Nonconventional welding (hybrid welding)

The aim of nonconventional welding is increasing of joining process efficiency. Welding is today a key manufacturing process, present practically in all industrial sectors. One of the principal directions for the progress of the welding is the development of hybrid welding processes. These are created by combination of two conventional welding processes and through effects of the advantages with respect to each individual welding process, first of all an increase of the process stability and efficiency.

Hybrid welding processes combines two welding processes to improve or increasing of joining process efficiency. The first hybrid welding process was the plasma – MIG welding which represents a combination between plasma welding and shielded gas welding with fusible electrode (MIG welding). At present over 20 hybrids welding processes are known, the most important as the following:

- Laser arc hybrid welding which combines the laser welding with a TIG or MIG shielded gas electric arc welding process;

- MIG welding combined with submerged arc welding.

- Resistance spot welding combined with brazing.

- Laser activated friction stir welding

- A-TIG welding (chemically activated TIG welding).

- Ultrasonically activated TIG welding.

PLASMA – MIG HYBRID WELDING

The plasma – MIG welding process is a combination between the plasma welding and the MIG welding. The electric arc produced between a fusible electrode (wire) and the component is situated in the hot ionized gas current of a plasma arc. The process principle is illustrated in figure. Usually, the plasma arc is supplied in direct current direct polarity and the MIG arc in direct current reversed polarity.

The MIG arc ignites in the interior of the plasma stream which assures a contraction effect. Two operating modes are possible. In the case of a MIG current having a

reduced value the electric arc is narrow, this technological version can be used for thin plates high speed welding or when welding thick plates at reduced welding speed. The second version uses a high intensity MIG current. In this case the wire melting rate increases.

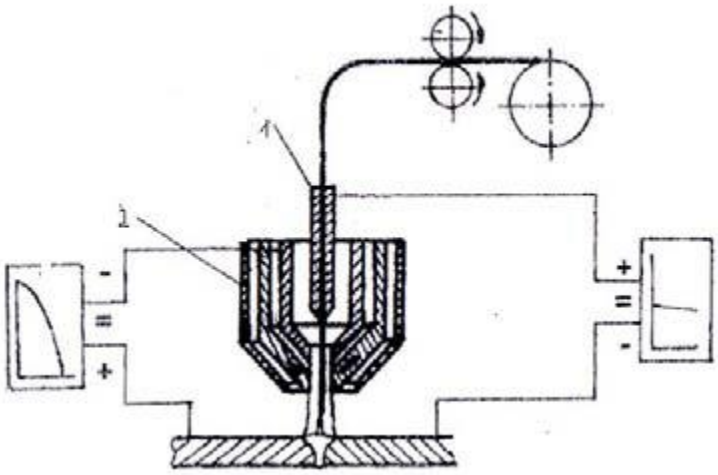

Figure 38 Principle of plasma – MIG hybrid welding (1- MIG, 2 -Plasma)

There appears a rotation effect of the plasma arc which has as effect a rotation of the MIG arc and a deposition of the melted metal with small drops on a higher radius action. The result is a greater width of the weld and reduced penetration, recommended for the application of hardfacing by welding. The plasma – MIG welding is achieved by high efficiency, the deposition rate exceeds that corresponding to the two original processes (up to 25kg/h). This process can lead to very good quality welded joints, too. The process is applied in fillet and butt welding of relatively thick plates and in hardfacing by welding. A new welding version is realized by combining the plasma welding and TIG welding, resulting in this way, plasma – TIG welding. The welding root is deposited by plasma welding and the filling is performed by cold wire TIG welding.

Laser – Electric Arc Hybrid Welding

The laser – electric arc hybrid welding is based on the overlapping, in a single melted pool, of a laser radiation action and an electric arc (TIG or MIG) as shown in figure.

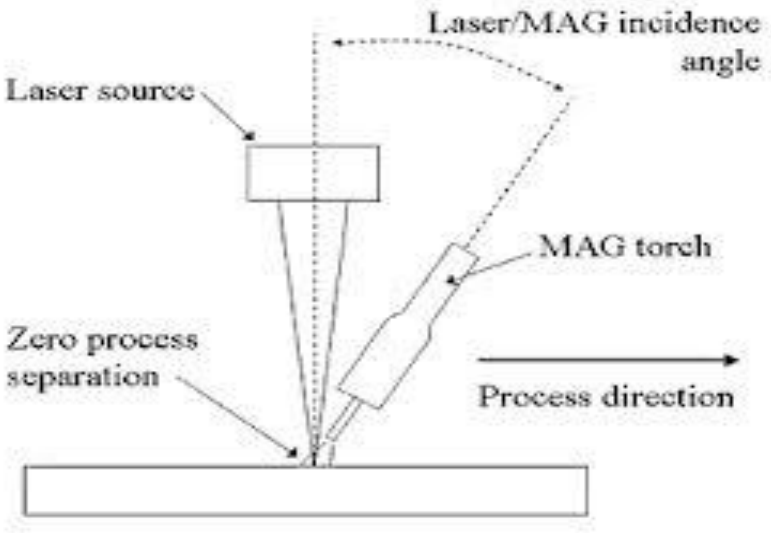

Figure 39 Laser – electric arc hybrid welding

Advantages of Hybrid Welding

The new process combines the advantages of the two welding processes, namely productivity by energy concentration, high welding speed, deep penetration and reduced heat influence on the material and as an effect the reduced level of deformation by welding, specific characteristics of laser welding, with the toughness application by using a filler material. So, the hybrid welding is applicable mostly for the series produ ction welding of thicker materials considering greater tolerances to prepare components for the welding operation.

The hybrid process eliminates the metallurgical problems specific to laser welding caused by the too high speed cooling of welding. As compared with the laser welding the hybrid process assures an improvement of the "surface absorbability" of the laser radiation following the pre-heating effect produced by the TIG arc.

As compared with the TIG welding, the hybrid laser – TIG welding:

- Increase of the anodic spot magnitude and stability of the electric arc under the effect of the laser.

- Possibility to weld with a longer electric arc.

- Ignition without pulses of high voltage.

- Higher welding speed.

- Increase the weldable material thickness without groove preparation.

The melted metal volume in the case of hybrid laser – arc welding of aluminium is up to 80% higher than the sum of melted metal volumes obtained from the two welding processes considered separately. The main industrial applications of the hybrid laser – electric arc welding are: naval industry, automobile industry, as well the fabrication of special steel pipelines having a difficult welding behaviour (ex. supermartensitic steels).

To improve welding efficiency, the laser-MAG welding process was developed, a version which uses two MAG (Metal Active Gas) welding wires which melt in same time with the high intensity electric arc. This version can be applied to weld pressure vessels and pipelines, by the reduced melted metal volume and as a consequence, the more reduced level of deformation by welding. The hybrid laser – plasma welding is possible, a version which is used in rapid prototyping processes.