Description

Process schematic

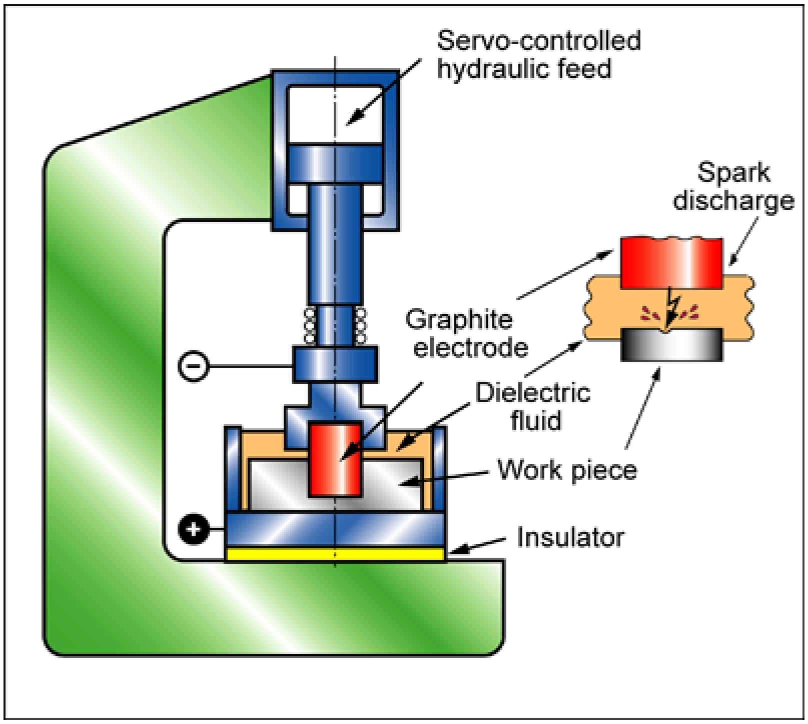


Figure caption

Electro-discharge machining

The process

In ELECTRO-DISCHARGE MACHINING (EDM) the work-piece is held in a jig submerged in a dielectric fluid such as kerosene. A power supply generates rapid electric pulses that create a discharge between the work piece and an electrode (a shaped graphite form) at the point of which the two are closest. The discharge creates a plasma causing the melting (and probably the vaporization) of a minute bite of material, slowly eating into the work piece; the debris is swept away by the dielectric fluid. EDM is remarkable for its ability to shape difficult materials, provided they are conductors, and do so with great precision.

Tradenames

Spark erosion; EDM

Material compatibility

Metals - ferrous	✓
Metals - non-ferrous	✓

Shape

Flat sheet	✓
Solid 3-D	✓
Hollow 3-D	✓

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	high			
Labor intensity	medium			
Economic batch size (units)	1	-	5e3	

Physical and quality attributes

Mass range	0.01	-	10	kg
Range of section thickness	0.125	-	5	mm
Tolerance	0.05	-	0.2	mm
Roughness	0.2	-	6.3	µm
Surface roughness (A=v. smooth)	A			
Cutting speed	0.02	-	1	mm/s
Minimum cut width	0.05	-	0.3	mm
Processing temperature	6.85	-	26.9	°C

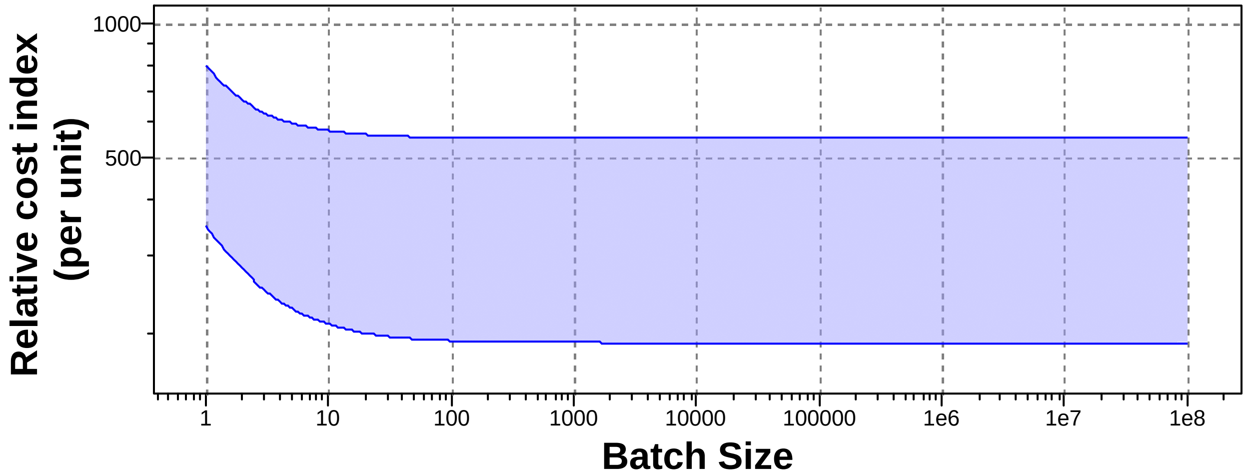
Process characteristics

Machining processes	✔
Cutting processes	✔
Discrete	✔
Prototyping	✔

Cost model and defaults

Relative cost index (per unit)	* 191	-	551

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	* 3.28e4	-	8.2e4	USD
Material utilization fraction	* 0.8	-	0.95	

Production rate (units)	* 0.3	-	1	/hr
Tooling cost	* 82	-	328	USD
Tool life (units)	* 5	-	10	

Supporting information

Design guidelines

EDM is very versatile and very precise, but it is slow and limited to materials that are electrical conductors. It is particularly attractive when limited numbers of parts are to be made from very hard, conducting materials: molds, dies etc. But it has other uses such as the machining of metal foams and honeycombs (fast by EDM and difficult to cut without surface damage by other methods) and low volume production of thin-walled parts in light metals and steels. It is capable of cutting slots as narrow as 0.05 mm.

Technical notes

EDM works by electric breakdown: the enormous potential gradient between tool and work-piece pulls electrons free from molecules of the dielectric, and accelerates them into projectiles, kicking more electrons from molecules as they pass, thereby creating a cascade. The resulting plasma, with temperatures of around 10,000C blasts a tiny nugget of metal from the surface. When the pulse ends, the blast stops. Typical operating conditions are: potential up to 300 volts, current of 0.1 to 500 amps, frequency 200 to 500,000 Hz, using a hydrocarbon as dielectric fluid.

Typical uses

Cutting and shaping of metals and conducting ceramics that are difficult to shape in any other way: dies for molding, stamping, extrusion and forging; making tool fixtures; aircraft and medical parts. EDM is particularly used to cut Stellite, Inconel, Hastelloy, Nitralloy, Waspaloy, Nimonic, Udimet, tool steels, tungsten carbide and titanium alloys. EDM is also used to cut fragile metal structures such a honeycombs and metal foams, doing so without significant surface damage.

The economics

Die and tool costs are low but the slow rate of cutting (measured in a few mm/min) limits its use to small batch sizes. The process can be fully automated with low labor costs, giving an overall cost of about $50 / hour. Typical machining times are 1 to 6 hours.

The environment

The process poses no great environmental

Links

MaterialUniverse

Reference