MIG/MAG brazing of zinc coated and stainless steel sheet

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Abstract

MAG-welding of zinc coated steel sheets faces a number of difficulties, such as spatter and porosity. These problems are caused by zinc being vaporised during the welding process. In two prior projects at SIMR — JTC, MAG-welding of zinc coated steel sheets has been studied, where improved weldability has been shown. A literature study indicated that another method had further potential when joining zinc coated sheets of steel — arc/laser brazing.

In this project, methods and possibilities for arc brazing and laser brazing were studied. A literature study was performed in order to compare arc- and laser brazing processes with the MAG-welding process. A special focus was set on thin zinc coated steel sheet materials and automotive applications.

The results from the literature study showed that both arc brazing and laser brazing could be a good alternative to conventional MAG-welding of thin steel sheets. Brazing is reported to be advantageous when joining zinc coated steel sheets, where the use of conventional MAG-welding can be limited and/or costly.

After the literature study, MIG/MAG-brazing trials were performed on lap joints with varying gap between the sheets and a fix lap length. Comparative MAG-welding trials were made on lap joints with zero gap between the sheets and a fix lap length. Base material was a cold forming steel sheet (max Rm=500 MPa) with both 7 m and 20 m hotdip zinc coating. Limited MIG/MAG-brazing trials were also performed on low alloyed stainless steel sheet (W-no: 1.4310). Two filler materials were tested, SG-CuSi3* and SG-CuAl8* (* = According to DIN 1733 (1988)). SG-CuAl8 was however only used on the zinc coated material.

Five different shielding gases were tested in the MIG/MAG-brazing trials in the zinc coated material: Ar+0,03%NO, Ar+2%H2+0,03%NO, Ar+2%CO2, Ar+1%O2 and Ar+0,5%CO2+1%H2. Only Ar+0,03%NO was tested in stainless steel. The MAG-welding trials were performed with Ar+8%CO2+0,03%NO.
Both short arc and pulsed arc transfer were tested in the MIG/MAG-brazing trials with different parameter settings for each shielding gas. Only short arc was tested in the MAG-welding trials.

Each test joint was evaluated with respect to process stability and visual appearance (including amount of spatter and presence of surface breaking defects). The stainless steel joints were also evaluated with respect to the level of distortion. Selected test joints were also evaluated with static shear tensile testing, X-ray, Dye Penetrant testing, bend testing and metallographic examination.

The results from the MIG/MAG-brazing trials show that pulsed arc transfer seemed to give better process stability and visual appearance of the joint compared with short arc both in the zinc coated and the stainless material. Regarding the shielding gases Ar+2%CO2 and Ar+2%H2+0,03%NO gave inferior results with respect to the process stability and visual appearance of the joint compared with the other gases. Ar+2%H2+0,03%NO also generated a lot of porosity including surface breaking pores. Ar+1%O2 and Ar+0,03%NO were regarded as the best shielding gases both with respect to process stability and visual appearance of the joint both in the zinc coated material and in the stainless steel.

The travel speed for the evaluated case of MIG/MAG brazing was equal to the welding speeds (corresponding trials) in earlier SIMR-JTC projects. Very high travel speed (220cm/min) was achieved for stainless steel with good results. Tensile-shear tests showed varied results on both the welded and the brazed joints. The welded specimens all fractured above the tensile strength of the sheet, regardless the fraction location. The brazed specimens with different shielding gases on zero gap had a scattered result and most of them fractured in the braze metal and fusion line. The brazed specimens on different gap widths fractured around the tensile strength of the base material with a majority in the base metal. On the 20m zinc coated material, it was difficult to obtain a stable process and a spatter free joint. The trials in the 7m zinc coated and stainless material showed good results with respect to the process stability and the amount of spatter. With a few exceptions the joints did not contain any serious defects such as cracks, lack of fusion, blow holes etc.

The joints in stainless steel showed a low level of distortion. The zinc layer on the zinc coated materials was much less damaged with the MIG/MAG brazing process compared with the MAG-welding process.

It can be concluded that the MIG/MAG brazing process can be an alternative to the MIG/MAG welding process when joining zinc coated and stainless steel sheet. However, the choice of joining process should be dependent on the application requirements. More work has also to be done in order to further improve the process stability when MIG/MAG-brazing 20m zinc coated steel sheet.