EXPERIMENTAL STUDY ON HARD CHROMIUM COATING OF TESTING MANDRELS FOR CONTRACEPTIVES (A CASE STUDY)

K.C. Raipurkar * and S.G. Kulkarni
Department of Mechanical Engineering
Government College of Engineering,
Aurangabad –431005 (M.S), India

Abstract This paper highlights the solution to the problem in deciding the optimum thickness of Chromium coating. A case study of contraceptive testing mandrels of a contraceptive manufacturing company was undertaken. The requirement of the company was to suggest recoating period of mandrels and the optimum thickness of chromium coating.

Keyword: Tribotesting

INTRODUCTION

Electroplaters are exercising their long experience and knowledge for deciding the coating thickness. Chromium coated mandrels are used for testing the contraceptives (Leakage testing i.e. pin holes on the surface of condom) In this process the product is mounted on the mandrel and passed through a salt bath, through which current is circulated. In case there is a hole in the product, a mechanism separates out the defective pieces.

Even though, the chromium coating gives excellent performance in corrosion prevention, the mandrels are found rusted after some period. Presently, the mandrels are recoated after sufficient corrosion is observed.

Due to repetitive mounting of the product on mandrel, wear of chromium coating takes place. This experimental study facilitates logical information, which provides a guideline:

- For selecting the coating thickness optimally
- For deciding the recoating period of chromium on mandrels.

The observations and conclusions are briefly narrated in this paper.

METHODOLOGY

For carrying out the experimentations, tribotesting techniques were adopted. The experimental set up and strategy were given due considerations to actual working conditions. Complete experiment was divided in two parts.

*Email: kcraipurkar@yahoo.com

Part A: - Mandrel test.
Part B: - Pin on disc test.

By mandrel test, weight loss of chromium was calculated by measuring change in dimension by a mechanical comparator with a dial indicator of 1 micron least count.

With the help of data obtained by pin of disc test a graph was plotted representing weight loss vs. pressure.

This graph was used to co-relate the weight loss by mandrel test for rubber pressure 0.002N/sq. mm

EXPERIMENTAL PROCEDURE

Mandrel test:

In this test the product (condom) was mounted on a fixture as shown in the fig. 1 and by reciprocating action of shaper ram the external surface of chromium coated mandrel was rubbed against the internal surface of the product. Trial was taken on a fresh product after 100, 200, 500, 1000, 4000 cycles. Products were observed under microscope of 800 X magnification to observe the chromium particles on the product surface.

During rubbing action, silica powder was used to lubricate the mating surface. Chemical test of used powder was carried out to confirm the wear of chromium.

The pressure of rubber (condom) on the mandrel surface was calculated separately by expanding rubber (By filling air) and connecting one end to manometer filled with water column. Pressure calculated was 0.002 N/sq. mm

Rubbing velocity of shaper ram was 26 cm/sec, which was close to actual or manually loading velocity of

product while testing. ["Tribotesting Methods", Dr. Braham Prakash ITMMEC, IIT Delhi.]

Pin on Disc Test:

In most of the industrial applications, various components are subjected to relative motion. Coating surface is subjected to some load. With the variation of the load, the rate of wear changes. In order to find out weight loss for different loads, pin on disc test was carried out.

In this experiment circular chromium coated pin surface of 12 mm diameter was rubbed against a rotating disc of EN-32 material. Pins were tested for 2,5,9 and 20 kg loads. This sequence was repeated for 300 and 600 rpm. By using micrometer of 1micron accuracy, the change in the dimension was recorded and weight-loss was calculated. (refer table 2)

Finally, a graph (fig 2a) was plotted representing weight loss versus pressure, for 300 and 600 rpm. for 20 minutes duration. ["Material coatings and Surface Treatments", Bhushan Bharat, Gupta B. K.]

The graph (fig. 2b) was used to co-relate the weight loss by mandrel test for rubber pressure 0.002 N/sq mm i.e. by relating Part A with Part B.

Observation and Results

Mandrel Test:

Initial reading of mandrel diameter = 37.990 mm
Final reading of mandrel diameter = 37.985 mm
(After 17683 cycles)

Change in diameter = 37.990 – 37.985 = 0.005 mm
Change in Thickness = 0.005 /2 = 0.0025 mm
= 2.5 micron

CHEMICAL TEST FOR CONFIRMATION OF CHROMIUM IN USED SILICA POWDER

Oxidation to chromate test

It is done by acidifying with acetic acid. Then barium chloride and sodium acetate solution are added to obtain yellow precipitate of barium chromate.

Pin On Disk Test:

Table –1 Apparatus used Ducon Pin on Disc Tester

Pin material – Chromium	Density - 7.19 gm. /sq. cm
Disc Material – EN – 32	Duration - 20 min
Hardness – 65 HRC.	Track radius – 40 mm.

Table –2 Set No. 1 For 300 RPM, Sliding Distance = 150796 cm, Sliding Velocity = 125 cm / sec.

Pin No.	Load – Kg.	Area A Sq. mm	Wear height H mm	Wear volume V=A*H	Total Weight V*Density	Pressure N/ sq. mm	Weight loss mg/sq. mm X 10^{-4}
01	2	20	0.00625	0.125	0.008975	0.981	4.4875
05	5	34	0.007	0.238	0.017112	1.44	5.0
02	9	25	0.0135	0.337	0.024266	3.53	9.7
08	20	35	0.016	0.56	0.040264	5.60	11.5

Fig. 1 Trouble testing set-up for mandrel test

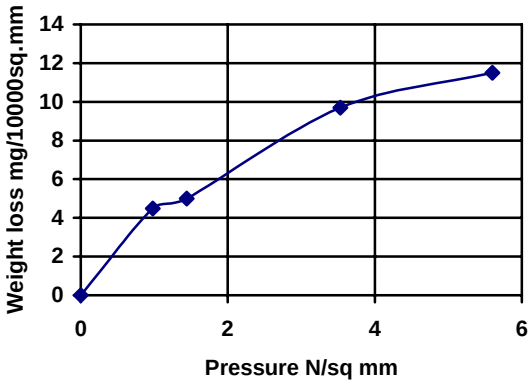

Fig. 2a Graph (Weight loss Vs Pressure)

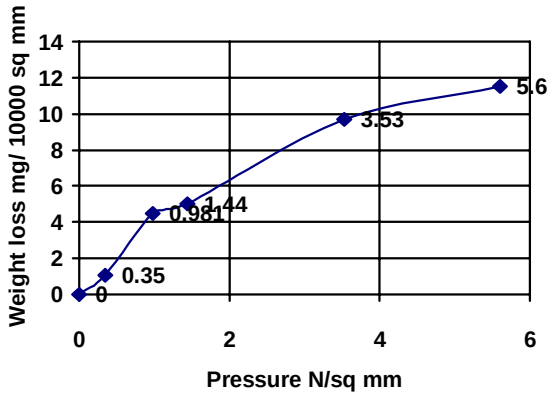

Fig. 2b Graph (Weight loss Vs. Pressure) with point (0.35,1.07)

CONCLUSIONS

Mandrel Test

Variation in the surface finish is one of the indication of wear taking place on the coated surface of chromium.

Even though after microscopic observations after 1200 cycles very small no. of particles were observed on product no. 3. Large quantity was observed after 10000 no of cycles, on product no. 7, which confirms the beginning of the wear process.

Dimensional change of thickness was confirmed 2.5 micron after 17683 no. of cycles. Hence thickness calculated after 10000 no. of cycles:-

2.5 * 10000 / 17683 = 1.4 micron

Hence, the thickness is optimised as 2 to 3 micron, which can fulfil the functional requirement up to 10000 no of cycles.

Since up to 9000 no. of cycles particles were observed occasionally and at the end of 10000 no of cycles notable quantity of particles was observed the mandrels can be recoated between 9000 to 10000 no. of cycles.

PIN ON DISC TEST

Initial rate of wear is high . This is because of roughness of the coating or high points. Nature of change of wear rate is parabolic in nature.

No peal off is observed on the surface, which shows that the quality of coating is good.

Weight loss versus pressure graph is plotted with the data of part B Experiment. Relation of part A and Part B experiments is explained below:

Experimentation area of mandrel and rubber contact
= ∏ * D * L = ∏ * 38 MM * 25 MM
= 2985 sq. mm
Where D is mandrel diameter and L is contact length

Considering change of thickness 2.5 micron

Total weight loss = 2985 * .0025 * 7.19 * 10/1000
= 1.07 mg.

Weight loss / sq mm =1.07/2985 = $1.79 * 10^{-4}$ mg

Weight loss by mandrel test = $1.07 * 10^{-4}$ mg
Rubber pressure on surface = 0.002 N/ sq. mm

From the graph plotted with the result of pin on disc test

For the weight loss= $1.07 * 10^{-4}$mg
Pressure = 0.35 N/sq. mm.(From Fig. 2b)

2.5micron thickness can be optimised for 0.002N/sq.mm pressure, which is quite below 0.35N/sq.mm pressure. (Refer fig. 2b)

2.5 micron thickness can be recommended safely.

Relation of these two independent experiments proves the validity of experimental data up to the extent of use as a guideline for calculating the coating thickness

REFERENCES

Bhushan Bharat, Gupta B. K. "Material coatings and Surface Treatments", Mc Graw-Hill .INC

Dr. Braham Prakash Paper on tribotesting ITMMEC, IIT Delhi.

Czichos H, " Tribology: a system approach to science and technology of friction, lubrication and wear", Elsevier scientific publishing, Amsterdam, 1978.

"Friction and wear devices", American Society of Lubrication Engineers, 1976