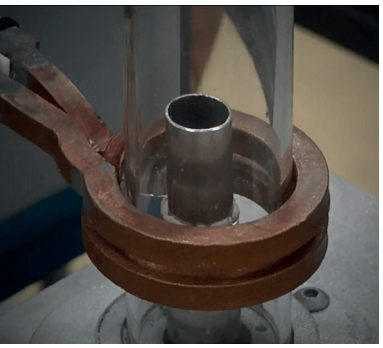
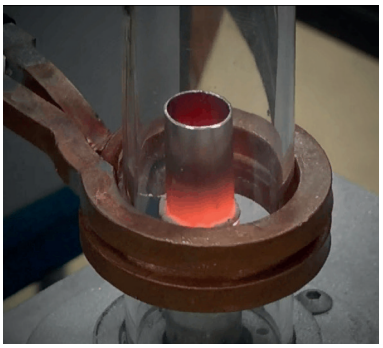
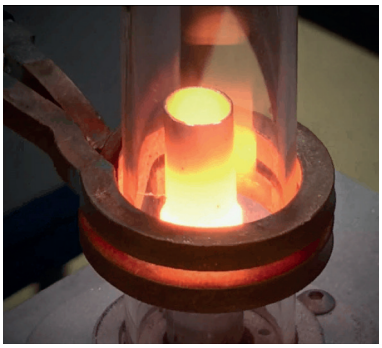
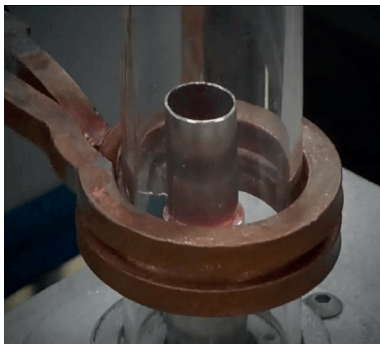
Induction Brazing

Inductive heating

Induction brazing uses inductive heating to bring the components up to the brazing temperature in a controlled manner. In induction heating processes, eddy currents are induced in metallic materials when they are exposed to the alternating electromagnetic field of a coil (inductor).

Due to the electrical resistivity of the metal, these currents generate precise and localized heat without any direct contact between the part and the coil. The heating effect is largest on the surface of the component being heated, called the skin effect. The depth of penetration of the induction heating is a function of the base material and induction frequency. For most induction brazing processes equipment operating at medium range frequencies (1 to 50 kHz) are used. High frequency range (50 to 400 kHz) equipment is typically used for small parts or very small brazing areas. The equipment controls automatically adjust the frequency to give the most optimal heating.

Brazing process

Induction brazing enables the brazing process to be performed very quickly compared to other heating methods. Induction heating enables a heat input up to 30.000 W/cm^2, compared to around 1.000 W/cm^2 for torch brazing. Heat is applied locally, which avoids having to heat the whole assembly. This can be especially favorable for large components with only a few braze joints, where in many cases induction brazing can have a cost advantage over continuous belt furnace brazing. As the process is quick, and introduces heat locally in the area to be brazed, negative effects on the base materials such as sensitization and grain growth can be minimized. With suitable control systems in place, the induction brazing process has a very good repeatability, enabling high production rates and consistently good product quality. Turnkey induction brazing solutions are available from the equipment suppliers.

Induction brazing is a commonly used brazing technique in industries such as the tool industry and the automotive industry. For example, automotive fuel rails are often brazed by induction brazing. Normally the brazing filler metal is applied as preforms, but for some applications it might be favorable to use brazing paste. However, for successful induction brazing using brazing paste, some changes are required compared to when brazing with preforms.

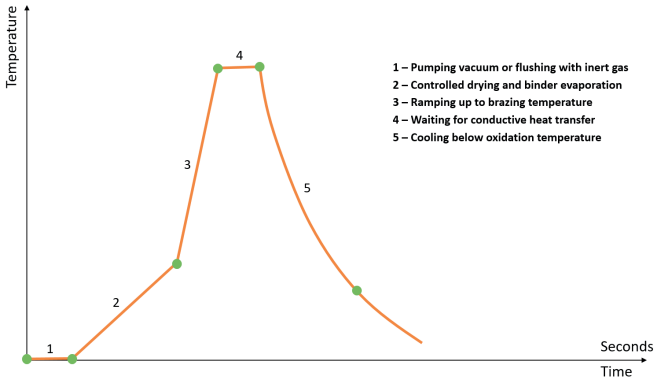


Figure 1:
Schematic induction brazing profile with brazing paste

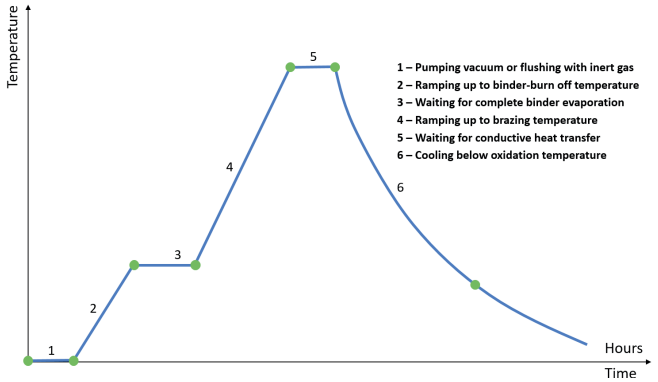


Figure 2:
Schematic furnace brazing profile with brazing paste

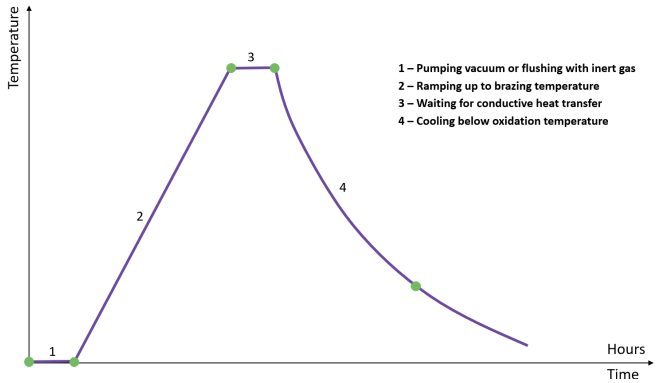


Figure 3:
Schematic furnace brazing profile with brazing filler metal preforms

Considerations for induction brazing with brazing paste

- Close temperature control is required to control the binder burn-off stage. This is normally controlled by including an additional, low-temperature pyrometer. With too fast heating in this temperature range, excessive outgassing can cause the paste to blow off the joint. The brazing paste can ideally be placed inside the component for more controlled drying and binder burn-off, due to heat convection through the base material.
- A protective atmosphere such as N_2, H_2 or vacuum is recommended to prevent oxidation of the base material and filler material during brazing.
- Selection of a brazing paste with proven performance for induction brazing is required, as not all brazing pastes will give good results with induction brazing. Höganäs have brazing pastes in the BrazeLet® product range that have proven to give good results and little or no residues during induction brazing.

Induction brazing profile

The main difference between the brazing profile when doing induction brazing and conventional furnace brazing is the brazing cycle time. While furnace brazing cycles take hours, the induction brazing cycle can be completed within seconds or a few minutes depending on the component. For induction brazing with paste, a controlled drying and binder evaporation stage with lower heating rate is required to avoid excessive outgassing. For induction brazing with solid filler metal preforms, this is not required and the assembly can be heated directly up to the brazing temperature.