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RESIDUAL STRESSES, MICROHARDNESS AND MICROSTRUCTURE IN FLUX CORED ARC WELDING SUPERDUPLEX STAINLESS STEEL PIPES

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ABSTRACT

The present study aims to evaluate the microstructure, microhardness and residual stresses in superduplex stainless steel welded pipes with different heat inputs. The welds were made in robotic workbench using the FCAW process. Multipass welded joints were manufactured with different heat inputs (0.5, 1.0 and 2.0 kJ/mm). The microstructural characterization was performed using light microscopy and scanning electron microscopy. Microhardness tests were performed using a automatic Microhardness testing machine. For measuring the residual stress was used a portable X-ray diffractometer with anode of Cr. It was used the method of analysis of $\sin^2\psi$. The measurements were performed on outer surface. The determination of residual stresses in each phase individually considered the family of crystallographic planes {211} for ferrite and {220} for austenite. The results showed that the levels of voltages provided to lower energy was low in the weld region. With the increase in heat input was an increasing stress levels. The microscopic analysis revealed that the tensions to low thermal inputs the ferrite is subject to tensile stresses and compressive stresses to austenite. For highest heat input an inversion behavior.

Keywords: welding, superduplex steel, residual stress, microstructure.

INTRODUCTION

The distribution of residual stresses in welded components may be responsible for the catastrophic failure of equipment. In the case of steels having biphasic structure this behavior can be even more complex [1]. Since these steels has been applied in the construction of equipments used on the topside of oil platform, which is a critical application, it is essential to know the stress distribution and mechanical behaviour of the welds [2]. The aim of this study was to evaluate the residual stresses, microhardness and microstructure of superduplex stainless steel welded pipes with different heat inputs using the FCAW process.

RESULTS AND CONCLUSIONS

The results of phase quantification are presented in Table 1. Based on these results and in the values of the measured stresses, obtained by x-ray diffraction for both directions measured: axial and hoop, were determined the macroscopic welding residual stresses, and are shown in Fig. 1. The results shown that the hoop stresses were essentially compressive. However, the same behaviour was not for stresses in axial direction, in which the tensile stresses were found in the heat affected zone (HAZ) and fusion zone (FZ). Notwithstanding, the levels of these tensile stresses were lower.

Table 1 - Volumetric fraction of both phases in the weld zones.

Weld zones	Volumetric fraction of phases (%)					
	Weld heat input (kJ/mm)					
	0.5		1.0		2.0	
	Ferrite (α)	Austenite (γ)	Ferrite (α)	Austenite (γ)	Ferrite (α)	Austenite (γ)
Base metal	55.0	45.0	55.0	45.0	55.0	45.0
HAZ	71.1	28.9	63.6	36.4	66.0	34.0
FZ	62.8	37.2	55.1	44.9	53.6	46.4
HAZ	71.1	28.9	63.6	36.4	66.0	34.0
Base metal	55.0	45.0	55.0	45.0	55.0	45.0

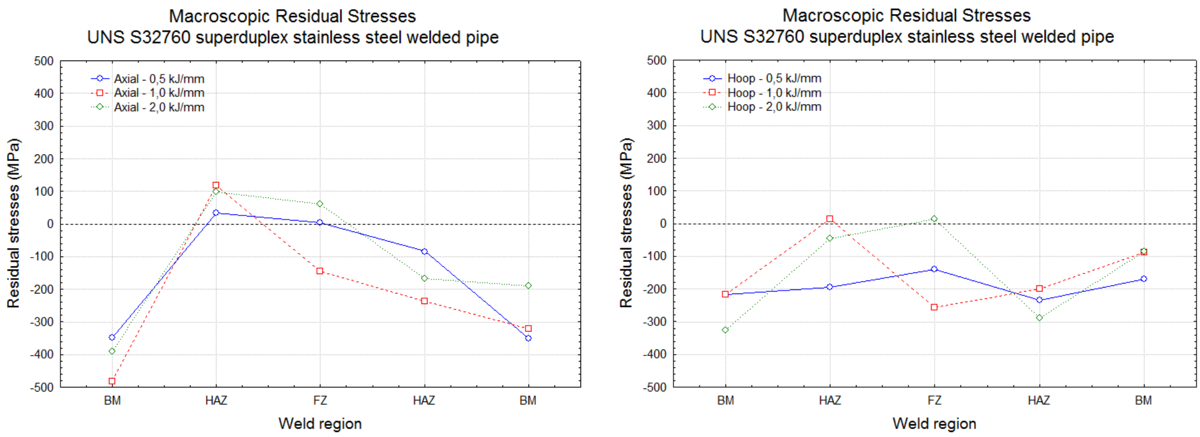

Fig. 1 - Macroscopic residual stress distribution. (a) Axial stresses; (b) Hoop stresses.

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