MICROSTRUCTURE MODELING OF WELDED JOINTS MADE OF AISI 304L AND AISI 316L STEEL IN THE TERMS OF IMPROVING CORROSION RESISTANCE

OF PROCESS VESSELS

SUMMARY

The thesis consists of two thematic blocks. The first one concerns the development of an innovative solution for the production of process tanks with heat exchangers, made of austenitic stainless steels (ASSs), for the conditions of FME Food Machinery Europe Sp. z o.o., which allowed for a reduction in time and costs. This was achieved by replacing the previous method of preparing cut-outs from metal sheets, which were then profiled on a press brake to the shape of coils and, after being pressed against the tank shell, were joined to it using the TIG manual welding technique. The developed automated station, shaped from the outer wall profile strip of the heat exchanger and its assembly on the tank surface, as well as the robotic welding process assembly, allowed for an improvement in the efficiency of the manufacturing process. Class B welded joints were obtained, characterized by higher aesthetics compared to those previously manufactured.

The second thematic block concerned the modeling of the microstructure of welds by changing the amount of heat input (HI) and through post-weld treatment. It was shown that by changing the HI value, the structure of welds can be modeled. Reducing the HI value increases the FN value and the proportion of δ ferrite with lath and lace morphology at the expense of the proportion of δ ferrite with vermicular morphology, which was also modified. This issue was also addressed in the publication entitled: “Microstructure of welded joints of a heat exchanger, process tank made of AlSI 304L and AlSI 316L steel” (15 pages), which was submitted for publication in the journal Przegląd Spawalnictwa (Welding Review).

There is a small amount of δ ferrite in the welds of ASSs structures due to the need to reduce their susceptibility to hot cracks. On the other hand, under the operating conditions of these structures in a chlorine-containing environment, micro-corrosion

cells form in the micro-areas of austenite adjacent to δ ferrite, initiating pitting corrosion. To minimize this problem, physical modeling of the microstructure was performed by post-weld treatment, which allowed for a significant reduction in the δ ferrite content to (FN approx. 1%), which had a positive effect on reducing the susceptibility of welds to pitting corrosion initiation. It turned out that welded joints after the post-weld treatment presented in the paper were characterized by higher tensile strength and impact resistance no worse than in the as-welded condition.

This new knowledge on the possibilities of modeling the microstructure of welded joints made of ASSs, presented in this paper, was presented in more detail at several welding conferences. The great interest of welders resulted in a commitment to disseminate it by preparing another publication in Przegląd Spawalnictwa (Welding Review). The publication is entitled: “Physical modeling of the microstructure of welded joints in a heat exchanger made of AISI 304L and AISI 316L steel for a process tank to reduce its susceptibility to corrosion” (17 pages). It has already been submitted for printing.