Description

Image

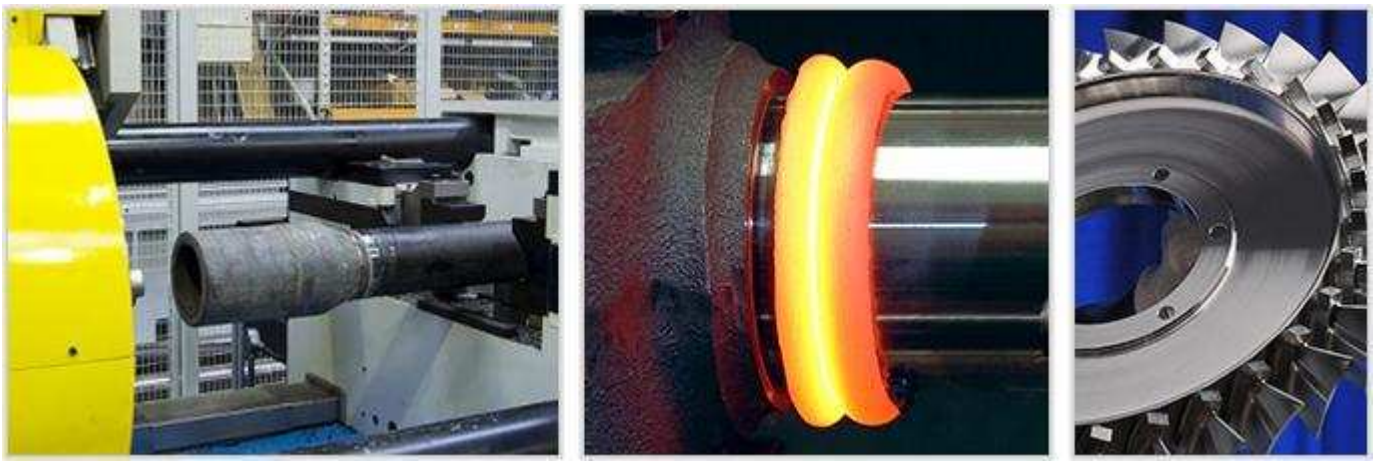

Image caption

(1) A rotatory friction welding machine © Thompson Friction Welding (2) Friction welding process in action © TWI Ltd at flickr (3) Linear friction welded blisk © TWI Ltd at flickr

The process

In FRICTION WELDING, one component is rotated or vibrated at high speed, forced into contact with the other, generating frictional heat at the interface, and - when hot - the two are forged together. In direct drive friction welding, the motor is connected to the work piece and starts and stops with each operation.

In INERTIAL FRICTION WELDING, the motor drives a fly wheel that is disconnected from the motor to make the weld. In friction stir welding a non-consumable rotating tool is pushed onto the materials to be welded. The central pin and shoulder compact the two parts to be joined, heating and plasticizing the materials. As the tool moves along the joint line, material from the front of the tool is swept around to the rear, eliminating the interface. The weld quality is excellent (as good as the best fusion welds), and the process is environmentally friendly.

Process schematic

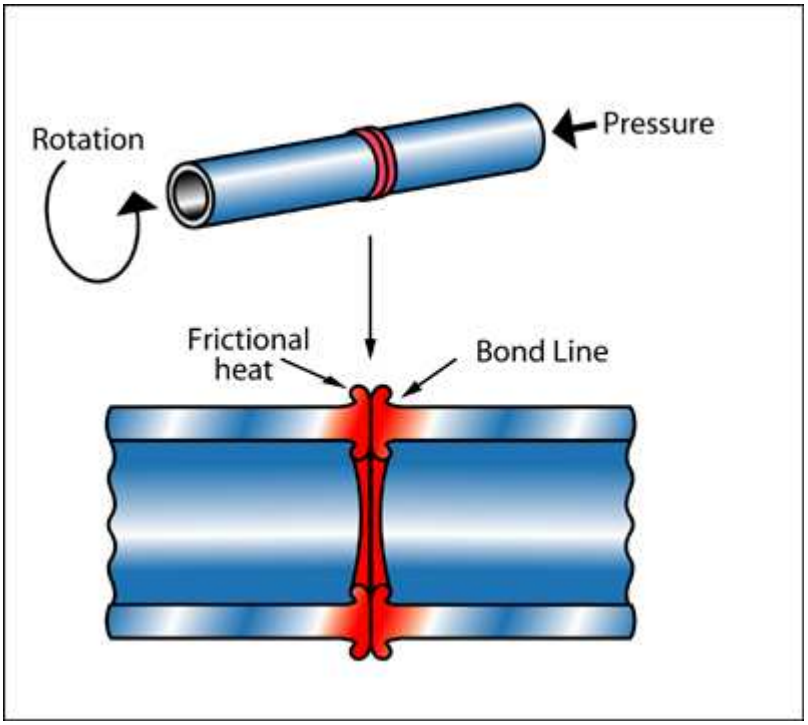

Figure caption

Friction welding

Material compatibility

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

Function compatibility

Electrically conductive	✓
Thermally conductive	✓
Watertight/airtight	✓
Demountable	✗

Joint geometry compatibility

Butt	✓
Tee	✓

Load compatibility

Tension	✓
Compression	✓
Shear	✓
Bending	✓
Torsion	✓
Peeling	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	high
Labor intensity	low

Physical and quality attributes

Range of section thickness	39.4	-	1.97e4	mil
Unequal thicknesses	✓			
Processing temperature	764	-	2.2e3	°F

Process characteristics

Discrete	✓

Supporting information

Design guidelines

Friction welding gives clean, high quality joints between a wide variety of metals - particularly metal matrix composites can be joined in this way. Dissimilar materials can be joined: stainless steel and aluminum for instance. No melting is involved so no protective flux or gas are needed. Linear or orbital motion allows non-circular shapes to be joined.

Technical notes

For small components, rotational speeds of up to 80,000 rpm and a few kilograms load are used; for very large components the rotational speed is as slow as 40 rpm with thousands of kilograms forging load. Weld times range from 1 - 250 seconds.

Typical uses

Friction welding is widely used to join automobile components, agricultural machinery, and for welding high-speed steel ends to twist drills. It is the best way of attaching forgings to shafts or bars, or hub bearings to axles.

The economics

The capital cost of equipment is high, but tooling costs are low. The process is fast and can be fully automated.

The environment

Friction welding is clean and energy-efficient.

Links

MaterialUniverse

Reference