ALUMINO THERMITE WELDING (ATW)

The thermite welding process is a simple exothermic chemical process and has been used for over a 120 years. Thermite welds have a lower tensile strength than Flash Butt Welding (FBW). Thermite welding requires the lowest capital investment and can be applied economically in many instances where FBW is too difficult to access site or the mobilization of FBW is too costly for a few welds. Thermite welding requires some experience for setting the rail joint and adjusting the preheating flame. The actual "welding" process is without manual welder skill activity.

Welding crane rails requires a high level of precision, efficiency and safety. The considerable crane wheel loads as well as the duration and frequency of the load place huge mechanical demands on the weld.

Thermite-welding is a process that realizes joining of two separate rails, end to end. It fuses them together with the heat obtained from superheated molten iron. The major advantage of Thermite-welding is its portability from place to place. It is economic as it does not need costly equipment.

For rail joint welding on site, aluminothermic rail welding has been adopted worldwide as the standard procedure. For welding, the ends of the rails are set with a gap between and aligned. The gap between them depends on the process, within pre-prepared rail casting moulds and sealant in form of paste or sand.

The mould system and rail is preheated. The weld portion is ignited in crucible and molten metal flows into the moulds at approx. 2,500 °C, the hot steel is channeled into the mould, where it melts the pre-heated rail ends and joins them together with a seamless weld. After about 3-4 minutes the casting mould and weld excess are removed.

After the weld has fully cooled it is ground to the correct profile.

The aluminothermic reaction of thermite-welding provides, in its basic configuration, both heat and filler metal without additional external power source, except for preheating. The process therefore is suitable for welding in remote areas where common supplies are not available.

An example of the several formulations available is reported hereafter

$$Fe_2O_3 + 2Al \gg 2\ Fe + Al_2O_3$$

NOTES - ALUMINO THERMITE WELDING

The proportions of the components in this and similar mixtures are about three parts by weight of iron oxide to one part of aluminum in powder, thoroughly intermixed. The reaction of the Thermite-welding powder mixture is started at about 1200 °C (2200 °F) using a special ignition rod. The reaction is extremely rapid taking less than one minute to complete irrespective of the total weight of the reacting materials.

Care must be used to assure that all materials and molds are completely dry to prevent the formation of steam under pressure that could eject molten metal. The maximum reachable temperature is 3090 °C (5600 °F) that has to be reduced quickly to about 2480 °C (4500 °F) by the addition of non-reacting pellets of ferroalloy, because at 2500 °C (4530 °F) the aluminum would vaporize.

Thermite-welding temperature cannot be much lower, since the alumina slag (Al_2O_3), that must remain liquid to float and separate from the metal, would solidify at 2040 °C (3700 °F) and less.

Rail sections, must be cut square, cleaned of all contaminants and then aligned with the proper gap, mostly that standard gap is 25 -30 mm depending on weld portion. A mould in the shape of the rail profile has to be assembled around the joint prepared for Thermite-welding with proper sealing of all clearances between mould and rail.

Preheating of the joint faces by external means of fuel oxygen flame is usually required to assure elimination of all moisture in the mould and raise the rail parent material to promote complete fusion. After the weld metal is solid and cooled down, the mould is removed and the joint is finished by grinding.

EN BS 14730 2017 and the aluminothermic welding of crane rails.

The EN BS 14730 “Railway applications – Track – Aluminothermic welding of rail” is a European and British Standard. The standard is divided into two parts. Part 1 includes all the testing procedure for the process and all materials used for the production of the aluminothermic weld (Part 1 “Approval of the welding processes “). Whereas in Part 2 the welder and welding contractor qualification process and the documentation of the performed welding is defined. (Part 2 “Qualification of aluminothermic welders, approval of contractors and acceptance of welds”).

From the outset we would like to note that many of the individual test and documentation requirements for aluminothermic welding of railway should be incorporated into a aluminothermic welding approval document for crane rails, whereas some criteria should be changed to reflect the different application of crane rail and railway rail.

At this stage the EN BS 14730 - 2017 does not apply to aluminothermic welding of crane rail for the following reasons:

a. The welding processes between crane and railway rail differ substantially. The welding gap, the preheating temperature and duration thereof are different.

b. The profile geometry of the rails differ in that the crane rails tend to have thicker webs and wider rail head with larger radii to afford a greater running surface for the crane wheels. None of the crane rail profiles are mentioned in the EN BS 14730 – 1, Table 1 (standard rail profiles EN 13674-1, groups 1-3) to qualify the process.

c. The process of the crane rail welding supplied by the aluminothermic welding suppliers such as Pandrol and Goldschmidt differ to that of the approved processes under EN BS 14730.

Presently there is no standard or norm applicable to the aluminothermic welding of crane rails.