REBUILDING AUTO PIECES BY WELDING IN ULTRASONIC FIELD

Oana CHIVU, Polytechnic University of Bucharest, Romania, Department of Materials and Welding Technologies, virlan_oana@yahoo.co.uk

Abstract. In the trucks manufacturing industry, railway industry, metallurgy industry, petrochemical and chemical industries are used several reconditioning technologies, the most common being: restoring plastic using deformation, welding, soldering, metallization, cutting through micro-splintering and deposition of non-metallic materials. The problem of reconditioning of the auto parts is a particularly complex and so the problem arises of finding technical solutions that meet current needs, and in this sense in the paper is approached a technology by reconditioning considering the welding in ultrasonic field.

Key words: rebuilding, auto pieces, welding, ultrasonic field

1. INTRODUCTION

In the auto transport industry for over 45% of the pieces used in the construction of various technological and transport equipment are of different types of wheels and arbors. All these pieces are very highly loaded during the operation mainly at the wear and fatigue, being most often removed from exploitation due to enhance wear on the functional and assembly surfaces [1, 2, 3].

Some examples of used pieces, with widespread use in auto transport industry are presented in Figures 1 ... 4. For example, the wheelset truck (Fig. 1) has a high wear on the bearing spindle (see Figure 2) and the grease box (Fig. 3).

Also, the truck axle spindles are intens wear out, after a certain number of hours of operation (Fig. 4) and the crankshaft bearing spindle (Fig. 5) has an intense wear. An enhanced wear is noticed also at gear wheels used in various subassemblies and assemblies of the equipment used in the auto transport industry (Fig. 6) [4, 5, 6].
In the trucks manufacturing industry, railway industry, metallurgy industry, petrochemical and chemical industries are used several reconditioning technologies, the most common being: restoring plastic using deformation, welding, soldering, metallization, cutting through micro-splintering and deposition of non-metallic materials.

Reconditioning by loading by welding consists of depositing a layer of material on the surface of a piece by welding in order to compensate for wear and restoring the nominal dimensions of the piece. Between the deposited layer and piece is realised the monolithic by continuing the crystal lattice which is obtained either by melting or by pressure [7, 8, 9].

Geometry elements of a reconditioned area by depositi by welding are shown in Figure 7. Layer of deposited material by welding consists of a superelevation area, composed mostly of filler material and denoted in the figure with MA and a penetration area consisting mainly of material melted at loading and marked in the same figure with MB. The two areas are not strictly delimited, because the dilution: base material - filler material plays a very important role. It should be minimal, because with the layer of deposited material must be as close to the filler material and to obtain specific properties and structure for which it was selected a particular filler material [10, 11, 12].

Reconditioning processes by loading by welding can be classified according to the following criteria:
- after the welding process used is distinguished as follows: - oxyacetylene flame; electric arc (manual welding with wrapped electrodes, flux, the environment with protective gas, the slag bath, plasma); by pressure;
- depending on the degree of mechanization and automation, distinguished: manual; semi-automatically; automatically.
- after the presentation form of the filler material, the most commonly used are: powder; with rods; with wrapped electrodes; with one or more wire-electrode filled; one or more pulverulent core wire; with powdered cored wire with self portection; two full bands; powder core band
2. FILLER MATERIALS USED AT RECONDITIONING BY LOADING BY WELDING

The filler materials should be compatible with the base materials, forming the homogeneous metallic connection as consistent as possible, to be deposited by simple processes and without the occurrence of defects, to lead to technical and functional properties better than the base material in terms of greater efficiency.

The selection criteria for loading materials are:
- field of use indicated by the manufacturer;
- alloy group of deposited metal;
- their behavior in various typical requests (specific requests for which were created specific materials are: abrasion, pressure, shock, erosion, heat, corrosion, cavitation, etc..)
- structure of the deposited material layer;
- economic efficiency;
- environmental impact.

Choice of filler material based on the application field is made in the following steps:
- establish actual operating and requesting conditions of the piece in mining (there are framed the real operating and requesting conditions of the piece in one of the recognized specific domains, for which exist recommendations);
- proper select the material by loading by welding using the analyse method of the optimal values.

Characterization and main domains of use of the types of electrodes by loading by welding used in experiments according to STAS 1125/6-82 are listed below:
- type EH 1 - deposited metal is weak or alloyed with max. 0.4% C and the content of the alloying elements Mn, Cr, Si, Mo, etc. max. 5%. It is generally splintered without heat treatment. Examples of use: rails, couplings, shafts, wheels, pieces for vehicles, paths and
rolling wheels generally pieces which work in not too severe wear conditions;

- type EH 2 - deposited metal is like the Type EH 1, but with carbon content above 0.4%. Besides reconditioned pieces with Type EH 1 is recommended for loading parts as: bands and screw conveyors, molds for soft steels, ventilator wheels, kneaders etc.;

- type EH 3 - deposited metal is alloyed, thermally stable, due to the presence of Cr, W, V. Is used for pieces that require good durability at high temperatures. Splintering is possible after annealing. In order to prevent cracking, it is recommended to preheat the pieces and slowly cooling.

   It is recommended at loading of the tools used for hot processing: molds, stante, axises, scissors etc.;

- type EH 4 - deposited metal reaches 1% C and has the properties of high speed steel due to the presence of Cr, W, V.

   Splintering is possible only after annealing and is machinable only by polarization and rectification.

   It is recommended at loading the splintering and cutting high speed steel tools as: cutters, knives, scissors, etc.;

- type EH 5 - deposited metal is alloyed with more than 3% Cr and low content of C (below 0.2%). Splintering is not always possible given the content of chromium and carbon. Hardness is a function of the content of martensite. It is resistant to oxidation and high temperature (even in the gas environment with high content of sulfur).

   Example: loading pistons, valves, pieces for ovens subject to hot wear etc.;

- type EH 6 - deposited metal is alloyed with more than 5% Cr and 0.2 ... 2 % C. The corrosion resistance is lower and hardness is higher than the type EH 5. Loaded metal is machinable only by polarization and rectification.

   Example: molds, axes which work at cold, scissors, etc.;

- type EH 7 - deposited material is austenitic manganese with a content of Mn of 11 ... 18 %, more than 0.5 % C and up to 3 % Ni. Provides high durability to shock wear due to hardening phenomenon. The processing is possible by polishing.

   Examples of use: jaws crusher, hammer of mills, plates, teeth of excavator, axles of wagons and locomotives, etc.;

- type EH 8 - deposited metal is austenitic containing Cr, Ni, Mn. It hardening less than metal loaded with type EH 7 and resists to corrosion. It can be splintered. It is recommended for loading of crus her pieces which are not working under very severe conditions, rails, rail crossings, switch lines, pieces of hydraulic turbines etc.;

- type EH 9 - deposited metal is austenitic with high content of Cr and Ni and provides hot corrosion resistance, oxidation and cavitation.

   It is recommended for loads with low hardness, resistent to corrosion and oxidation;

- type EH 10 - deposited metal is ledeburitic containing Cr up to 35 % and carbon up to 5.5 %. Provides high resistance to wear and is machinable only by polishing. Cracking of the deposit can be prevented by preheating and heat treatment after deposition. Charged metal has good corrosion resistance.
Examples of use: axises, pulled molds, cutting tools, carriages and locomotives axles etc.;
- type EH 20 - alloys based on Co with Cr and W, with or without Ni and Mo. It has a good wear resistance and high hardness at high temperatures. Hot hardness decreases with increasing Fe content. It is recommended to load pieces of type: armatures, valve seats, shafts for pumps, shafts in reconditioning and gearbox etc.;
- type EH 21 - alloys based on W and Cr carbide. They have a very high durability to wear. It is recommended to pre-heat at a temperature of 673 ... 873 °K. Examples of use: dredge, palettes of a fan to assist sandblasting, tools which work in rocky sol, in ceramics industry etc.;
- type EH 22 - alloys based on Ni with Cr and W, has a high durability to metal wear resistance and good corrosion resistance. Durability at heat is high. Examples of use: valves, shafts for cement pumps etc.;
- type EH 23 - alloys based on Ni alloyed with Mo, with or without Cr. They are resistant to corrosion and thermostatable to a temperature of 773°K. There is possible an easy ecruisare. It is recommended to pre-heat at a temperature of 673 ... 773°K.

Use at the load of the contact surfaces of the fan, chemical machines, plating tools of steel alloyed with Cr, Ni, Mo working at high temperatures;
- type EH 30 - alloys of copper - tin. These filler materials have a content of 6 ... 14 % Sn and up to 0.5 % phosphorus. Depending on the tin content, hardness of deposited metal is between 60 ... 130 HB. The metal deposited by welding is characterized by good resistance to chemical corrosion (in the salt or acid environments) and high resistance to the metal to metal wear.

Examples of parts that can be loaded with this type of alloys: valves, housings, bearings, gear wheels, armatures etc.
- type EH 31 - alloys copper - aluminum. These filler materials have a content of 5 ... 15 % Al, aluminum is the main alloy element. In the case of the binary alloy Cu - Al, the hardness of the deposited metal is carried out between 60 ... 100 HB, being conditioned by the aluminum content. Deposited metal has good resistance to chemical action. Polinari alloys also contain the alloying elements Fe, Ni, Mn, which can significantly influence both the mechanical properties and corrosion resistance of alloys copper - aluminum as follows:
  - introduction of iron (Fe=max. 6%) leads to an increase in the hardness of the alloy up to 320 HB;
  - introduction of nickel (Ni = max. 6%) determine an increase of the hardness of alloy up to 250 HB, the deposited metal having a good resistance to cavitation and erosion;
  - an increase in manganese content of up to 20 %, in the case of alloy copper - aluminum with Fe, and Ni, lead to a deposited metal with a hardness of 250 HB and a tensile strength up to 735 N/mm2 (manganese alloys of copper - aluminum).

Alloys copper-aluminum are resistant to cavitation and corrosion. Manganese alloys of copper - aluminum present high values of fatigue strength and high electrical resistance.
Examples of pieces loaded with alloys copper - aluminum: valves, mixers, components for pumps, turbines, propellers for boats, shafts, cylinders, etc.;
Deposited metal contains 5 ... 45 % Ni, they can be alloyed with other elements ( Fe max. 1.5 % Mn max. 3.5 % ). The hardness of the deposited metal is 160 HB. Alloys Cu - Ni exhibits good corrosion resistance in seawater.

Examples of loaded pieces: seawater pipes, condensers, heat exchangers, apparatus for distillation - cooling and other appliances used in the chemical and rail industries;

- type EH 33 - deoxidized copper. The deposited metal has a high content of copper (with min. 99 %) and the remaining: alloying elements like Sn, Mn, Si, P are intended to deoxidizing. The hardness of the deposited metal is min. 50HV. Deoxidized copper present resistance to corrosion and good electrical and thermal conductivity.

Examples of loaded pieces: electrical contactors pipes, heat exchangers, pipes for electric furnaces, copper pieces at vents of furnaces etc.

Basic technical characteristics and directions for use of the electrodes according to STAS 7242-82 are:

- **type EF - FeCN** - Electrodes with rolling pin of cast iron with nodular graphite. Before the welding, the pieces will be pre-heated to a temperature between 723 ... 873 °K. Preheat temperature and velocity are determined by the shape and size of the piece. After welding it will be made a heat, stress relief and annealing treatment. The structure and color of the deposited metal is similar to that of the base metal being splintered. The hardness of the deposited metal is about 200 HB;

- **type EF - FeCl** - rolling pin electrodes made of cast iron with lamellar graphite. Before the welding, the pieces are preheated to between 723 ... 873 °K temperature. Preheat temperature and velocity are determined by the shape and size of the piece. After welding it will be made a stress relieving treatment. The structure and color of the deposited metal are similar to that of the base metal and it is splintered. The hardness of the deposited metal is 200 ... 250 HB;

- **type EF - Fe** - rolling pin electrodes of unalloyed steel. Before the welding, the pieces will be preheated to a temperature between 473 ... 873 °K. Preheat temperature and speed of preheat of the piece is determined by the shape and size of the piece. The hardness of the deposited metal is 150 ... 600HB, depending on the temperature of the preheating, the cooling rate and the applied treatment after welding;

- **type EF – NiFe** - Electrodes with rolling pin from analloynickel - iron. These electrodes allow cold welding of cast iron parts with high phosphorus content. High mechanical characteristics of the deposited metal allow the welding large parts and of those required mechanical. In some cases, it admits the welding with an uniformly preheating of the piece approximately at 473K. The hardness of the deposited metal is max. HB 220. The color of the deposited metal is different from that of the base metal;

- **type EF–Ni** - Electrodes with nickel rolling pin. These electrodes are recommended for welding cold of cast iron pieces by small and medium sizes. The higher phosphorus content of the metal core restricts the use of this type of electrode. The hardness of the deposited metal is 150 ... 200 HB. The color of the deposited metal is different from that of the base metal;
-type EF – NiCu - Electrodes with rolling pin from an alloy nickel - copper. These electrodes are recommended for welding cold-of cast iron parts. The sensitivity of the deposited metal from the metalloids of parent metal is higher than that the electrodes by nickel type and nickel - iron. The hardness of the deposited metal is about 140 HB. Is recommended the low preheating prior to welding. The color of the deposited metal is different from that of the base metal;

-type EF – CuAl - Electrodes with rolling pin from an alloy copper - aluminum. These electrodes are generally used for loading of cast iron parts. The hardness of the deposited metal is 120 ... 300 HB. The color of the deposited metal is different from the base metal and is resistant to chemical agents and at the abrasive wear;

-type EF – CuSn - Electrodes with rolling pin from an alloy copper - tin. These electrodes are generally used for charging. Because of cast iron inclusions, the metal processing is made more difficult. The color of the deposited metal is different from that of the basic metal. It is recommended to preheat the components before welding at a temperature of 423 ... 473K, minimum welding current, and high speed by welding. Shall be welded without Pendulum compensation, in order to minimize the dilution with the base metal. The resistance of the deposited material is lower.

The choice of filler material depending on the structure of deposited metal is made taking into account the distinct groups by fillers materials, differentiated by the ratio of the structural constituents, granulation and level of alloying.

The choice of filler material depending on technical factors - economic is made in the following steps:

- The establishing of actual operating conditions and solicitation of the piece in operation;
- The disposal of the unusable materials;
- The disposal of the compatible materials with the base material;
- The ordering of compatible materials in terms of the dilution and productivity.

3. CONCLUSIONS

1°In the engineering industry, railway transport industry, metallurgy, petrochemical and chemical industry are use several technologies of reconditioning, the most commonly used being: reconditioning by plastic deformation; by welding; by solder; by metallization; splinting; by micro-splinting and by deposition of non-metallic materials;

2°The filler materials should be compatible with the base materials, as to form as far as possible homogeneous metallic bonds, to can be made by the simple processes, without the possibility to appereance by defects and lead to technological and functional properties better than those of the base material;

3°At the reconditioner through loading by welding with electric arc, the parameters of regime are: the time, nature and size of filler material and base material; the temperature by pre-heating; Welding current; Welding voltage; the geometric parameters of the deposited layers and temperature between rows;

4°At reconditioned through loading by welding in ultrasonic field, the parameters of regime are: the nature and size of filler material and the base material; the welding
current; the welding voltage; the linear energy; the welding speed; the way of introduction of ultrasonic energy in the bath of weld; the time by ultrasonic actuating; the intensity, frequency and type of ultrasonic waves; the amplitude of vibration; geometric parameters and the number of layers deposited.

REFERENCES