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High-temperature corrosion analysis of Inconel 625 alloy in a chlorine-containing atmosphere.

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Introduction

The thermal conversion of biomass and municipal solid waste in waste-to-energy plants is an essential strategy for waste management and carbon emission mitigation. However, this technology faces a structural thermodynamic and chemical barrier: deleterious agents such as chlorine, sulfur, and alkali metals. This research studies the chlorine effect on high-temperature corrosion at 700 °C and 800 °C, isothermally, in an atmosphere of N_2 + 10,000 ppm of HCl.

Objectives

The following research aimed to analyze the performance of the Inconel 625 alloy in an chlorine-containing atmosphere, one of the most aggressive specie during combustion of biomass and solid waste. Furthermore, the experiment required the assembly of a test system to adapt a furnace previously used for oxidation tests. Figure 1 shows the setup assembled for testing.

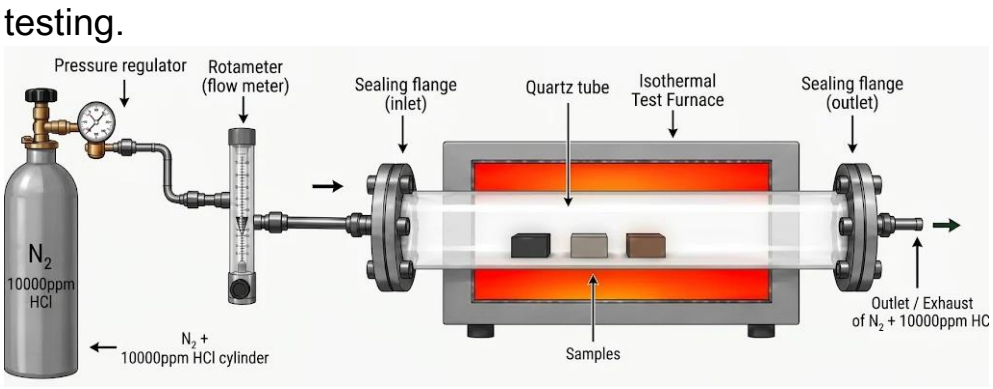


Figure 1. Schematic used in the tests.

Methodology

The hot corrosion tests were performed at at 700 °C and at 800 °C and lasted 4 hours each, and were conducted inside a quartz tube that passed through the heating zone. The samples were placed in the furnace prior to heating, and the flow of a gas mixture consisting of N_2 + 10,000 ppm HCl was initiated 120 minutes before the equipment was turned on for the first test, and 50 minutes before for the second test. The gas flow rate was 10 L/h throughout the entire test. The 4-hour test duration was measured from the moment the furnace reached 700 or 800 °C.

Results and discussion

Figures 2a and 2b show the mass variations obtained in the tests at 700 and 800°C.SEM/EDS represented in Figures 3a and 3b analyses revealed that the corrosion products are highly heterogeneous across the surface. The sample exposed to 800°C showed a greater mass variation compared to the sample exposed to 700° C.

In the sample exposed at 700°C, chlorine appears to be more prevalent compared to the sample exposed at 800°C. The XRD for the test at 700° C is shown in Figure 4 and detected the delta phase, nickel oxide, and chromium oxide.

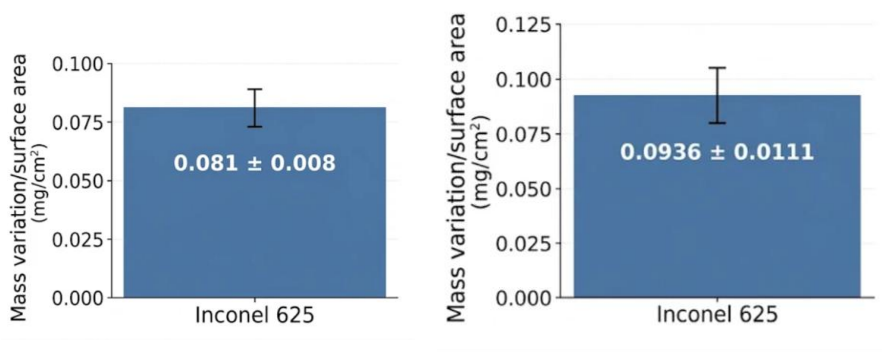


Figure 2 a. Mass variation and samples after test 700°C. 2b mass variation after test 800°C

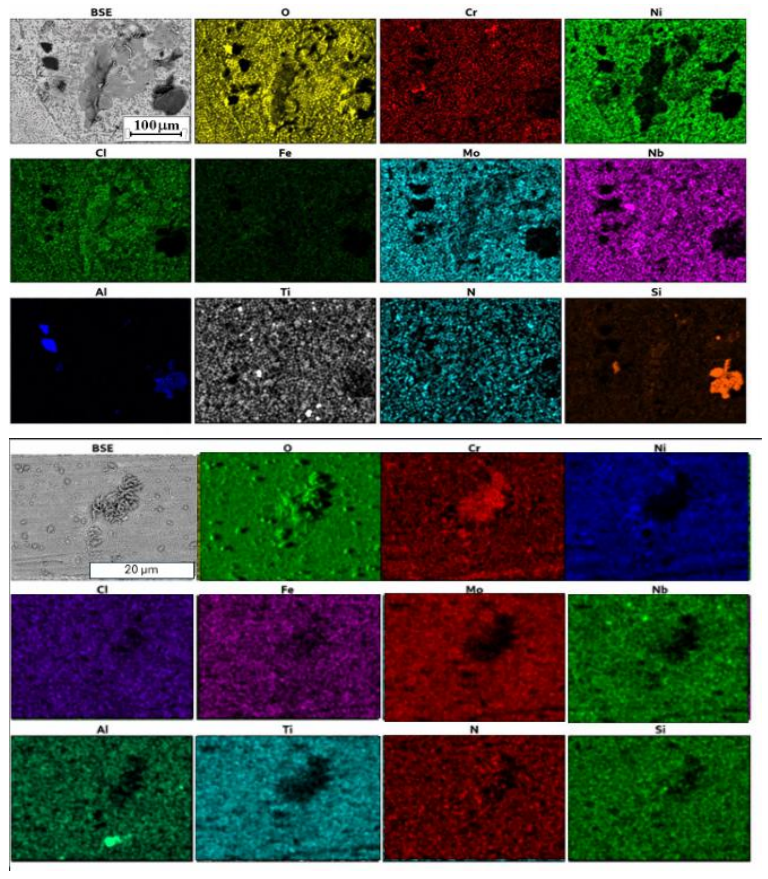


Figure 3. Samples cross-section obeerved by SEM/EDS after test at a) 700°C and b) 800°C.

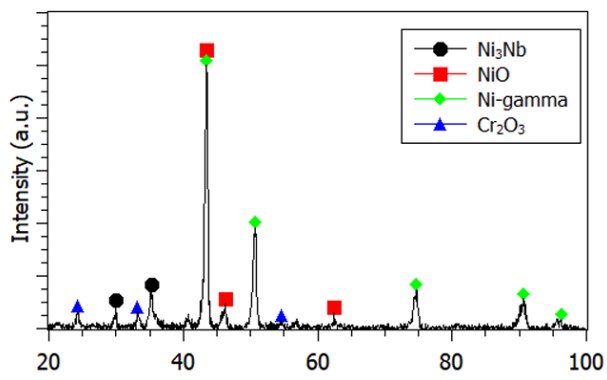


Figure 4. XRD for 700°C.

Conclusions

SEM/EDS analyses revealed a highly heterogeneous corrosion surface, with enrichment of Cr, Ni, and Al. Chlorine was also detected on the surface, confirming its involvement in the degradation process, although it was not possible to conclusively identify which chlorine-containing compounds were present.

References and Acknowledgments

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