ALTA 2022 26
20-27 May | Perth, Australia | Online

ADVANCEMENTS IN SURFACE MODIFICATION FOR SEVERE SERVICE VALVE TRIM

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ABSTRACT

Callidus Welding Solutions (CWS) & Callidus Process Solutions (CPS) form part of the Callidus Group of companies. Together, they offer a broad service range, specializing in the management, maintenance, diagnostics and supply of service equipment, providing custom engineering and repair services to the High-Pressure Acid Leaching (HPAL) and Pressure Oxidization (POx) industries in Australia and the surrounding Pacific region. Callidus' extensive range of capabilities results in clients' enhanced equipment performance by improving reliability and extending component life offering time and cost savings in all facets where Ti, its alloys and exotic alloys are used.

Hydrometallurgical extraction by HPAL uses titanium in autoclaves, valves, piping systems and auxiliary equipment because of its excellent corrosion resistance, good mechanical properties and high strength-to-weight ratio. However, Ti and its alloys also present poor erosion and abrasion resistance and are susceptible to fretting and wear damages when in contact with abrasive undissolved minerals in the slurries combined with the high demands on the material by operating at elevated temperatures, pressures, low pH and erosion of solids. Standard solutions such as the use of refractory ceramics and thermal spray of ceramic coatings also present limitations in the same application. A known surface modification method to improve the tribological properties of Ti alloy is surface nitriding. Traditional Titanium Nitride surface modifications are very thin layers which, although are very hard, present very little in the way of erosion protection once compromised.

With the objective to offer solutions to their clients always at the forefront, CWS has been leading the field in advancing unique surface modification and weld overlay treatments for Ti alloys that offer enhanced tribological properties. Over the last few years, CWS developed and refined a novel Titanium Nitride surface modification process in-house, further validated by client acceptance in successful field trials, in equipment areas including wear plates, internal piping protection around bend extrados and agitation components. This in-house Titanium Nitride surface modification, referred to as the first generation, showed increased hardness of the surface and thus increasing resistance to sliding abrasive wear.

In order to optimize and expand the application base, CWS collaborated with Deakin University in Geelong, Victoria, Australia, to comprehensively characterize CWS's in-house technologies and to formalize the understanding of the microstructure-property-performance relationship. Over the past five years, Deakin and CWS have worked together to further progress the novel surface nitriding method to its full potential, resulting in the latest generation of Titanium Nitride that has advanced into production on components and a patent. In synergy with CPS, the collaboration has culminated in the production of a patented severe service ball valve trim possessing a remarkable increase in material properties including hardness, toughness, wear resistance and corrosion resistance.

This paper and subsequent presentation will provide background on where this novel Titanium Nitride surface modification fits into the erosion-protection suite of solutions and specifically its application as valve trim on HPAL severe service valves. The key findings of the initial characterisation which guided the areas of development and advancement will be presented, in addition to field trial results.

Keywords: Valves, Hydrometallurgy, Autoclave, High Pressure Acid Leach, Titanium Nitride, TiN, Novel, Innovation, Surface Modification, Equipment, Optimization, Wear, Abrasion, Corrosion-Resistance, Hardness, Erosion, Fracture Toughness, Microstructure, Properties, Performance, Decreased Downtime