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The effect of small additions of ruthenium on the pitting corrosion resistance of LDX2101 duplex stainless steel

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ABSTRACT

This dissertation is a study of the effect of small additions of ruthenium on pitting corrosion resistance of LDX2101 duplex stainless steel. Four stainless steel alloys with incremental ruthenium (wt %) as per Table I were produced from pieces cut from commercial LDX2101 duplex stainless steel plate with the manufacturer's composition of 0.03C, 0.22N, 21.5Cr, 1.5Ni, 0.3Mo and 5.0Mn plus, pressed ruthenium powder with purity of 99.8%. After solution annealing the samples, the actual chemical composition was analysed using XRF analysis and then, ASTM A923 (01.03) Test method A – Sodium Hydroxide etch test for classification of etch structures of duplex stainless steel was used to analyse their microstructure.

Table I: Chemical composition (wt %) of alloys which were produced.

Alloy Designation	Targeted Composition (wt %)
A	*0.03C, 0.22N*, 22.26Cr, 1.58Ni, 0.25Mo and 4.99Mn + 0.13Ru
B	*0.03C, 0.22N*, 22.46Cr, 1.50Ni, 0.29Mo and 5.14Mn + 0.20Ru
C	*0.03C, 0.22N*, 22.31Cr, 1.60Ni, 0.26Mo and 4.84Mn + 0.31Ru
D	*0.03C, 0.22N*, 20.10Cr, 1.37Ni, 0.30Mo and 4.32Mn + 0.66Ru

NOTE: C and N shown in italics were not measured.

Corrosion potentials and pitting potentials of these samples were evaluated using a potentiodynamic polarisation technique and the results were compared to corrosion potentials and pitting potentials of control alloys: LDX2101, 304L and 904L. The tests for both produced and control alloys were carried out in naturally aerated 3.56% sodium chloride (NaCl) aqueous solution at 25^{o}C±2^{o}C. The results indicated that small additions of ruthenium slightly improved the corrosion potential of the resulting alloys. However, there was a significant improvement on the pitting potential of the resulting alloys compared to LDX2101 and 304L stainless steels. Exposed to the same experimental environment, 904L stainless steel did not experience pitting corrosion. Potentiodynamic polarisation evaluation of LDX2101 with 0.66%Ru samples in de-aerated 3.56% NaCl showed a decrease in both pitting and corrosion potentials with the decrease in oxygen content in the NaCl aqueous solution. Microstructural analysis results indicated that ruthenium addition has no detrimental

effect to the microstructure of the resulting alloys. However, alloys containing ruthenium were not commercially viable as the pitting corrosion resistance benefit ruthenium brought did not offset the cost of adding the ruthenium to LDX2101 stainless steel.