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Experimental analysis of manganese phosphating on steel materials

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Abstract - *Most of the metals or components react with air and water. The salt remains on outer surface layer of the components, it reduces the life time of the components. To overcome these problems Phosphate coating is used on the steel materials. Phosphating is a pretreatment process; it is the most widely used metal for the surface treatment and finishing. Due to its wealth, speed of process and capacity to give excellent adhesion, lubrication, wear resistance and corrosion resistance properties. It plays an important role in automobile manufacturing industries. Manganese phosphate coating decreases the coefficient of dry sliding friction. Phosphating is generally used method of reducing wear on machine components and moving parts. The appliance of phosphating coating improves the adhesive bonding of carbon steels. Manganese phosphate coatings are most normally used for wear resistance and lubrication applications. The manganese phosphates commonly used in automobile industries to improve sliding parts and the reduction of wear of two steel surfaces sliding one against the other.*

***Key Words*: components, phosphating, steel materials, surface treatment, manganese phosphate coating, sliding friction.**

1. INTRODUCTION

A manganese phosphate coating is defined as the treatment of a metal surface to give a hard, electrically non-conducting surface coating. The coating is fashioned as a result of a topochemical reaction, which causes the surface of the base metal to mingle itself as a part of the corrosion resistant layer. When a steel material is passed into the Phosphating solution, a topochemical reaction takes place .In this reaction the ion dissolution is initiated at the micro anodes present on the substrate by the phosphoric acid present in the bath. Modern day's several automobile manufacturing industries using surface coating method. Manganese phosphate coatings reduce friction and wear of the two sliding components. This coating is extensively used to improve the sliding properties of engine, gear, and power transmission systems .These pre-treatment processes which may result in different adhesion strength of the coatings deposited. Hence this paper selected is to make the investigations on surface modified manganese phosphate coatings on steel materials. Manganese phosphating as a wear protection measure is generally used in the automobile industry. Crown and pinion gears in the differential, Gearwheels in the gearbox, cam-shafts, valves and valve-steams as well as pistons in larger diesel engines are regularly treated in this way.

2 LITERATURE REVIEW

Chao-Min Wang [3] reported the effects of temperature and applied potential on the microstructure and electrochemical behavior of manganese phosphate coating on CrMoV steel surface. He evaluated the material characteristics and corresponding corrosion resistances in his study. He showed 27 experimental results in manganese phosphate formed at 90 °C but not at 70°C or 80°C in the solution used in this study. At 90 °C, the phosphate consisted of two different layers, with a iron-rich inner layer and a Manganese-rich outer layer. A large amount of substrate dissolution occurred during the phosphating treatment at 90 0C.

Jose Danie et al [8] analyzed friction and wear behavior of steam-oxidized sintered iron components coated with manganese phosphate. Manganese phosphate coatings have lubrication properties and low friction coefficients. He reported that the steam oxidation treatment formed homogeneous oxide layers covering the surface, including the surface and internal pores, the later phosphating treatment reduced the thickness of the oxide layer, which became porous and finally discontinuous in some areas, reducing the load bearing capacity, the phosphated samples offered poorer abrasive and dry sliding wear resistance than the non-phosphated. This result was more important for samples with thinner oxide coatings.

Rout et al [9] investigated Enhanced forming properties of galvannealed steel sheet by Poly manganese phosphate coating .Poly manganese phosphate coat on galvannealed steel sheet can be made intense with uniform crystallite size of 1–2 m. He confirms that Polymanganese coated galvannealed (GA) steel sheets with 1000 g/m2 oil helps in reduction of coefficient of friction with the die surface from 0.22 to a value of 0.11 indicating better lubricating property. Granular phosphate coating act as a lubricating base for reduction of coefficient of friction and manganese phosphate acts as an anti-sticking base to make the surface smooth during forming operation.

Yasar Totik [10] studied the corrosion behavior of manganese phosphate coatings applied to AISI 4140 steel subjected to different heat treatments. He concluded that the corrosion resistance of the coatings on the quenched and tempered substrates is higher than that of non heat-treated substrates and the corrosion behavior of the coatings on the quenched substrates was better when compared to the tempered substrates.

3 PROBLEM DEFINITIONS

Most of the automobile components are exposed to atmospheric air and water it will cause the rust and corrosion formation on the surface of the material .Many parts of an automobile are sliding with each other, parts like cylinder and piston , gears and transmission systems. Due to sliding, wears occurs, it will affect the life time and properties of the materials. Inducing manganese phosphate coating on steel materials is one of the potential items to improve the corrosion resistant, wear resistant, durability and increase load capacity and stiffness. The introduction of manganese phosphate coating on steel materials surface helps in designing better mechanical properties. It can be achieved without much increase in price and decrease in worth and reliability.

4. METHODOLOGY

- The spring steel material was taken as a specimen.
- The dimension of the specimen is 600mm length, 60 mm width and 8mm thickness.
- The wear test was done in specimen by using surface grinding machine.
- The weight of the test piece was noted by digital weighing scale.
- specimen was exposed to manganese phosphate surface coating process
- Again the wear test was done in manganese phosphate surface coating specimen by using surface grinding machine.
- The weight of the manganese phosphate surface coating specimen was noted by digital weighing scale.

5. EXPERIMENTAL ANALYSIS

Fig -1: wear testing by surface grinding machine

The dimension of the specimen is 600mm length, 60 mm width and 8mm thickness was fitted on the work table of the surface grinder machine. The spindle speed of the grinding machine 2800 rpm should be kept constant. The vertical feeds to be given (0.01mm, 0.02mm, 0.03mm, 0.04mm and 0.05mm).After completion of each feed, measure the thickness of the specimen. Same procedure was done after manganese phosphate coating process.

Table -1: Specification of surface grinding machine

1	Working surface of the table	300 x 600mm
2	Max height from the table to grinding wheel	275mm
3	Vertical feed least count	0.01
4	Cross feed least count	0.05
5	Spindle speed	2800 rpm

5.1 wear test before manganese phosphating

Table -2: Feed vs. Thickness before phosphating

SL.NO	Vertical feed (in mm)	Thickness of the specimen (in mm)
1	0.01	7.99
2	0.02	7.98
3	0.03	7.97
4	0.04	7.96
5	0.05	7.95

5.2 Manganese phosphating process

- Degreasing and cleaning
- Water rinse
- Pickling in mineral acid (where necessary)
- Water rinse (only after pickling)
- Activation
- Manganese phosphating
- Water rinse
- Final oven drying(optional)
- Lubricating with special oils or emulsions

The degreasing and cleaning are frequently done with powerfully alkaline cleaners at concentrations of 2-6% and temperatures 70-95°C. Treatment times range from 12-15 minutes. In modern years, a highly effectual activating pre-rinse has been developed for manganese which allows alkaline cleaning and pickling of the work, without the penalty of coarse-crystalline phosphate formation. This is based on a finely-dispersed manganese phosphate at concentrations 1-2 g/l. Manganese phosphating is mainly done by immersion. Treatment period ranges from 10-20 minutes, the period depending on the surface condition of the sample piece. The bath operating temperature is around 90 -95°C and only in special cases can satisfactory coatings be formed at temperature around 75 -80°C. The phosphated components, after drying, are wrapped up in the oil or lubricant baths for 1-2 minutes, allowed to drain. The thickness of the resulting oil film depends on the oil used and its concentration.

Fig -2: Manganese phosphate tank

5.3 wear test after manganese phosphating

Table -3: Feed vs. Thickness before coating

SL.NO	Vertical feed (in mm)	Thickness of the specimen (in mm)
1	0.01	8.00
2	0.02	7.99
3	0.03	7.98
4	0.04	7.97
5	0.05	7.96

Table -4: Comparison the thickness of the specimen before and after manganese phosphate coating

Sl. no	Vertical feed (in mm)	Thickness of the specimen (in mm) before coating	Thickness of the specimen(in mm) after coating
1	0.01	7.99	8.00
2	0.02	7.98	7.99
3	0.03	7.97	7.98
4	0.04	7.96	7.97
5	0.05	7.95	7.96

This table shows the wear of the specimen of varying feed in before and after manganese phosphate surface coating process. From the above readings we can observe that the manganese phosphate surface coating piece has low wear than that of non coated sample.

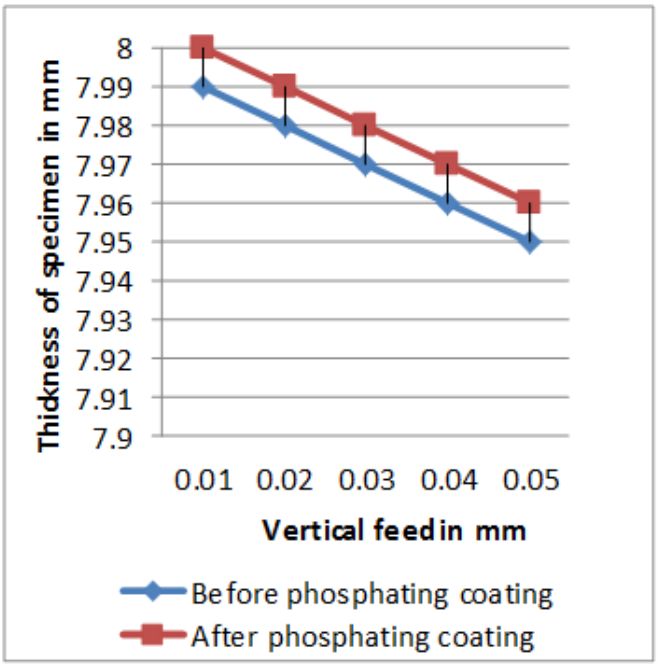

Chart -1: Vertical feed vs. thickness of the specimen

6 INFLUENCE OF MANGANESE PHOSPHATING

6.1 speed vs. wear rate

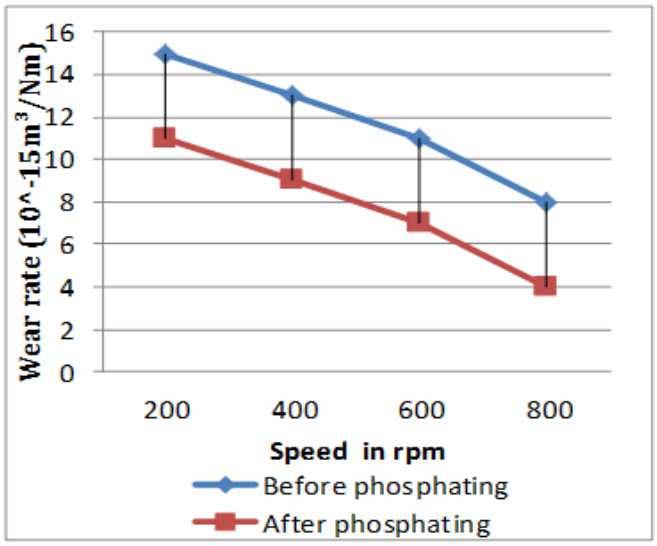

Chart -2: speed vs. wear of the specimen

This graph shows that normal speed Vs wear rate. Blue line indicates that the wear rate of the specimen due to normal load or speed without phosphating process. Red line indicates that the wear rate of the specimen due to normal load or speed with phosphating process. We can observe from the graph that the phosphating process reduced the wear rate which develops between two surfaces of the specimen.

6.2 NORMAL LOAD VS FRICTION CO EFFICIENT

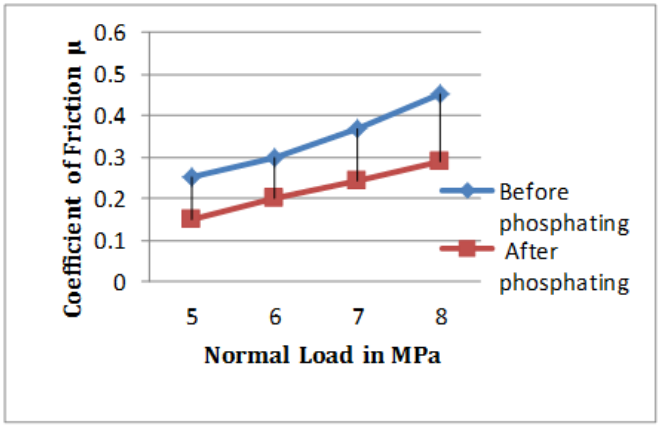

Chart -3: Normal load vs. coefficient of friction

This graph shows that normal load Vs friction co efficient .Blue line indicates that the frictions coefficient of the specimen due to normal load without phosphating process. Red line indicates that frictions coefficient of the specimen due to normal load with phosphating process. We can observe from the graph that the phosphating process reduced the friction which develops between two surfaces of the specimens.

7. CONCLUSIONS

As increasing the life time of the steel materials, manganese phosphate surface coating is recommended. It leads to Reducing coefficient of the friction and wear. Increasing life time and reducing friction and wear of steel materials are high research demands in the world. Manganese phosphate surface coated materials are getting to be up to the mark of satisfying these demands. In this paper reducing wear and friction of the steel material is considered. The Graphs reveals that the steel specimen after manganese phosphate surface coating has reduced the wear and friction.

A comparative study has been made between steel specimen before and after manganese phosphate surface coated. Manganese phosphating surface coated materials reduce the friction co efficient and wear rate.

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BIOGRAPHIES

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