Study on the Corrosion Resistance of Welded-Brazed Joints

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In order to study the effect of braze welding to processed area, from corrosion resistance point of view, different types of samples were obtained. The samples included different types of braze-welded joints of duplex type steel sheets. As method we chose salt fog atmosphere, being very aggressive, and the corrosion on zinc and braze-welded joints are accelerated, allowing the shortening of the tests with good results.

Keywords: braze welding, duplex steel, corrosion resistance, joints

The new generation materials used for braze welding and especially the hybrid and composite ones tend to respond to a large number of requirements for various industrial applications. They selectively offers new advantages compared to using conventional technologies or repairs using conventional alloys [1-9].

The technology of blending the materials made of steel, duplex type (protected with a layer of zinc) must be designed so that, in the operation of brazing-welding the possibility of evaporation of the zinc coating must be avoided, thereby maintaining the original quality of the material [10-15].

In the experiments of brazing-welding of carbon steel duplex we used alloys falling in the category of Cu-Zn, respectively Cu58Zn. They are characterized by a homogeneous composition.

Experimental part

Materials and methods

At the application of a brazing-welding technology to metallic components, duplex type made of carbon steel, the base material is ferrite carbon steel, for which the content of carbon is very low (table 1). These types of duplex materials are obtained by depositing a coating, where the primer layer is a combination of Fe-Zn. Galvanic deposits are obtained for specific mass of about 91g Zn/mm^2. The detachment of the zinc coating appears on values over 140-200 MPa.

The corrosion resistance test were applied according to the following standards: ASTM B117 – Practice for Operating Salt Spray (Fog) Apparatus, D609 – Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings and Related Coating Products, D1141 – Practice for the Preparation of Substitute Ocean Water, D1193 – Specification for Reagent Water and D1654 – Test Method for Evaluation of Painted or Coated Specimens [14-19].

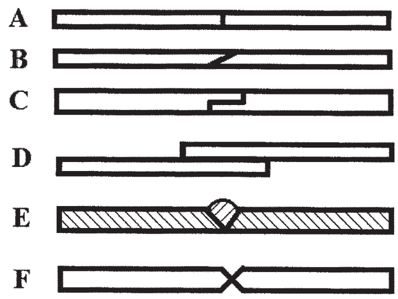

Fig. 1. The types of the joints used in welding-brazing operation: Type A – head to head, Type B – oblique head to head, Type C - with adjustment and overlapping, Type D – with overlapping, Type E – with chamfering, Type F – double chamfering.

For the test in salt fog the samples were divided into experimental sets and were introduced in the instalation (fig. 2). In table 3 are presented the parameters of the test procedure for corrosion resistance of duplex carbon steel materials.

Results and discussions

We should point out that the zinc coating of steel is an anti-corrosion protection, of cathodic type, due to the strong anodic character the deposited zinc layer plays on the substrate made of carbon steel, which after deposition substantially modifies the electrochemical potential to negative values, thereby achieving protection of the steel layer regardless of the type of coating process which has been used. Due to the strong electronegative character of

Table 1
CHEMICAL COMPOSITION OF THE STEEL

Element	C	Mn	P	S	Al	Si	Nb	Ti	N_2
Percent	0.001 … 0.15	0.12 … 0.30	0.01 … 0.02	0.005 … 0.02	0.037 … 0.01	0.07 max.	0.022 max.	0.032 max.	0.0025 max.

Table 2
CHEMICAL COMPOSITION OF THE WELDING MATERIAL

	Chemical composition									
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	max. 0.2	rest

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Concentration	Temperature	Time
5% NaCl	25°C	480 hours

Table 3
PARAMETERS OF THE TEST PROCEDURE

Fig. 2. Installation for testing specimens in salt fog chamber (solution 5% NaCl) ; 1 – the chamber with the mounting racks, 2 – general view of the system with the pressure cylinder for salt solution, 3 – the control panel (SC METAV-CD SA Bucharest)

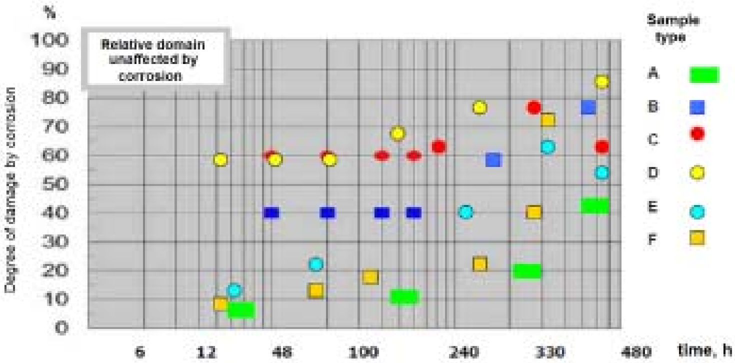

Fig. 3. Representation of the percentage of the degree of damage by corrosion of the samples, based on the hold time and the salt spray test specimen set

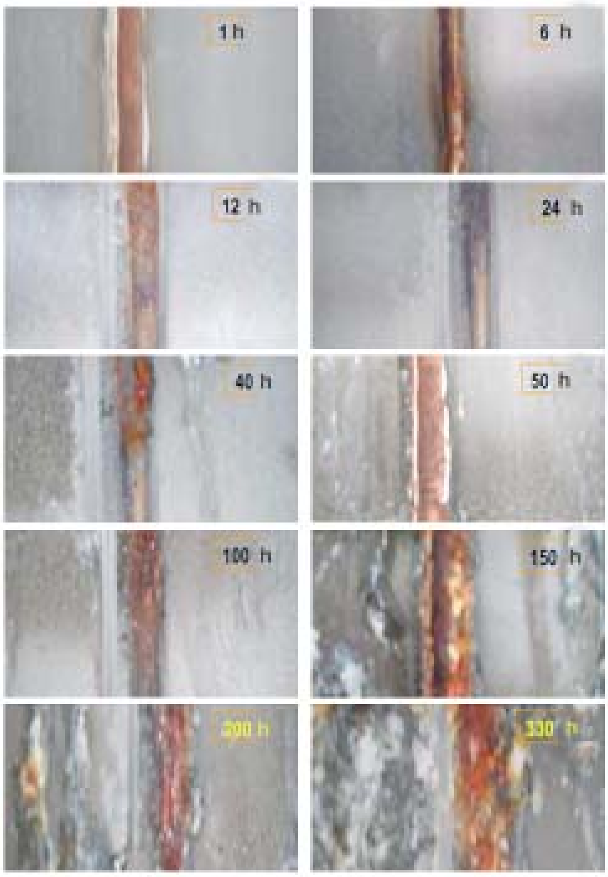

Fig. 4. Corrosion evolution from 1 to 330 h

zinc (E = -0.76 V), compared to iron (E = -0.44 V), in the duplex steel in which the couple Zn-Fe, zinc becomes the anode and corrodes (it is consumed) and the steel substrate will not corrode as it becomes the cathode (cathode is protected).

In figure 3 is presented the percentage of the degree of damage by corrosion for the test samples.

The degree of damage means the percentage of the total area of the sample that was affected by the corrosive effect. Evolution of corrosion on samples having dimensions of 100 x 50 mm is done by visual observation, direct, qualitative and quantitative. For the tests conducted by us, the maximum speed of corrosion is that for which we obtained a maximum, corroded surface of the specimen per time unit.

The damage to the samples and Evolution of corrosion can be seen in figure 4.

From the comparative analysis conducted on samples subject to accelerated corrosion in salt fog (fig. 4.) showed that in the early hours of testing, the least affected by the corrosive effect was sample type A, followed by those of type F.

At the end of the corrosion test after 480 h of exposure, the less affected by the effect of the corrosion tests were also type A samples followed by the type E. The most affected samples were D type, for which the joint was done by overlapping and brazing-welding on both sides.

The results of corrosion tests reveal good corrosion behaviour of welded-brazed areas, since in the salt fog the ferritic steels reacts to corrosion. The ferritic mass reacts

Time, h	Evolution of corrosion
1	Initial sample – not corroded
6	Appearance of a stain of corrosion on the welded-brazed joint
12	Multiplying the spots corrosion on the welded-brazed joint
24	Emphasizing the areas of corrosion
40	Appearance of corrosion areas on steel under the joint
50	Effect on adjacent area of the joint
100	Emphasizing the areas of corrosion
150	Extending the corrosion to adjacent areas of the joint
200	Appearance of multiple corrosion areas with punctual affecting of the steel under joint
330	Generalizing the effect of corrosion
400	Intense corrosion of the joint material
480	Compromising both the joint material and the steel.

Table 4
SURFACE CORROSION OF THE TYPE A SAMPLES IN SALT FOG ACCORDING TO EXPOSURE TIME

even in the first hour. Zinc coatings protect the carbon steel duplex material for a period of 24 h, after which the first spot of corrosion appears. The graph in figure 2 shows that a first reaction of the welded-brazed areas only appears after about 12 h of testing. Corrosion tests carried out indicates that the MIG brazing-welding process in pulse current with coated electrode is a good way of technological approach that can be recommended for direct application to the automotive industry.

Conclusions

For corrosion resistance test of the welded-brazed joints was used an aggressive environment of salt fog (5% NaCl at 25°C, for 480 h).

The results of the corrosion tests reveal good corrosion behaviour of the welded-brazed areas: first reaction occurs after about 12 h, while the metallic carbon steel duplex material, subject to corrosion, under the same conditions, the reaction occurs even in the first hour of the process, due to ferritic mass.

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