Description

Image

Image caption

(1) Brazing Equipment © Phil Gradwell at Wikimedia Commons (CC BY-SA 2.0) (2) Cyfac filet brazing custom steel bicycle © Cyfac at Wikimedia Commons (CC BY-SA 3.0) (3) Propane torch soldering (Brazing) copper pipe © Kevin L Neff at Wikimedia Commons (CC BY-SA 2.0)

The process

When the components to be joined cannot tolerate the temperatures required for welding, the alternatives are brazing, soldering, mechanical fasteners or adhesives. Brazing is the hottest of these. In brazing a low melting temperature metal is melted, drawn into the space between the two solid surfaces by capillary motion, and allowed to solidify. Most brazing alloys melt above 450 C but below the melting temperature of the metals being joined. The braze is applied to the heated joint as wire, foil or powder, coated or mixed with flux, where it is melted by a gas-air torch, by induction heating or by insertion of the components into a furnace; the components are subsequently cooled in air.

Process schematic

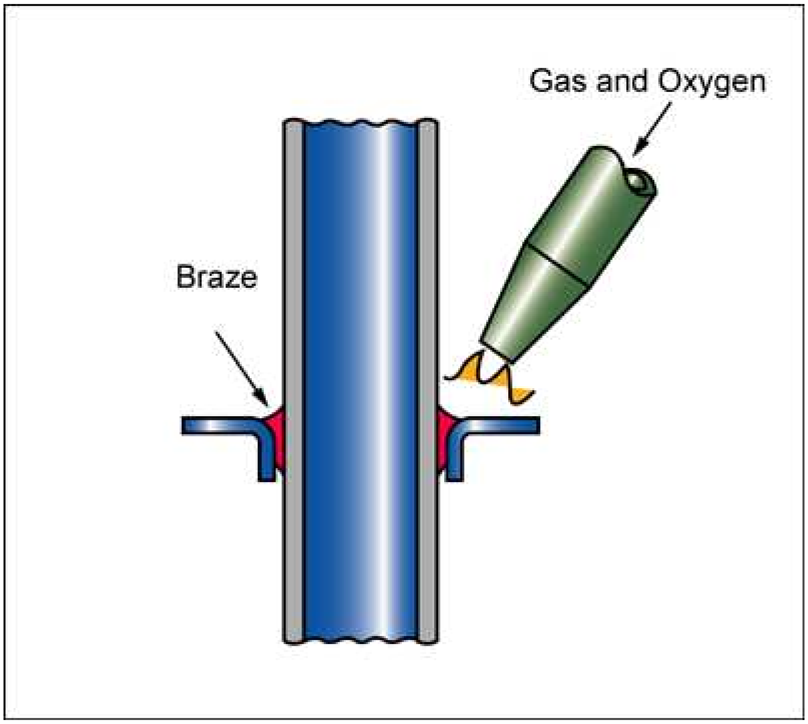

Figure caption

Brazing

Material compatibility

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

Function compatibility

Electrically conductive	✔
Thermally conductive	✔
Watertight/airtight	✔
Demountable	✘

Joint geometry compatibility

Lap	✔
Butt	✔
Sleeve	✔
Scarf	✔
Tee	✔

Load compatibility

Tension	✔
Compression	✔
Shear	✔
Bending	✔
Torsion	✔
Peeling	✔

Economic compatibility

Relative tooling cost	low
Relative equipment cost	low
Labor intensity	low

Physical and quality attributes

Range of section thickness	0.1	-	30	mm
Unequal thicknesses	✔			
Processing temperature	457	-	607	°C

Process characteristics

Discrete	✔
Continuous	✔

Supporting information

Design guidelines

Almost all metals can be joined by some variant of brazing, provided they have melting temperatures above 650 C. The process can join dissimilar metals even when they have different melting temperatures. Brazing is easily adapted to mass production (cheap bicycles are brazed) and the joint is strong, permanent and durable. A large joint area is good - it compensates for the relatively low strength of the brazing metal itself. Joints need a clearance of 0.02-0.2mm to allow a good, strong bond to form. Ceramics can be brazed if the mating surfaces are first metallized with copper or nickel.

Technical notes

Brazing alloys are designed to melt at modest temperatures (450 - 600 C), to wet the surfaces being brazed (often by forming an alloy with the surfaces) and to be very fluid. The most common are those based on brass-like compositions (hence the name) and on silver. Brazing brass (0.6 Cu, 0.4 Zn) and bronzes (the same with 0.0025 Mn, 0.01 Fe and 0.01 Sn) are used to join steel, stainless steel, copper and nickel; silver solders (0.05 - 0.8 Ag, 0.15 - 0.5 Cu + a little Zn) are even better for the same metals. Fluxes play an important role in removing surface contamination, particularly oxides, and in improving wettability by lowering surface tension.

Typical uses

Brazing is widely used to join pipe work, copper piping and boilers, heat exchangers, bicycle frames, fittings and to repair castings and assemble machine parts.

The economics

The equipment and tooling costs for brazing are cheap. Torch brazing requires a certain skill; furnace brazing can be automated, requiring no skilled labor. The process is economical for small runs, yet allows high production rates when automated.

The environment

Brazing generates fumes, and some fluxes are toxic - good ventilation and clean-up are important. Otherwise, brazing has a low environmental impact; the metals involved a non-toxic.

Links

MaterialUniverse

Reference