# Obtaining of New Flux Coated Electrodes used for Welding-brazing Operations

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*The paper presents the technological steps to obtain new electrodes, made by Cu-Zn alloy, coated with one flux layer, which may be used to welding-brazing of thin plates from ferritic steels, with applications in automotive industry. The experiments realised for elements casting, was made on induction furnace, and the production technology of experimental batch for flux coated electrodes, begins with the elaboration of the alloy and his casting. The obtained electrodes have low production costs and good welding properties.*

*Keywords: electrodes, welding-brazing; flux; galvanized steel*

The implementation of new technologies for metallic assemblies and structures by welding-brazing, without using welding electrodes at high temperatures, allows the decrease of manufacture, service and repair costs, with the maintaing of quality standards for assembled products [1-4].

In the case of galvanized steels, keeping intact the zinc layer after welding-brazing, increases the life of products. The assembly may be realized without vaporization of zinc layer, the phenomenon which appears at welding [7].

The thin steel sheet, with the surface of which has been made deposition of zinc layers, are known under name galvanized steel plates, these being duplex structures made by construction steels with zinc layer deposition, with different thicknesses and textures [13].

There are known many technological methods to obtain a welding-brazing structure, but the most used is the method with oxy-fuel burner and MIG/MAG electrical methods [14-19]. The alloys used to obtaing of welding-brazing structure of duplex steels, are the alloys from Cu-Zn system [8].

For industrial applications, which implies steel joints, the Cu-Zn alloys, with minimum of 40% Zn, presents interest. The principals brasses marks for brazing, according SR EN 1044:2002, from Cu-Zn system, used for steels, are presented in table 1 [6,17].

**Table 1**
USUAL BRASSES COMPOSITION USED FOR BRAZING

| Alloy | Chemical composition, % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Cu | Si | Sn | Zn | Pb | Fe | Sb | Sn |
| BCu58Zn | 58-62 | 0.2-0.3 | - | rest | 0.5 | 0.5 | 0.3 | 0.3 |
| BCu59Zn | 59-61 | 0.2-0.3 | 0.8-1.2 | rest | 0.5 | 0.5 | 0.3 | - |

Comparative with the welding of two materials, which implies the local melting and their merge, the welding-brazing represents the method in which the two materials are joined by the melting of aditional material, at temperatures over 450°C and penetration of these materials in the area in which is desired, to realize the assemble.

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Technological parameters for obtaining the welding-brazing joints, for duplex materials made of carbon steels, are as following:

- melting temperatures for aditional material: 870-890°C;
- the pre-heating temperature for intervention area, by welding-brazing: 120°C;
- work atmosphere: air (oxy-fuel welding-brazing method) and argon (at MIG weldin-brazing method);
- aditional material: Cu-Zn alloy with 60%Zn;
- fluxes for steels welding-brazing: type FH;
- material thickness for welding-brazing: 2 mm;
- filler material: Cu-Zn alloy, ~60% Zn.

The joint gap is choosen such that to permit the action of capiliarity effect, and, in same time, the flux movement with aditional metal, in the time of his flow in the joint (fig. 1 and 2).

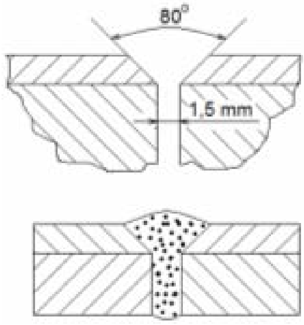


Fig. 1. Chamfering for the simple joint made by welding-brazing

Due to the corrosive nature of flux, some precautions in joints design must be taken, in order to prevent the appearance of inclusions. Butt joints or joints with overlapping edges, which permits the aditional material flow by capilarity phenomenon, could be used.

The joint gap, at welding-brazing temperature, must be between 0.10 and 0.25 mm, for thin plates made from duplex materials, from carbon steels, and for plates and profiles, which have the thickness more than 5 mm, the rost must be done at 1.5 mm. It is necessary to make the small posible gap, because these things permit a acceptable flow of aditional material and corresponding capilarity.

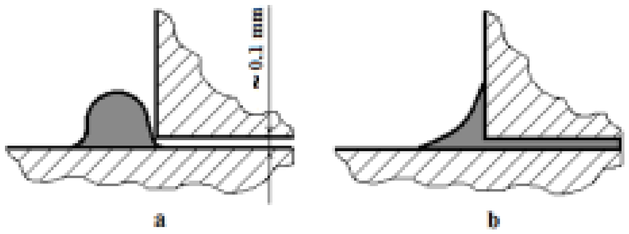


Fig.2. The assembling process by welding-brazing:
a) Initial phase of process and the acces by capilarity
of the alloy in joint area; b) Final phase of assembling process

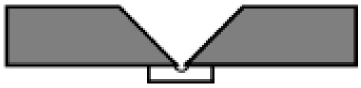

Fig. 3. Cooper profiled suports for welding-brazing method

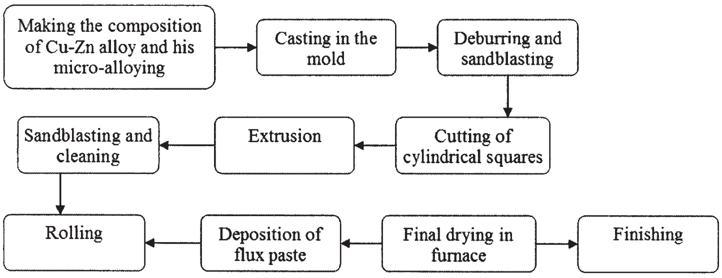


Fig. 4. Technogical steps for
obtaining flux coated electrodes

In the case of profiles thicker than 3 mm, for which is applied the butt joint method, profiled supports from cooper, placed under the plates from duplex materials, by carbon steels (fig. 3) could be used.

*The flux coated electrodes obtaining technology*

The production technology of experimental batch for flux coated electrodes (necessary in the case of welding-brazing method with coated electrode) starts with the elaboration of Cu-Zn alloy and the casting [9-12], according to the chart presented in figure 4. Chemical composition of alloy presented in table 2 must satisfy the preset conditions for material electrode.

The melting was made in a metallic mold with cylindric shape of 35 … 40 mm diameter, formed by two metallic semi-molds, realized by processing from two iron cast plates and designed to obtain cylindric cast elements (fig. 5).

The preparation of cast mold consist by painting with special dyes, based on graphite, in order to prevent the occurrence of alloy adhesion after casting and solidification and also contamination of cast alloy with iron oxides, that occurs from the mold walls.

The experiments realised for elements casting, was made on Balzers induction furnace, type HU-40-25-40-04 (fig. 6). In the experiments are used advanced crucibles, base on magnezite $MgO{\cdot}Al_2O_3$, used to obtain alloys of high purity.

After the solidification, the elements are processed by deburring and sandblasting, after these are cut in cylindrical elements, with 30 mm diameter and 150 mm height. These are extruded on a vertical extruder stranded, mounted on a vertical pressure of 350 tf.

Before the use of mold container (fig. 7), punch and pill die was heating at 150°C and are painted with a special paint, based on colloidal graphite.

Before extrusion, in the container habitation was introduced a special lubrifiant for extrusion, and the elements were heating at 300°C. The extrusion speed was by 0.1 m/s.

After extrusion, the obtained wires for electrodes, with 2.5 mm diameter, will be cleaned, sandblasted and preparated for rolling operation.

The wires for electrodes, resulted after extrusion, are subject to roll fingerprinting surfaces, to create an additional relief necessary to adhesion of flux paste electrodes. The mold for flux deposition is composed by 2 semi-molds (fig. 8), which have alveolar cylindrical cavities, which are separated by small bridges. The alveoli for the flow are made from 4 to 4 mm, and designed for compacting the mixture of salts that comprise the coating of the electrode (fig. 9).

The wire of the electrode is fixed on central area of metallic mold, in order to deposit the flux paste. Fixing of the electrode wire was made in such way that his active part remains uncoated on a length of about 20 ... 25 mm.

After fixing the electrode wire in the mold, this is prepared for flux deposition [16], as following:

-filling the mold with an omogenous paste made of flux salts combination, with 2.5 … 3 mm tickness;

-shaving is performed and the pressing of the wire electrode in the axial direction, in order to set the mixture of salts;

-carefully extract electrode from the mold;

-after drying is completed, the paste electrode areas not yet covered is subject to new drying operation;

-final drying of the layers is made in the oven for 1 hour at 250°C;

-last operation is grinding the surface of the electrode, resulting in the final electrode coating thickness of approx. 1 mm.

**Table 2**
CHEMICAL COMPOSITION OF ADDITIONAL MATERIAL
USED IN MIG WELDING-BRAZING JOINT

| Element | Cu | Si | Mn | Pb | Fe | Sb | Sn | Al | Ti | Zn |
|---|---|---|---|---|---|---|---|---|---|---|
| Concentration % | 58-62 | 0.2-0.3 | 0.4 | 0.5 | 0.5 | 0.3 | 0.3 | 0.1 | 0.2 | rest |


Fig. 5. Casting mold – assembled (a)
and disassembled (b) and respectively
the elements extracte from the mold
casting (c)

Fig. 6. Balzers furnace used for Cu-Zn alloys elaboration.


Fig. 7. Mold for the extrusion of electrodes

Fig. 8. General aspect of semi-molds, used for flux coating deposition on electrode wires.

Fig. 9. Experimental electrode extracted from mold, with partial flux deposition and respectively the final welding-brazing electrode

The use of wire-flux systems make possible the optimization of assembling materials. In this case, on the metallic bath and on the zinc layer can be made fine adjustments of alloying level and zinc protection for steel parts, fact which permit a rational use of alloying elements.

## Conclusions

The welding-brazing of carbon steels structures, duplex type, is a joint solution, compared with classical solutions like welding or brazing, and ensure the following:

- obtaining identical mechanical and corrosion resistance to initial materials, after assembling intervention by welding-brazing, including joint area;
- simplyfing the service and maintenance technologies of structures, along with the obtaining of mechanical and corrosion resistant joints;
- decrease the weigth of structural components, by elimination of assembling processes with screws or rivets;
- elimination of the necessity further environmental protection for assembling areas with protection layers based on paints and syntetic resins;

The additional material must have the melting temperature lower than base metal and in particular case of galvanized steel (912°C).

In welding-brazing experiments realized on duplex metallic materials, are used Cu-Zn alloys like filling materials, characterized by an omogenous composition and 870…890°C melting temperature.

In welding-brazing processes, it is necessary that the joints surface to be cleaned, without oxides or salts. The pickling materials create on joints surface a thin layer made of salt mixture, which are designed to decrease the superficial tension between additional material of electrodes and the surfaces which will be jointed.

## References

1.BERGER, D.M., WINT, R.F., New Concepts for Coating Protection of Steel Structures, ASTM Special Technical Publication Philadelphia, 1984
2.DANA, D., SANDU, I.G., VIZUREANU, P., SANDU, I., Rev. Chim. (Bucharest), **64**, no. 12, 2013, p. 1465
3.DANA, D., SANDU, I.G., VIZUREANU, P., SANDU, I., Journal of Optoelectronics and Advanced Materials, **15**, no. 9-10, 2013, p. 1153.
4.BUZAIANU, A., Sudo-brazarea otelurilor galvanizate, Ed. PIM, Iaşi, 2008.
5.CHAISRI, M., PEASURA P., Advanced Materials Research, **16**, no. 20, 2011, p. 341.
6.DANA, D.I., VIZUREANU, P., CIMPOEŞU, R., RATOI, M. Metalurgia International, **18**, Spec. 1, 2013, p. 122.
7.FERARU, L., GÂLEA, A., TANCO, C., TRIF, I. N., Metalurgia International, **16**, no. 3, 2011, p. 71.
8.FORTAIN, J.M., GUIHEUX, S., OPDERBECKE, T., Welding International, **27**, no.1, 2013, p. 30.
9.FUNK, E.R., Handbook of welding, Delmar Pub, 1985.
10.GAWRYSIUK, W., Welding International, **20**, no.1, 2006, p. 10.
11.IORDĂCHESCU, D., QUINTINO, L., MIRANDA, R.M, The Bulletin of Institute of Welding and Material Testing, **3**, 2007, p. 12.
12.JOSEPH, A., Welding Journal, **36**, no.10, 2001, p. 36.
13.LEE, H.S., Applied Mechanics and Materials, **302**, 2013, p. 136.
14.LEVY, C., Solder, **3(5)**, 1997, p. 49.
15.LI, Y.L., Advanced Materials Research, **4**, 2011, p. 233.
16.SALLEH, M.A.A.M., AL BAKRI, A.M.M., SOMIDIN, F., SANDU, A.V., SAUD, N., KAMARUDDIN, H., MCDONALD, S.D., NOGITA, K., Rev. Chim. (Bucharest), **64**, no. 7, 2013, p. 725.
17.POP, D.M., ROMINU, M., TOPAU, F.I., SINESCU, C., DODENCIU, D., ROMINU, R.O., ARDELEAN, L., RUSU, L.C., ANDONI, M., PETRESCU, E.L., NEGRUTIU, M.-U., Rev. Chim. (Bucharest), **62**, no. 12, 2011, p. 1203.
18.DANĂ, D.I., Teza de doctorat: Contribuţii privind caracterizarea unor materiale sudo-brazate, de tip duplex, din oţel carbon.
19.*** http://www.asro.ro

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