Corrosion Performance of Superhex Heater Tubes Exposed to Alumina Refinery Plant Conditions

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Abstract

Superhex is a high acid corrosion resistance heat exchanger tube that has been exposed to the alumina refinery process condition for the first time in January 2021. Two brand-new heat exchanger units have been tubed with this material and its corrosion performance monitored during the acid wash and Bayer liquor exposure. Its corrosion performance was monitored using a corrosion probe positioned between two live steam heaters (LSH) of an evaporation train and the corrosion rate in millimeters/year (mmpy) was measured from electrochemistry data of linear polarization resistance (LPR) and impedance. Unlike the corrosion assessment in the laboratory; where the parameters surrounding the corrosion cell are controlled and consequently clear electrochemistry data is obtained, the data obtained in the plant is affected by the presence of corrosion inhibitor (low corrosion rates), scale formed during liquor flow (inaccurate corrosion data before the scale is dissolved), and pump mechanical condition (noisy data). It was also observed, that the exposure time of the tube during the acid wash is considerable shorter than during Bayer liquor exposure. Overall, Superhex showed better corrosion performance than the other materials under evaluation. One of the units containing the Superhex tubes will be opened for visual inspection around February 2022.

Keywords: Sulphuric acid, Corrosion resistance, ASTM 179, Heat exchanger tube.

1. Introduction

In its dilute form, sulphuric acid reacts with metals (e.g. iron) through Equation (1) producing hydrogen (gas) and metal sulfate (salt) on the metal surface [1, 2, 3] given by Equation (1):

$$Fe_{(s)} + H_2SO_{4\,(aq)} = H_{2\,(g)} + FeSO_{4\,(aq)} \tag{1}$$

Recent advanced technology on crystallography and passivation film [10] has identified key metallurgical parameters that can provide high corrosion resistance in acid solutions. Figure 1 shows an example of the in-laboratory behaviors of two cold-drawn low-carbon steel ASTM-179 tubes, with preferred versus unpreferred crystal grain orientation condition, after 15 h exposure to 6 % v/v **uninhibited** sulphuric acid at 60 °C and flow rate of 1 m/s. Significant corrosion of the unpreferred orientation (STD ASTM 179) with 94.3 wt. % mass loss in comparison to the relatively unaffected preferred orientation (Superhex) with only 5.5 wt. % mass loss. As previously presented (ICSOBA 2020), the main difference between Superhex and other low carbon steel HEX materials is the formation of a passive film in contact with dilute sulphuric [7] and hydrochloric acid that inhibits the corrosion attack by keeping at lower levels. The same materials tested in the laboratory were assembled in a corrosion probe and inserted into the Bayer process, between two life steam heaters of an evaporation train.

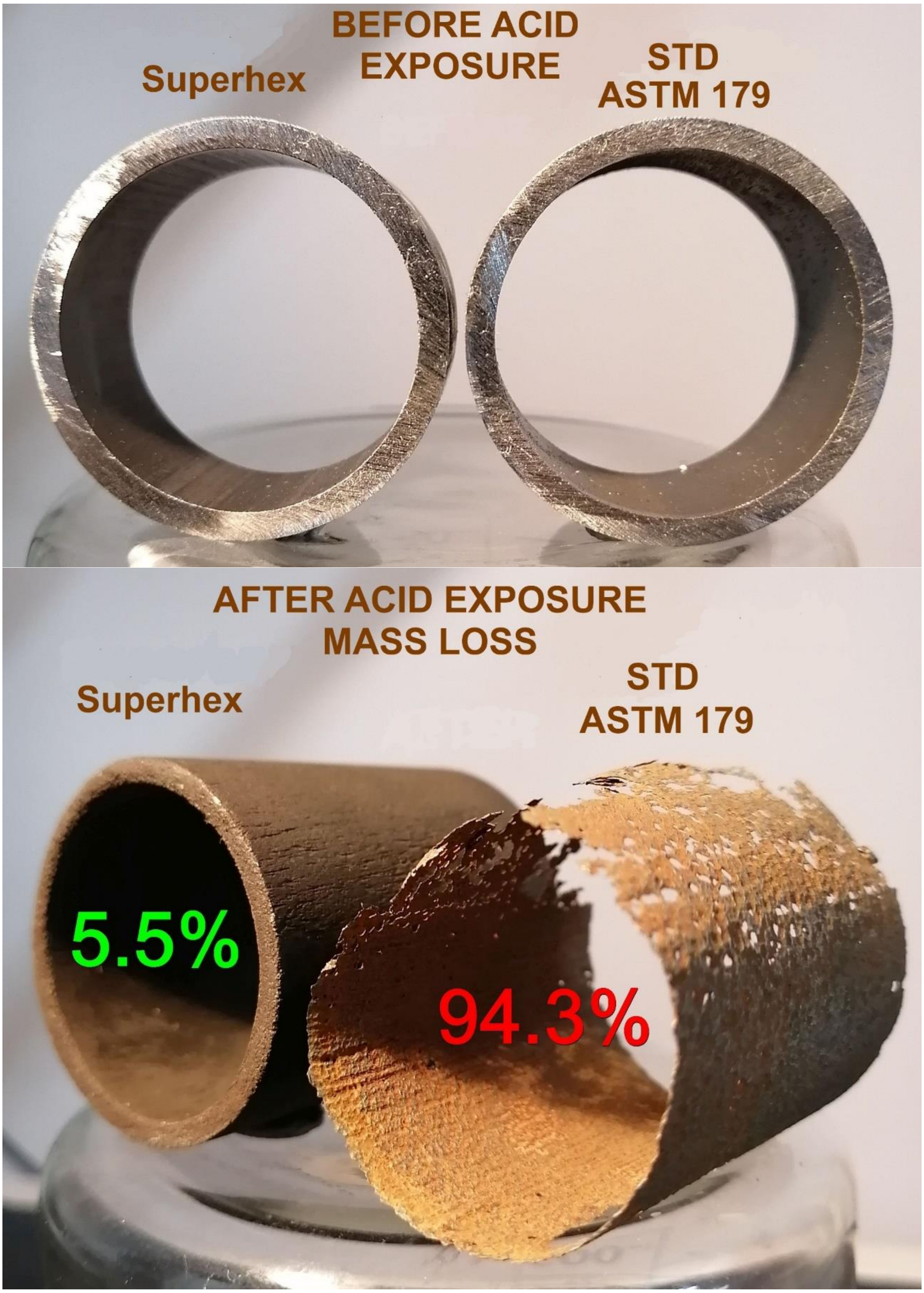

Figure 1. Laboratory mass loss images of Superhex vs STD ASTM 179

About 1000 tubes (lengths) of the Superhex material have been placed in each brand-new heat exchanger (HEX) unit and exposed to the alumina refinery process conditions as showed in Figure 2.

- Coordinate another visit to discuss the content of this report and perform another short data collection series to determine the exact process time required for the acid solution to dissolve the DSP scale deposited on the existing online corrosion probe ERC-1.

5. References

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