Presentation on thermit welding

HISTORY

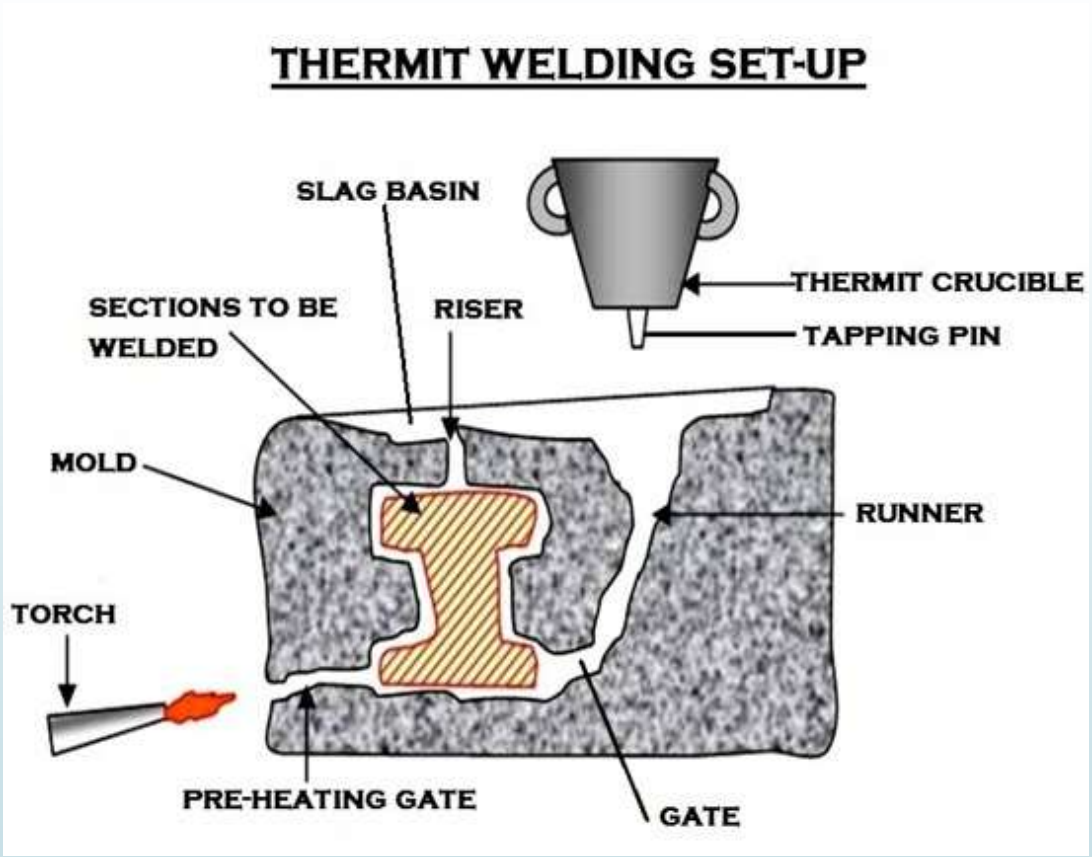
- In 1893 Hans Goldschmidt of Germany began to experiment with aluminothermic reactions.
- Aluminothermic reactions are highly exothermic processes involving reactions of metallic oxides with aluminum powders.
- This work led to a patent application for the Thermit process in 1895.
- Due to the large amount of heat released by exothermic chemical reactions and the versatility of the thermit process, other applications were quickly found and Goldschmidt started a corporation in 1897.
- By the end of the 19th Century, the thermitprocess had been successfully used to makerepairs to large cast and forged steel parts.

INTRODUCTION

- It is a process in which heat for coalescence is produced by superheated molten metal from the chemical reaction of thermite.
- Thermite is mixture of Al and Fe3O4 fine powders that produce an exothermic reaction when ignited.
- Also used for incendiary bombs.
- Filler metal obtained from liquid metal.
- Process used for joining, but has more in common with casting than welding .

PRINCIPLE OF OPERATION

- In thermit welding the heat is produced by highly exothermic reactions between metal oxides (usually iron oxides) and a metal reducing agent (usually aluminium but magnesium).
- The chemical affinity of aluminium for oxygen is the basis for the thermit process.
- Some of these reactions are Eqn.
- $Fe_2O_3 + 2Al = 2Fe + Al_2O_3 + 181.5$ kcal Eqn.
- $3Fe_3O_4 + 8Al = 9Fe + 4Al_2O_3 + 719.3$ kcal
- These reactions produces temp up to 3000 Degree Celsius.


THERMIT WELDING SET-UP
SLAG BASIN
THERMIT CRUCIBLE
TAPPING PIN
SECTIONS TO BE WELDED
RISER
MOLD
RUNNER
TORCH
PRE-HEATING GATE
GATE

- The volume of molten weld metal is also produced by the chemical reactions involved.
- Now this molten metal is used to weld the joint inside a mould.
- For maximum efficiency, the magnetite thermite mixture should contain 23.7% aluminium and 76.3%iron oxide (mass percent).

METHODS OF THERMIT WELDING

- The heat of thermit welding may be utilized in two ways-
- **Fusion welding:**

It may heat and fuse the metal parts, thermit mixture acts as the filler metal also.

- **Pressure welding:**

It may heat the metal parts and raise them to forging temperature, and forging force is applied to join them.

PROCEDURE&PREPARATION OF THERMIT

- The ends of parts to be joined are kept parallel with a uniform gap between them.
- That gap is filled with wax which becomes the pattern.
- Molding sand is rammed around wax pattern. Pouring gate, heating gate and risers are cut.
- Joints to be welded are preheated by a flame (external source). Due to preheat wax melts and goes out.
- After melting of wax, weld joints are preheated due to flame.
- Then heating is stopped and heating gate is closed.

- The mixture of aluminum and iron oxide is placed in a crucible.
- Barium Peroxide is added to the crucible. Barium peroxide arises by the reversible reaction of O2 with barium oxide. The peroxide forms around 500°C and oxygen is released above 820°C
- Mixture is ignited using a match stick (or) small magnesium wire. So combustion takes place in the crucible.
- Due to combustion, thermite mixture becomes superheated liquid within max. time of 30 seconds.
- That superheated liquid (pouring metal) have temperature of 2500--3000°C (around 5000°F)
- • The reduction of ferric oxide by aluminum is highly exothermic and therefore the iron formed will be in the molten state.
- • Aluminum is chosen as metal since it has strong affinity towards oxygen and its oxide, Al2O3 is a highly exothermic compound.
- • Reaction takes place: $Fe_2O_3 + 2Al \text{ --------> } Al_2O_3 + 2Fe + heat$

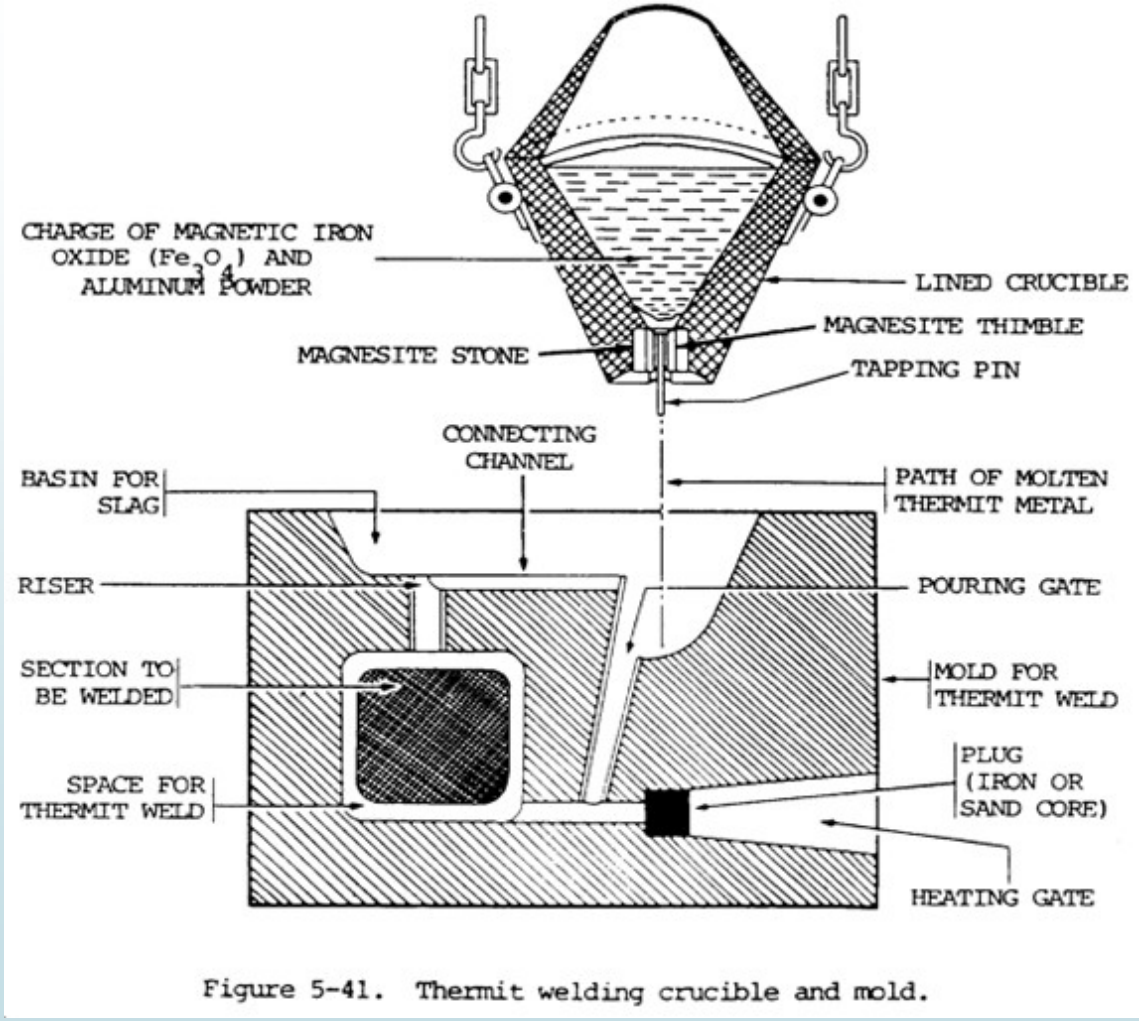


Figure 5-41. Thermit welding crucible and mold.

JOINING PROCESS

- Crucible is placed directly above the joints to be welded.
- After preheating of joints, liquid thermite steel from the crucible is poured into mold between the gap to weld.
- The molten metal solidifies and weld is completed.

ADVANTAGES

- It is very portable process.
- No external power supply required.
- It is very cheap process for repairing broken parts of large metal structures such as rail lines, large parts of ships.
- On site welding can be done for railways.

LIMITATION

- Can only be used for ferrous metals.
- It is uneconomical when used for welding cheap metals or light parts.
- Thermite mixtures can not be stored due to safety hazards and should be used as soon as prepared.

APPLICATION

- Repairing fractured rails
- For butt welding pipes end to end
- For welding large fractured crankshafts
- For welding broken frames of machines
- Welding of sections of casting where size prevents there being caste in one piece
- Replacing broken pieces or large gears
- End welding of reinforcing bars used in huge concrete constructions

Thank you