Stainless Steel 303 Figures and Tables

- **83 References**
- **96 Tables and Figures**
- **12 pages Text**

Listings of all the Tables and Figures in Stainless 303 Chapter

Figure 2.3.1.1 Optical micrographs of the surface (top) and of the cross section (bottom) of a 1 mm thick disc sample of a conventional wrought AISI 303 alloy after a 72 h immersion in a 1% $FeCl_3$ solution at room temperature demonstrating the pitting corrosion at sulfide inclusion sites (Ref. 32)

Figure 2.3.1.2 Potential-time plots for conventional wrought and rapidly solidified/hot extruded powder metallurgy (see Figure 1.5.8) AISI 303 alloy electrodes immersed in 1% $FeCl_3$ solution for 72 h, showing that the rapidly solidified alloy is significantly more noble in regard to pitting corrosion in this medium than the conventional alloy (Ref. 32)

Figure 2.3.1.3 Potentiodynamic polarization curves conducted at a scan rate of 0.1 mV/sec for conventional wrought AISI 303 and 304 stainless steels (303W and 304W) and rapidly solidified and consolidated AISI 303 stainless steel (303RS) in a 1 N H_2SO_4 deaerated solution, demonstrating the corrosion current of the wrought AISI 304 alloy from Tafel extrapolation was 50 µA/cm² corresponding to a corrosion penetration rate of 0.6 mm/y, while the corrosion penentration rates for the rapidly solidified powder metallurgy 303 and wrought 303 alloy were, respectively, 0.1 and 36.0 mm/y (Ref. 32)

Figure 2.3.1.4 Passivation of a 303 stainless steel panel in a 50 vol. % HNO_3 aqueous solution for 60 min dissolved the MnS inclusions (see Figure 1.5.4) and left many pits behind, while micron-sized elemental sulfur particles, identified by EDXS (b), were redeposited back on the surface in the vicinity of these pits (a); precision cleaning that followed the nitric acid passivation (see Figure 2.3.1.5) could not remove these particles (Ref. 30)

Figure 2.3.1.5 Sulfur particles indicated by arrows redeposited during passivation of a 303 stainless steel panel in a 50 vol. % HNO_3 aqueous solution for 60 min (see Figure 2.3.1.4) did not significantly dissolve as a result of the subsequent hot DI water rinse (Ref. 30)

Figure 2.3.1.6 A soak in 5% NaOH at 160F for 30 min dissolved the sulfur particles and improved pitting corrosion resistance of 303 stainless steel panels after HNO_3 passivation (see Figures 2.3.1.4 and 2.3.1.5) (Ref. 30)

Figure 2.3.1.7 Micrograph of an unetched section through a 303 stainless steel valve exposed to an acidic soft drink (2.4-2.5 pH) in a vending machine showing localized corrosion along sulfide stringer inclusions at the exposed end grain surface of valve body causing hydrogen sulfide concentrations to rise in infrequent failures in the first cup of beverage after the machine was idle for a period, after which the beverage dispensed was discolored and unpalatable (N.B. a 304 stainless steel was recommended in place of 303 for this application , even if failures were infrequent) (100X) (Ref. 51)

Figure 2.3.1.8 Macroscopic and microscopic polarization curves measured in 0.1 M NaCl at 75F on annealed samples of 303 stainless steel rolled plate showing that, in the macroscopic polarization curve, current density gradually increase with increasing potential with initiation and growth of pitting being indistinguishable (because many pits initiate and grow continuously on a large electrode surface) while, in the microscopic polarization curve, MnS dissolution (0.3 V), metastable pitting (0.45-0.5 V) , and stable pitting events (sharp increase in current at 0.5 V) are distinguishable (Ref. 53)

Figure 2.3.1.9 Polarization curves measured in 0.1 M NaCl at 75F on annealed samples of 303 stainless steel rolled plate using an electrochemical microcell with polarization measurements stopped after stable pit initiation (see Figure 2.3.1.10) and the final current (iF) of specimen D and E is, respectively, 5.0 and 1.1 µA (Ref. 52)

Figure 2.3.1.10 SEM images of MnS inclusions and pits formed at MnS inclusions in specimen D (a) and specimen E (b) after polarization measurements shown in Figure 2.3.1.9 with arrows indicating small polygonal pits (a synergistic effect of dissolution products of MnS inbclusions and chloride ions appear to attack the metal surface newly exposed by dissolution of the inclusions) (Ref. 52)

Figure 2.3.1.11 SEM micrograph of a polished and sterilized coupon of 303 stainless steel exposed for 10 days in a cultured medium containing Vibrio natriegens bacteria, commonly found in marine and estuarine environments, having a biological N_2-fixation capability that promoted the pitting and general corrosion of the 303 stainless steel (a conclusion supplemented by electrochemical impedance spectroscopy and potentiodynamic polarization studies) (Ref. 53)

Table 2.3.1.12 Effect of cathodic protection with potentials determined against a saturated calomel half cell on corrosion of 303 and 304 stainless steel propeller shafts exposed for 2 yr without rotation in quiescent seawater, during which time they became completely fouled with marine organisms (Ref. 50)

Table 2.3.2.1 Causative factors in ClSCC of austenitic stainless steels (Refs. 54-56)

Figure 2.3.2.2 One example of a set of 303 stainless steel bolts after service in a marine environment exhibiting rust discoloration typical of all the bolts received in which the crevices created by the set screw holes and underneath the bolt heads allowed crevice corrosion and ClSCC to occur (a), and a longitudinal cross section through the bolt head at the set screw showing branching cracks (arrows) in the threads (b) (Ref. 57)

Figure 2.3.2.3 Closer view of the typical SCC multi-branched cracks in Figure 2.3.2.2 (a), high magnification etched micrograph of (a) showing partial sensitization with arrows pointing to carbides at grain boundaries (b), and an etched view of the cross section in (a) showing attack at the inclusions with branching cracks progressing from the inclusions (c) (Ref. 57)

Figure .3.3.1 Kinetics of cyclic oxidation for three separate experiments: polished and cleaned 1 mm thick discs of PM consolidated 303 exposed to flowing oxygen gas at 1652F for periodic cycles represented by the data points, quenched in air after each cycle, and returned to furnace after each weighing to determine Δm divided by original area A of specimen – n.b., spallation yielded weight losses (Ref. 58)

Figure Note: PM 303 material consisted of a fine grained, rapidly solidified powder produced sieved to -140 mesh, enclosed in a stainless steel can, and consolidated by hot extrusion at 1652F at a 10:1 reduction to fully dense 1 in. diameter rod (extruded rod microstructure contained equiaxed fine MnS precipitates of ~0.01-0.2 μm diameter at a volume fraction of ~1 per cent and a duplex grain structure of larger 5-10 μm grains surrounded by small, heavily dislocated grains of <1 μm).

Figure 2.3.3.2 Kinetics of cyclic oxidation for three separate experiments: polished and cleaned 1 mm thick discs of conventional wrought 304 rod of similar composition to the PM 303 rod (cyclic oxidation for 303 PM shown in Figure 2.3.3.1) exposed to flowing oxygen gas at 1652F for periodic cycles represented by the data points, quenched in air after each cycle, and returned to furnace after each weighing to determine Δm divided by original area A of specimen – n.b., spallation yielded weight losses significantly greater than for the 303 PM rod (ide scatter between tests due to spallation) (Ref. 58)

Figure 2.3.3.3 Comparison of SEM backscattered electron images of surface oxide after cyclic oxidation at 1652F in pure oxygen of a disc sample of 303 PM rod (see Figure 2.3.3.1) for 305 h and of a disc sample of conventional wrought 304 rod of similar composition (see Figure 2.3.3.2) for 298 h (Ref. 58)

Table 3.1.1.1 AMS specified mechanical properties for bars, wires, and forgings of 303 and 303Se grades of free machining 18Cr-9Ni austenitic stainless steels (Ref. 3)

Table 3.1.1.2 AMS specified mechanical properties for bars, wires, and forgings of free machining 18.5Cr-10Ni-0.22Se (SAE 30303Se) austenitic stainless steel (Ref. 7)

Table 3.1.1.3 AMS specified mechanical properties for free machining bars and forgings of 0.14S-18Cr-9.5Ni-0.50Mo-0.80Al (303MA) austenitic stainless steel (Ref. 6)

Table 3.1.1.4 AMS specified mechanical properties for free machining bars, wire, and forgings of 18Cr-10.5Ni-0.26S-0.60Cb (UNS S34720) and 18Cr-10.5Ni-0.14P-0.25Se-0.60Cb (UNS S34723) (Ref. 7)

Table 3.1.1.5 AMS specified mechanical properties for free machining bars, wire, and forgings of 18Cr-9Ni-0.21Pb (303Pb) austenitic stainless steel (Ref. 6)

Table 3.1.2.1 ASTM mechanical property specifications for various products made from free machining wrought 303, 303Se, XM-2, and XM-5 austenitic stainless steels and CF-16 and CF-16Fa cast stainless steels (Refs. 8-13)

Table 3.2.1.1 Tensile properties of 303 and 303Se stainless steel bar at room temperature (also see Se Table ctions 3.3.1-3.3.4) (Ref. 35)

Figure 3.2.1.2 Tensile properties of 303MA stainless steel (equivalent to XM-2 per Tables 1.3.1 and 1.4.2.1) bars at room temperature (Ref. 36)

Figure 3.2.1.3 Effect of cold reduction on room temperature tensile properties of 303MA stainless steel (equivalent to XM-2 per Table 1.4.2.1): —— cold drawn, ----- as cold drawn and stress relieved at 750F for 4 hr. with ductility curves averaged for cold drawn and cold drawn plus stress relieved conditions, elongation measured in 4D of test specimen, and yield strength at 0.2% offset (Ref. 36)