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SLIDING WEAR BEHAVIOUR OF AISI 304 STAINLESS STEEL WITH CERAMIC COATING

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ABSTRACT

In this investigation, friction and sliding wear behaviour of AISI 304 stainless steel with HVOF coating was studied. This approach explains the comparative study of steel and ceramics; and also to evaluate the frictional properties of coatings also. The austenitic stainless steels are good in mechanical properties. To enhance the tribological properties and surface hardness of the stainless steel the alumina – titania (60 – 40 wt. %) powder was deposited as coating using High Velocity Oxy-Fuel (HVOF) method.The experiments were carried out by adopting pin on disc sliding wear test method as per ASTM guidelines. The AISI 304 stainless steel was selected as the pin and the disc was coated with the ceramic coating. The parameters used to evaluate the friction and wear behaviour are such as sliding velocity, normal load and sliding distance were designed and studied as per ASTM G99 standard. From the experiment mass loss of the sliding pin was measured to calculate the wear rate of the material under the specified conditions. The variations in co – efficient of friction (CoF) obtained for steel and ceramic coating were also discussed with respect to the sliding parameters. The surface of the pin after wear was observed with the help of microscope to study the wear track and wear mechanism.

1. INTRODUCTION

AISI 304 Stainless Steel have excellent corrosion resistance and mechanical properties in many environments and have been extensively used in nuclear reactors, biomedical implants as well as in components for chemical and food industries. When in contact with themselves or other materials, austenitic stainless steels frequently suffer from severe metallic wear, AISI 304 stainless steels have shown the lowest wear resistance both in dry sliding and under lubricated conditions have severe adhesive and abrasive wear have been observed with significant mass losses. Coatings can be applied to surfaces to improve the surface characteristics and widely used in tribological applications either to reduce wear and/or to modify friction during sliding contact.

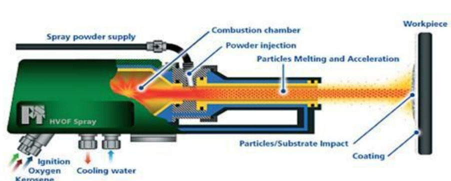
2. EXPERIMENTAL PROCEDURE

Stainless steel types 1.4301 and 1.4307 are also known as grades 304 and 304L respectively. Type 304 is the most versatile and widely used stainless steel. It is still sometimes referred to by its old name 18/8 which is derived from the nominal composition of type 304 being 18% chromium and 8% nickel.Type 304 stainless steel is an austenitic grade that can be severely deep drawn. This property has resulted in 304 being the dominant grade used in applications like sinks and saucepans.Type 304L is the low carbon version of 304. It is used in heavy gauge components for improved weldability. Some products such as plate and pipe may be available as "dual certified" material that meets the criteria forboth 304 and
304L. 304H, a high carbon content variant, is also available for use at high temperatures.Property data given in this document is typical for flat rolled products covered by ASTM A240/A240M. ASTM, EN or other standards may cover products sold by Tecni-Cable Ltd. It is reasonable to expect specifications in these standards to be similar but not necessarily identical to those given in this datasheet. In atmospheric conditions stainless steel AISI 304 SS has excellent resistance in rusting even with the presence of acids like nitric acid. The material has excellent resistance in alkaline solutions as well as organic and inorganic salts. In general this material is highly resistant to corrosion in atmosphere while in high salt spray like marine environment it might develop superficial staining which might be prevented with cleaning.

3. HVOF COATING PROCESS

High Velocity Oxygen Fuel (HVOF) coating is a thermal spray coating process used to improve or restore a component's surface properties or dimensions,

thus extending equipment life by significantly increasing its resistance to wear, corrosion and erosion.Molten or semi-molten materials are sprayed onto the surface by means of the high temperature, high velocity gas stream, producing a dense spray coating which can be ground to a very high surface finish. The utilisation of the HVOF coating technique allows the application of coating materials such as metals, alloys and ceramics to produce a coating of exceptional hardness, outstanding adhesion to the substrate material, and substantial resistance to corrosion.As the technology specialists in HVOF coating, Bodycote provides an array of spray coating materials to suit your specific needs. Backed by a customer-driven service, our facilities process a wide variety of component sizes to exacting standards with reliable, repeatable results.



4. WEAR TEST

The friction coefficient signal is displayed in real time on a color monitor using Falex's PC - Stripchart. Data can be viewed as it is recorded or accumulated over an extended period of time and later retrieved for display or printing. PC -Strip-chart features a data compression capa- bility which allows many hours of data to be con- densed and displayed on a single screen or printed on a single sheet of paper. To smooth dat, PC -Stripchart can be used to calculate the aver- age over a specified period of time and then dis- play or print the result.PC -Stripchart also displays the test time, turn count, linear velocity, and user -defined test parameters. This data can be stored and printed along with the friction traces. Designed for unattended use, a user need only place the test material into turntable's fixture and specify the test variables. A predetermined Hertzian pressure is automatically applied to the pin using a system of weights. Rotating the turn- table while applying this force to the pin includes sliding wear as well as a friction force. Since pins can be fabricated from a wide range of materials virtually any combination of metal,
glass, plastic, composite, or ceramic substrates can be tested. In POD system, there are two methods are there, First one is the disc is coated and then the pin as a non coated particle. Second one is pin is coated and then the disc as a non coated particle. After that the wear test is conducted as per the ASTM Guideline and then the wear is calculated. The disc and pin dimensions are prepared by the ASTM Guideline. Then the testing parameters are selected and then the various values are prepared for the parameters and then the values are measured. First the load is add to the one side and the speed is indicated in the system and then the sliding distance are calculated. Each values are applied and then the readings are taken and the wear is calculated. Then Dr. Taguchi of Nippon Telephones and Telegraph Company, Japan has developed a method based on " ORTHOGONAL ARRAY " experiments which gives much reduced " variance " for the experiment with " optimum settings " of control parameters. Thus the marriage of Design of Experiments with optimization of control parameters to obtain BEST results is achieved in the Taguchi Method. "Orthogonal Arrays" (OA) provide a set of well balanced (minimum) experiments and Dr. Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as objective functions for optimization, help in data analysis and prediction of optimum results.

5. RESULTS AND DISCUSSIONS

TESTING PARAMETERS

5.1 VELOCITY

The first parameter is velocity. Velocity is a how much distance is travelled in a particular time (i.e., load/distance). Unit is m/s. There are three levels are used, First level is 1 m/s, Second level is 2 m/s, Third level is 3 m/s. The various speed level is performed with various load and traveling distance

5.2 LOAD

The second parameter is load. Load is increase the contact level of the pin and rotating disc. The unit of load is Newton (N). There are three levels are used, First level is 10 N, Second level is 20 N, Third level is 30 N. The various load level is performed with various speed and traveling distance

5.3 DISTANCE

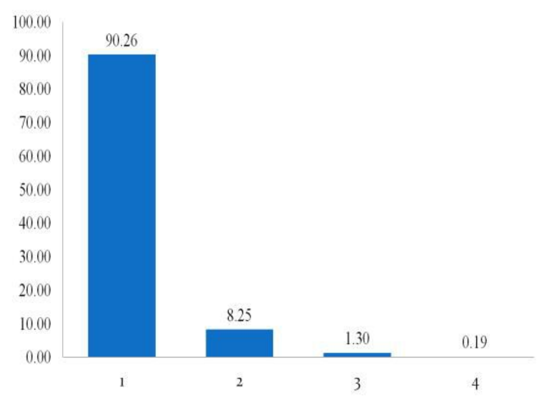
The third parameter is distance. Distance is nothing but a travel of rotating disc. Unit of travel is meter (m). There are three levels are used, First level is 3000 m, Second level is 4000 m, Third level is 5000 m.

Wear behavior of composite coating. There are three samples were tested and the corresponding weight loss function was founded, the given design represent the wear rate of the material coated under different thickness.

Velocity	Load	Distance	Mass Change	(Wear)^2	S/N ratio
m/s	N	mm	mg		
1	10	3000	0.001	0.0000012	59.172
1	20	4000	0.002	0.0000044	53.556
1	30	5000	0.004	0.0000194	47.131
2	10	5000	0.007	0.0000462	43.350

2	20	3000	0.009	0.0000733	41.351
2	30	4000	0.016	0.0002690	35.703
3	10	4000	0.034	0.0011696	29.319
3	20	5000	0.055	0.0030228	25.196
3	30	3000	0.059	0.0034692	24.598

ANOVA RESULT



19. CoF FROM VARIOUS SPEED

6. CONCLUSION

This project wear behavior of AISI 304 SS coated with Alumina – Titania (40%wt) Ceramic powder by HVOF process indicates the characteristics of wear behavior of AISI 304 SS and it is to be concluded that the wear resistance of the material is increased by applying the ceramic coating process and the coefficient of friction is decreased when the speed is increased.

7. REFERENCES

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