Comparative analysis for tribological behaviour of PTFE composite with different filler material

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ABSTRACT

A comparative analysis for tribological behaviour of PTFE (Polytetrafluoroethylene) composites with different filler material are investigated showing wear rate and coefficient of friction are compared with PTFE composite with different filler material on the effect of load and sliding velocity. It is used to investigated, coefficient of friction decreases with increases in load. In these investigation a comparative analysis of three different combination material investigated are PTFE+25%glass filled, PTFE+25% glass filled +5% graphite, PTFE+25%glass filled+5% molybdenum disulphide is presented. Wear and coefficient of friction comparatively evaluated on a pin on disc configuration and using Taguchi’s technique. The result of experiments proves that wear is strongly affected by the composition of filler content in PTFE

Keywords— Orthogonal Array, Pin-On-Disc Apparatus, PTFE Composite, Taguchi Technique

I. INTRODUCTION

Teflon based PTFE is a high molecular weight, strong carbon fluorine engineering polymer material. It is mostly used in several applications. It has unique self lubricating properties. This extremely slippery, chemically inert polymer has the lowest coefficient of friction and is very thermally stable. To obtain the comparable result of wear and coefficient of friction of Polytetrafluoroethylene-polyimide composite approaches the different tribological method and tribological behaviour is someway depend on the specific test method [1]. Various types of metallic nets and inorganic fillers in PTFE- based composites is to study friction and wear behaviour characteristics and to determine reduced composite wear Addition of any reinforcing filler significantly reduces wear and improve mechanical properties [2].

Yusuf Şahin [3] investigated wear behaviour of Polytetrafluoroethylene and its composites including glass-filled composites and carbon-filled composites under SiC abrasives and also used Taguchi method for wear effect parameter on the tested material. A proposed study of PTFE and PTFE composite with 40% carbon and 40% bronze under the effect of load, sliding velocity, sliding distance was found higher wear resistance for PTFE with 40%carbon. It can design and develop a best bearing material for industrial application [4].Sonam M Gujrathi et al. [5] presented showing how properties of PTFE can be improved even if the most attractive characteristic of low friction was presented by M. Conte, A. Igartua [6].A proposed study shows that PTFE, PTFE+25% Glass and PTFE+40% Bronze composites at dry sliding wear result sliding distance and applied load were found to be the more
significant factors among the other control factors on wear [7].

H. Unal et al. [8] observed that coefficient of friction of PTFE composite decreases with the applied load increases at low and high speed values. PTFE composite improved wear resistance, when it is exhibited higher heat absorption capacity [9]. M. H. cho et al. [10] found that PTFE along with PPS occur optimum reduction in wear.

The aim of the present investigation was to study comparative analysis of tribological behaviour of PTFE composite with different filler material such as graphite and molybdenum disulphide under ambient / dry condition. The tested material wear and coefficient of friction was depends on applied load, sliding velocity and contact pressure and for Plan of experiment Taguchi technique are used.

II. EXPERIMENTATION

A. Materials

In present work PTFE with different filler material wear and coefficient of friction studied. The materials wear provided in the form of pins with 10 mm diameter and 30 mm length.

- PTFE+25% Glass filled
- PTFE+25% Glass filled+5% Graphite
- PTFE+25% Glass filled+5% Molybdenum disulphide

Characteristics of glass filled PTFE was high compressive strength, better wear resistance and excellent chemical resistance and therefore, added graphite and molybdenum disulphide in glass filled PTFE, it increases all characteristics above with outstanding electrical properties and excellent flexural properties. The materials used for investigation were purchased from perfect packaging pvt Ltd.

B. Wear and friction test apparatus

The test was carried out on “pin-on-disc” apparatus at ambient condition. It determines wear and coefficient of friction under sliding contact. The tester is operated with pin positioned perpendicular to flat position disc. Machine compatibable to conduct tests confirming to ASTM G-99 standard. It consist display of frictional force, wear and speed on controller also acquire and store test data of temperature, frictional force and wear.

Wear disc material is EN31 hardened to 60HRC, ground to 1.6Ra surface roughness. Disc having diameter is 165 mm and 8 mm thick. Wear track diameter minimum 50 mm diameter to maximum 100 mm. Tribological test were conduct at room temperature on different filler polymer material under 1kg, 2kg and 3kg loads and at 0.5m/s, 1m/s, 2m/s sliding velocity. Fig. 1 shows schematic diagram of pin-on-disc apparatus that was used for the same work.

III. DESIGN OF EXPERIMENT

Design of experiment is the design of any information-collecting where variation is present. It involves planning of test, conducting test and analysis test result. By using Taguchi approach design of experiment was carried out. The Taguchi method consists reducing the variation in a process through complete design of experiments. Taguchi used to investigate how different parameters affect the mean and variance of a process performance characteristic that defines how well the process is functioning .The experimental design proposed by Taguchi involves using orthogonal arrays to arrange the parameters affecting the process and the levels at which they should be varies. Instead of having to test all possible combinations like the factorial design, the Taguchi method tests pairs of combinations [5] [11].

For design of approach, experiments were conducted as per plan of experiment three levels method in which L27 standard orthogonal array used. Table I presented L27 orthogonal array method. In three level L27 (313) orthogonal array 27 has rows and 13 has column. Therefore 13 factor study here in three levels. Experiment was conducted by chosen following parameters (1) Materials (2) load (3) sliding velocity and contact pressure varies with change in load at overall experiment. In the orthogonal array table column one present materials, column two present loads in kg, column five present sliding velocities in m/s while remaining column present the interaction between the parameter. The experiment was conducted as per orthogonal array and results indicate wear and coefficient of friction.

![Fig.1 Pin On Disc apparatus](image)

<table>
<thead>
<tr>
<th>Table I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L27 (313)</strong> Orthogonal Array</td>
</tr>
<tr>
<td><img src="table-content" alt="Table content" /></td>
</tr>
</tbody>
</table>
Table II.
Level Assign for conducting experiment condition

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>LEVEL 1</th>
<th>LEVEL 2</th>
<th>LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE+25% Glass Filled</td>
<td>PTFE+25% Glass Filled</td>
<td>PTFE+25% Glass Filled+5%Molebdenum disulphide</td>
<td></td>
</tr>
<tr>
<td>LOAD(kg)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>SLIDING VELOCITY (ms⁻¹)</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

In Table II material PTFE+25%Glass Filled assigns as “A”, PTFE+25%Glass Filled+5%Graphite assigns as “B” and PTFE+25%Glass Filled+5%Molebdenum disulphide assign as “C” in the result.

IV. RESULT AND DISCUSSION

The result of friction and wear PTFE composite with filler glass filled, graphite, molybdenum disulphide was shown in table III as per L27 standard orthogonal array experiments.

Table III
Result as per L27 standard orthogonal array experiments

<table>
<thead>
<tr>
<th>St. No.</th>
<th>Material</th>
<th>Load (kg)</th>
<th>Sliding Velocity (ms⁻¹)</th>
<th>Wear Loss (micro-meter)</th>
<th>C.O.F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>1</td>
<td>0.5</td>
<td>10</td>
<td>0.21</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>1</td>
<td>1</td>
<td>17</td>
<td>0.22</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>0.19</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>2</td>
<td>0.5</td>
<td>11</td>
<td>0.26</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>2</td>
<td>1</td>
<td>16</td>
<td>0.25</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>0.27</td>
</tr>
<tr>
<td>7</td>
<td>A</td>
<td>3</td>
<td>0.5</td>
<td>14</td>
<td>0.26</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>0.31</td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>3</td>
<td>2</td>
<td>25</td>
<td>0.26</td>
</tr>
<tr>
<td>10</td>
<td>B</td>
<td>1</td>
<td>0.5</td>
<td>8</td>
<td>0.03</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>0.03</td>
</tr>
<tr>
<td>12</td>
<td>B</td>
<td>1</td>
<td>2</td>
<td>17</td>
<td>0.05</td>
</tr>
<tr>
<td>13</td>
<td>B</td>
<td>2</td>
<td>0.5</td>
<td>7</td>
<td>0.07</td>
</tr>
<tr>
<td>14</td>
<td>B</td>
<td>2</td>
<td>1</td>
<td>88</td>
<td>0.03</td>
</tr>
</tbody>
</table>

The result investigate average coefficient of friction of PTFE+25% glass filled is higher than PTFE+25% glass filled+5% graphite and PTFE+25% glass filled+55 molybdenum disulphide. The average range of coefficient of friction for PTFE based 25 % glass filled with filler graphite and molybdenum disulphide is about 0.04 to 0.05.

Fig.2(a), Fig.2(b) and Fig.2(c) shows the variation of coefficient of friction with respect to time at three different velocities at load 1 kg, 2 kg and 3 kg for PTFE+25% Glass filled,PTFE+25% Glass filled+5% Graphite,PTFE+25% Glass filled+5% Molybdenum disulphide material.
V. CONCLUSION

- The range of coefficient of friction for PTFE and glass filled based composite with filler graphite and molybdenum disulphide is about 0.04 to 0.05 at ambient condition for a given load and speed.
- For the PTFE+25 % glass filled composite coefficient of friction is more while PTFE+25 % Glass filled+5% Graphite, PTFE+25 % Glass filled+5% Molybdenum disulphide material value of coefficient of friction is very less.
- Coefficient of friction may decreases and increases with increase in applied load.
- For all material at low velocity wear loss is less and at medium and high velocity wear loss may less or more.
- As per literature survey PTFE material having low coefficient of friction and high wear rate but adding suitable filler material in PTFE reduces wear rate and coefficient of friction also.

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REFERENCES


