Surface modification method of duplex type stainless steels by the pack boriding process

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Abstract

This work presents the investigation of a boriding process on two grades of stainless steel namely UNS32750 super duplex stainless steel and UNSS31803 duplex stainless steel in order to improve material properties and possibly to reduce catastrophic failure of industrial components. Usage of duplex stainless steels has become customary in the fields of oil and refinery, marine and pipeline applications due to increased corrosion resistance; however, these materials exhibit low wear characteristics. To overcome this problem, in this work the pack boriding process was employed. Evaluation of effects of the boriding process on the microstructure and mechanical properties was performed using scanning electron and optical microscopy, Vickers hardness tests and wear tests. It was shown that the 4 h process resulted in the greatest boriding layer thickness yielding the maximum surface hardness of 1407 HV in the super duplex stainless steel UNS32750 while this value was 1201 HV in the duplex stainless steel UNSS31803. Wear resistance of borided materials were up to 6-fold greater than those of non – treated materials. Also, the borided duplex materials were shown to be more suitable for industrial applications for valve and shaft components as compared to the boronized super duplex stainless steel.

Keywords: UNS32750; UNSS31803; SEM; wear; hardness.

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1. INTRODUCTION

Tribological properties of the duplex stainless steel family limit the usage of these metallic materials in industrial applications. Although these steels exhibit good corrosion resistance and mechanical strength, the wear resistance characteristics are poor. However, in hostile environments duplex stainless steels are the only alternative for standard austenitic stainless steels such as SS 304 and SS 316. Good strength and corrosion resistance of duplex stainless steels are due to the presence of chromium, nickel and nitrogen [1]. The increased mechanical strength, toughness and corrosion resistance makes these steels suitable in chloride environments [2]. These duplex and super duplex stainless steels, having increased pitting resistance [2] are applicable in the fields of oil and gas industry, marine applications, piping construction, chemical industry, and petrochemical plants [3]. Greater weldability and better mechanical properties of these steels as compared to those of austenitic stainless steels favor their usage in oil and gas refinery and chemical plants [4]. To increase the life of the sliding or mating parts, the material wear characteristics are considered as a dominant factor [5]. From the literatures, it is apparent that the valves and flanges require good tribological properties in addition to the corrosion resistance, which is not found in most of the materials. Good method to improve the material wear characteristics is by surface treatment. Among many surface treatment methods such as nitriding, carburizing, and nitrocarburizing, the boriding process based on the chemical treatment of the surface, was shown to

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