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SLIDING WEAR BEHAVIOR OFNICKEL-CHROMIUM BASED COATING ON 316L STAINLESS STEEL PERFORMED USING DETONATION GUN PROCESS

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ABSTRACT

A cylindrical specimen of 316L steel of dimensions 30mm length and 6mm diameter was coated with Ni-Cr powder by detonation gun technique. Sliding wear tests were performed on both coated as well as uncoated specimens against an EN-32 disc. Results demonstrate that as the sliding distance increases, both coated as well as uncoated specimens show an increment in the wear rate. The results also indicate that the uncoated part shows a higher wear rate as compared to the coated one.

Keywords: 316L steel,D-gun, Ni-Cr, Sliding wear,Coating

I. INTRODUCTION

Human needs are intensifying with every passing day. Owning equipment and gadgets that can serve purposes as efficiently and as economically as possible is in vogue. Further, a gadget that could perform some secondary task in addition to its primary function becomes more important and consequently more valuable. To make these tools available to people, industries are toiling hard. They in turn are trying to increase the efficiency of their machines. As such, components of these machines are subjected to a larger amount of relative motion and that too at unfavorable operating parameters and conditions.To ensure that a component serves for a reasonable amount of time and during its period of operation, performs satisfactorily, the component material has to be provided with enough resistance against wear [1].A coating powder deposited to act as an obstacle between the original component material and hostile environment is quite widely accepted as an effective means to prevent damage of the component. Components are often subjected to high mechanical loads, thermal stresses, oxidizing and corrosive environment. While providing mechanical strength is considered to be a function of the base material, coating powders are responsible for the protection of component material from the bleak surroundings with which it interacts [2-4]. Modification of surface of a substrate is now considered as an imperative process in a large number of engineering applications, especially those which involve interaction of material with an unwelcoming surrounding [5]. The extra cost incurred due to application of coatings is justified by the reduction in the cost of replacing the damaged component. Further, the coatings can be applied to a less expensive substrate to obtain the desired properties [6-8].Coatings applied by thermal spray process are the one most

extensively used to endure wear [9]. A great advantage inherent to these coatings is modification at microstructural level during processing of powder and spraying [10]. The present work involves investigation of sliding wear behavior of Ni-Cr coatings deposited on 316L stainless steel using detonation gun technique. Detonation gun (D-gun) is a thermal spray based coating technique which uses a large barrel along with valves for gases and powder. The barrel is water cooled [11]. The great advantage of this technique as compared to other thermal spray techniques is higher adhesion strength and low oxide generation. Running cost of the equipment, as compared to plasma and HVOF processes is quite low. This is mainly due to the fact that consumption of oxygen in detonation gun process is only 3-10% of HVOF process.

II. EXPERIMENTAL PROCEDURE

2.1 Sample preparation

Surface preparation is the primary step involved in any thermal spray coating. Roughness of the base material determines the adhesion quality of the coating powder to a great extent [11]. Grit blasting of the base material is done to attain a superior adhesion quality.Prior to coating, grit blasting of the samples was carried out using a grit blasting machine. The machine had a nozzle of inner diameter 6mm, kept at a distance of 30mm from the samples. Blasting was performed using 150 mm diameter alumina particles at an air pressure of 3 to 3.5 bars, and for duration of 1-2 minutes. Subsequent to sand blasting the samples were cleaned with acetone.Cylindrical samples of length 30mm and 6mm diameter were prepared for sliding wear test. A pin-on-disc test was carried out to study sliding wear. Base material used was 316L stainless steel and Nickel-chromium powder was used as coating material. Composition of the coating powder was 80%Ni-20%Cr by weight. Sliding wear behavior of different samples of uncoated and Ni-Cr Coated 316L Stainless steel was studied. Test was carried on a Ducom Instruments private limited build (TR-20 LE) friction and wear monitoring equipment. It contained a disc made of hardened ground steel (EN-32, hardness 72 HRC, surface roughness 0.6 µRa) as a counter body. A series of tests were conducted by varying sliding distance at a fixed load of 27N and a sliding velocity of 1.6m/sec. Loss in mass of the specimen after it slid for 1hr, 2hr, 3hr, and 4hr were measured. Sliding wear rate was calculated according to ASTM wear testing standard G-99.

2.2 Detonation Gun

Detonation gun technique was used to apply the coating powder on the base material. The detonation spray equipment used had a horizontal orientation. It had a double-walled barrel (length 1800mm and inner diameter 22mm), a combustion chamber and powder feeder, along with control panes to regulate gas flow and gas operation. Process parameters used during the coating process are listed in Table 1.

Table 1. D-gun process parameters

Spray Parameter	Parameter Value
Powder particle size	35-45 µm
Spray spot diameter	25mm
Spraying distance	200mm
Spraying atmosphere	Air

Thickness per shot	5-6 µm
Shots/second	4
Maximum coating thickness	250

2.3 Coating

Coating powder used was Ni-Cr. It contains 80%Ni-20%Cr by weight. The other properties of the powder are mentioned in Table 2.

Table 2. Properties of Ni-Cr coating Powder

Coating Powder	Coating Hardness (HV)	Operating Temperature (◦C)
Ni-Cr	200	1350

III. RESULTS AND DISCUSSIONS

Wear rate was plotted against sliding distance for both uncoated as well as coated samples. Corresponding graph has been shown in Fig. 1. A curve was also plotted between the volumetric wear rates and slidingdistance for uncoated as well as coated samples. The plot is shown in Fig. 2. Similarly a curve plotted between the specific wear rate and sliding distance has been shown in Fig. 3. A plot of weight loss against sliding distance has been shown in Fig. 4.

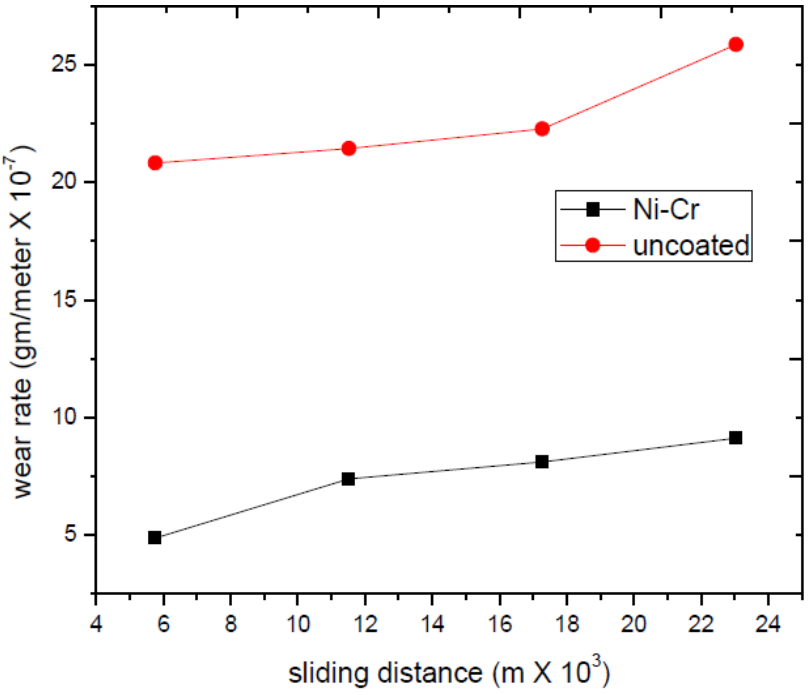

Fig 1. Wear rate against sliding distance

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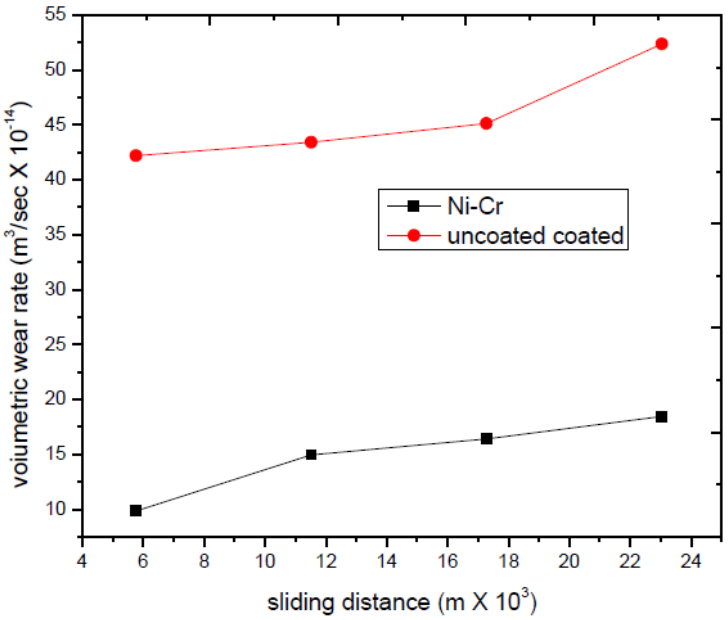

Fig 2. Volumetric wear rate against sliding distance

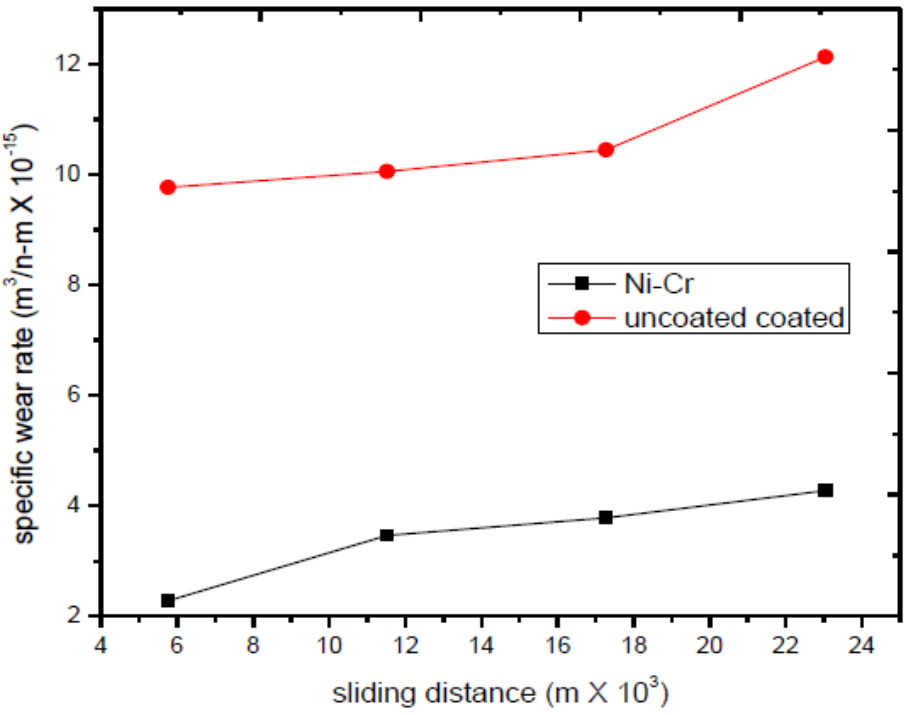

Fig 3. Specific wear rate against sliding distance

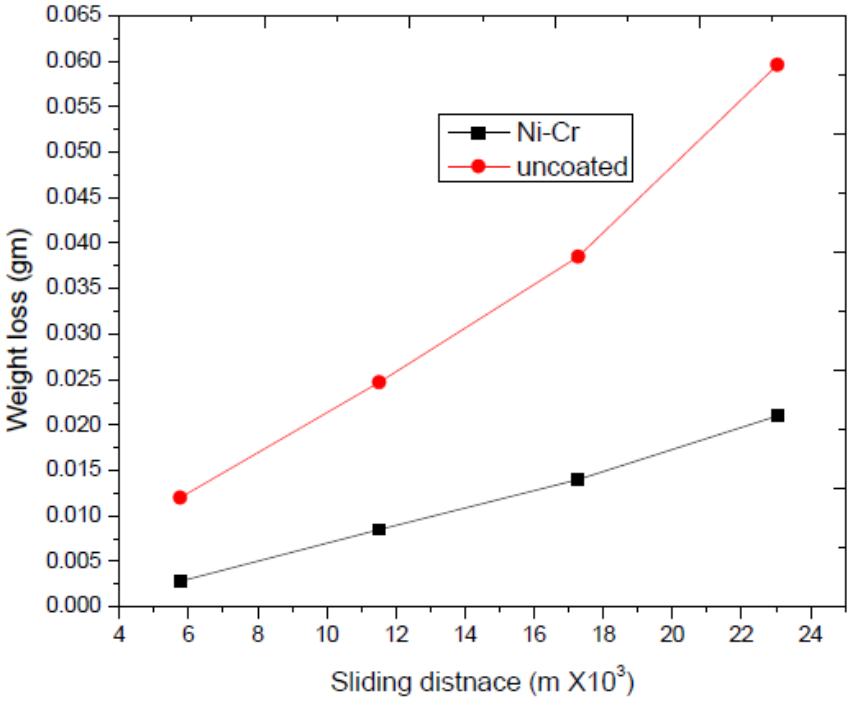

Fig 4. Weight loss against sliding distance

IV. CONCLUSIONS

Wear resistance of protective coating applied material, evaluated by means of dry sliding wear test is higher than that of uncoated substrate material. As sliding distance increases, both coated as well as uncoated material show an increment in the wear rate. Specific wear rate, which is expressed in terms of volumetric wear rate, also shows an increment with increase in sliding distance. The coating powder Ni-Cr is quite effective in resisting the wear and can be used for the protection of parts such as diffusers and valve seats in a hydraulic turbine. Its use in turbine blades may not fetch desired results because of lesser hardness. But its lesser cost as compared to other coating powders is an advantage.

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