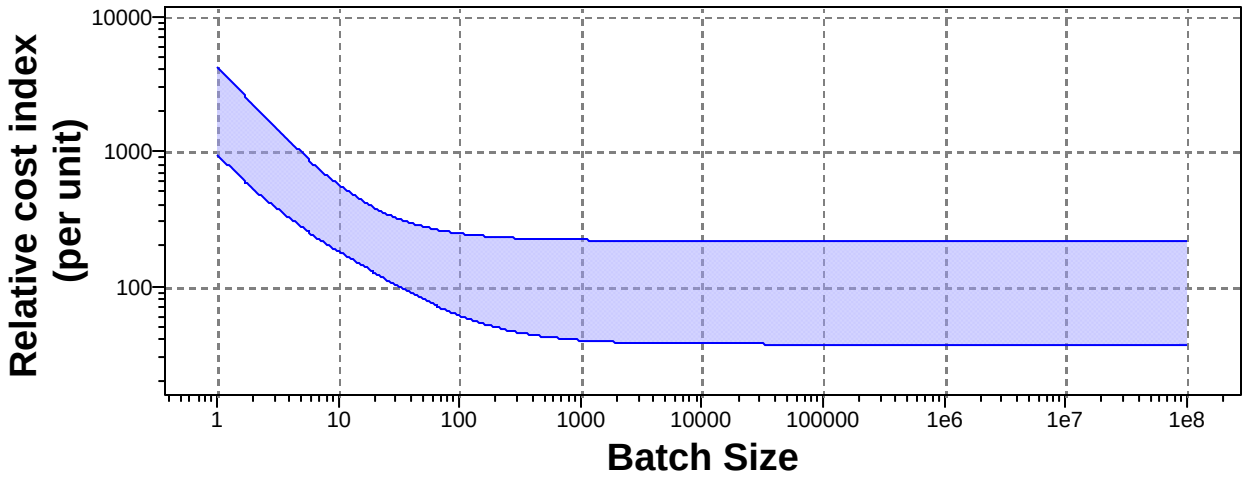
Process characteristics

Primary shaping processes	✓
Continuous	✓

Cost model and defaults

Relative cost index (per unit)	* 39.7	-	220	

Parameters: Material Cost = 8USD/kg, Component Mass = 1kg, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Material Cost=8USD/kg, Component Mass=1kg, Overhead Rate=150USD/hr, Capital Write-off Time=5yrs, Load Factor=0.5, Discount Rate=5%

Capital cost	* 1.64e5	-	1.64e6	USD
Material utilization fraction	* 0.9	-	0.97	
Production rate (units)	* 1	-	10	/hr
Tooling cost	* 820	-	4.1e3	USD
Tool life (units)	* 100	-	1e4	

Supporting information

Design guidelines

Metals extrusion is limited to ductile materials with melting points below 1700oC, commonly aluminum, copper, magnesium, low and medium carbon steels, low alloy steels and stainless steels. The extrusion of steel usually requires the addition of a molten glass lubricant. The tolerance is often lower than expected because of creep and die wear; it can be improved by cold drawing as a secondary process. Symmetric cross-sections, constant wall thickness and generous radii are the easiest to form; the aspect ratio of the section should not exceed 14:1 for steel or 20:1 for magnesium. Impact extrusion is a cold process for metals (aluminum, copper, lead, magnesium, tin, zinc, carbon steels, low alloy steels) which combines the principles of forging and extrusion. Polymer extrusion begins powder or pellets; pressure is built up by a rotating screw, forcing the polymer through a heating chamber and through the die. The extrusion cools as it leaves the die and can then be drawn to a smaller cross-section. Most polymers can be extruded (including those with particulate and short fiber-reinforcement). In ceramic extrusion ceramic powder is mixed with a polymer binder and extruded like a polymer. The extruded section is then fired, burning off the polymer and sintering the ceramic powder.

Technical notes

There are two variants of the extrusion process: direct - where the die is stationary and the metal is forced through it; and indirect - where the die itself compresses the metal. Indirect extrusion has less friction between the billet and die, so there are lower extrusion forces but the equipment is more complex and the product length is restricted.

Typical uses

Tubing, window frame sections, building and automotive trim, aircraft structural parts, railings, rods, channels, plastic-coated wire, seals, filaments, film, sheet, pellets, bricks.

The economics

Equipment and tooling costs are low - much lower than for injection molding - but cycle times are longer than any other molding process, and it is labor-intensive.

The environment

No special problems here.

Links

MaterialUniverse

Reference