Joining of copper alloys and low-carbon steels by electrical resistance spot brazing

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ABSTRACT: The general problems related to electrical resistance brazing of various metals were considered in this paper. In brazing different electrodes and technological parameters are used. For experimental purposes, electrodes were made of highly alloyed tungsten steel and of copper with graphite and tungsten inserts, so the symmetrical temperature field was obtained. Success of brazing was determined by testing the mechanical properties, micro hardness and microstructure of the brazed joint. Hardness measurement results suggested the strain hardening of the steel thin sheets, what imposed necessity of recrystallization annealing. It was necessary to apply both the flux and the silver solder for joining, since copper and iron are poorly mutually soluble. When the metallurgy problems were solved and the optimal brazing parameters selected, the optimal mechanical properties were achieved, which were experimentally confirmed.

1 INTRODUCTION

Due to low solubility of copper-based alloys' and steel's basic components, i.e., copper and iron, brass and steel are difficult to join by the welding procedures. This problem can be solved by inserting the inter-layer made of the third metal, which is soluble both in copper and in iron. In this case, that is the silver solder in the form of a foil with addition of the flux in the form of the thin coating. To enable successful joining of those alloys it was necessary to perform numerous tests to obtain mechanical properties, micro hardness and microstructure of the brazing joint. Hardness measurements results have shown hardening of the steel thin sheet, due to action of the compressive force during the brazing, what imposed the necessity for recrystallization annealing of the joint for the purpose of improving the structure and the mechanical properties.

2 EQUIPMENT FOR ELECTRIC RESISTANCE BRAZING OF THE TWO ALLOYS

Electric resistance spot brazing is done on the devices for the spot welding with energy of the alternate current, with voltage less than 20 V. The power of the apparatus ranges between 5 and 200 kVA, while electrodes material's characteristics are given in Table 1.

Electrodes for brazing are different from the welding electrodes. The most applied are the electrodes made of the strain hardened copper alloys, as well as of sintered alloys Cu-W and W-Mo. Besides the metal electrodes, the graphite electrodes are also used. They are characterized by relatively higher own electric resistance (0.01 to 0.06 Ωmm, depending on the graphite type) and by the lower thermal conductivity, what allows for brazing with the lesser intensity current Kianersi et al. (2014). For joining of materials with different thermal conductivity, electrodes made of different materials are applied; the metal with higher thermal conductivity comes to contact with electrode with the higher electric resistance.