International Journal on Interactive Design and Manufacturing (IJIDeM) (2023) 17:1515–1529
https://doi.org/10.1007/s12008-022-01196-2

ORIGINAL PAPER

Erosion behavior of plasma and DGun sprayed nichrome coatings on 2205 duplex stainless steel

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Received: 1 November 2022 / Accepted: 10 December 2022 / Published online: 7 January 2023

Abstract

The problems associated with erosion have emerged during the transportation of oil and gas. Piping industries have tried a variety of methods to comprehend the solid particle erosion. One such method is to perform coating on the substrate for effective erosion prevention. This novel work focuses on nichrome coating on duplex stainless steel (DSS2205) by atmospheric plasma spray method (APS) and detonation gun method (DGun), to minimize the erosion behavior. The velocities (150, 175 and 200 m/s), impact angles (30°, 60°, and 90°), and discharge rates (2.5, 3.75, and 5 g/min) were varied to carry out the experiments. Further, the Taguchi method is used for enhancing the performance, process, and reducing experimental cost and time. This method can optimize process parameters by combining the analysis of variance, response surface methodology, and desirability function analysis. It is evident that the coating has a significant influence on erosion behavior. Scanning electron microscope was used to examine at the degraded regions structure. The erosion resistance of the APS and DGun coatings over the uncoated specimens was increased by 29% and 52%, respectively. DGun coated specimens with a discharge rate of 2.56 g/s, flow velocity of 186.09 m/s, and impact angle of 90° were determined to have the optimum erosion rate. The DGun coating outperformed the APS coating due to its lower porosity, higher hardness, better density, and greater micro hardness.

Keywords Plasma coating · DGun · Duplex stainless steel · Erosion · Microstructure

1 Introduction

Solid particle erosion is a key challenge that has become more difficult to solve for engineering materials. This causes component degradation and a significant financial outlay due to damages, interruption, and maintenance. Many applications in pipelines, oil and gas industries are facing severe issues due to high degradation [1]. Therefore, this study desires to respond to the needs of developing materials resilient to erosion and innovative practices for protecting the material surface from erosion.

It is critical to think about material selection when choosing a material to withstand erosion. The probability of a material deteriorating is controlled by environmental factors to which the material is exposed. The failure can be prevented by carefully choosing an alloy or material that is resistant to erosion. Based on its appropriateness for the intended use in terms of economic, industrial, and feature requirements, the material was selected. Equipment made of stainless steel is preferred in many industries because it is more cost-effective than other alloys [2]. Ram Kumar et al. claim that DSS has stronger erosion–corrosion resistance and superior mechanical characteristics because the austenite and ferrite phases are present in about equivalent amounts [3]. The significance of DSS 2205 in the pipeline, oil and gas industries, which are vulnerable to corrosion and erosion, was emphasized by Renner et al. [4]. Duplex stainless steels require minimal to no maintenance in severe conditions [5].

Previous research has found that coating a component can improve its resistance to erosion. It is feasible to coat a variety of materials, including ceramics, metallic alloys, polymers,

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