Proceedings of Asia International Conference on Tribology 2018, pp. 59-60, September 2018

A Taguchi approach on influence of molybdenum disuphide as an anti-wear additive on the performance of lithium grease

P.N. Nagare[1,*], H.N. Kudal[2]

[1)] Mechanical Engineering Department, Amrutvahini College of Engineering, Sangamner, 422608, Maharashtra, India.
[2)] Mechanical Engineering Department, SND College of Engineering and Research, Yeola, 423401, Maharashtra, India.

[*]Corresponding e-mail: pnn_2276@yahoo.co.in

Keywords: ASTM D 2266, signal to noise ratio; analysis of variance

ABSTRACT – Molybdenum disulphide powder with different particle sizes and percentage volume by proportion are mixed with lithium grease and influence of molybdenum disulfide as an anti-wear additive on the performance of lithium grease was identified as per ASTM D2266 tests on four ball tribotester. Molybdenum disulphide particle sizes and percentage volumes by proportion were considered as performance variables and wear scar diameter as response. Signal to noise ratio analysis was done to identify the levels for optimum wear scar diameter. Analysis of variance was done to identify significant factor which affects wear scar diameter.

1. INTRODUCTION

Greases are semi-solid substances composed of lubricating oils and soaps or thickeners. The work reported by Bartz [1] was on optimal concentration exist for molybdenum di sulphide and graphite in liquid or paste lubricants. Less than this concentration of solid lubricant is insufficient to maintain protection against wear. Antony et al. [2] reported work on anti-wear/extreme pressure performance of graphite and molybdenum di sulphide combinations in lubricating greases.

The aim of this work was to identify effect of concentration and effect of particle size of molybdenum disulphide as an anti- wear additive in lithium grease for the optimum wear scar diameter.

2. METHODOLOGY

Design of experiments was done on the basis of Taguchi technique. The particle sizes of 0.5 micron, 1 micron and 1.5 micron of molybdenum di sulphide was mixed in lithium soap grease in different volume proportions of 5%, 10% and 15%. For three levels of two factors, L9 orthogonal array consisting of nine experiments was selected.

2.1 Four ball tribotester

The four ball tester machine TR-30L-IAS DUCOM make as shown in Figure 1 was used for tests. ASTM D 2266 standard procedure was followed to find wear scar diameter.

2.2 Testing as per ASTM D2266

Carbon chrome balls of 12.7 mm diameter each were used in tests. The temperature of 75 ± 2 ºC and speed of 1200 ± 60 rpm were maintained as per standards. The load 392 N was applied by load lever. The top ball was rotated by the spindle in contact with three balls in ball pot. The motor was run for 60 minutes duration as per standards.

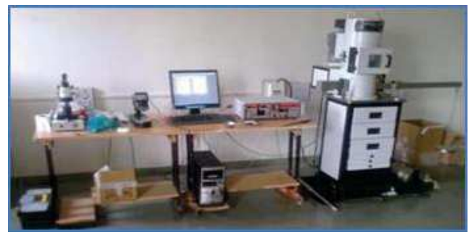

Figure 1 Four ball tribotester.

After the test, wear scar diameters for three balls were measured using image acquisition system in microns. Average wear scar diameters are listed in Table 1.

Table 1 L9 orthogonal array and Result table.

Test No.	Particle size (micron)	Proportion by volume (%)	Avg. wear scar diameter (microns)	S/N ratios
-	Plain Lithium Grease		753.00	---
1	0.5	5	602.33	-55.5967
2	0.5	10	722.33	-57.1747
3	0.5	15	870.00	-58.7904
4	1	5	570.33	-55.1225
5	1	10	709.00	-57.0129
6	1	15	744.46	-57.4368
7	1.5	5	536.33	-54.5886
8	1.5	10	630.33	-55.9914
9	1.5	15	738.33	-57.3650

3. RESULTS AND DISCUSSION

3.1 Signal to Noise (S/N) ratio analysis

Smaller the wear scar diameter better is wear preventive characteristics of grease, therefore ‘the smaller-the-better’ criterion was considered. Figure 2 shows that level 3 of particle size (1.5 micron) and level 1 of percentage proportion (5 %) of molybdenum disulphide as an additive in lithium grease will give optimum wear scar diameter.

Average S/N ratios are listed in Table 2 to find out influence of each level of particle size and percentage proportion on average wear scar diameters. Factor with large difference (Δ) of average S/N ratio means high influence to wear scar diameter.

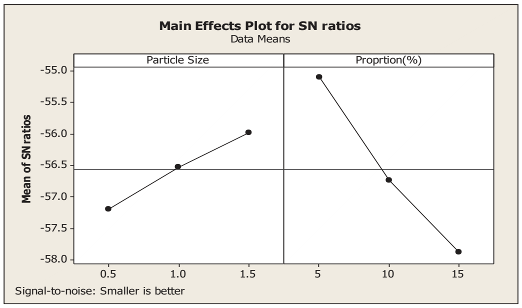

Figure 2 Effect of factors on S/N ratio.

Table 2 Analysis of average S/N ratios.

Levels	Particle size (micron)	Proportion by volume (%)
1	-57.19	-55.10
2	-56.52	-56.73
3	-55.98	-57.86
Δ = Max - Min	1.21	2.76
Rank	**2**	**1**

3.2 Analysis of Variance (ANOVA)

The analysis of variance was used as statistical tool for testing the significant factor which affects wear scar diameter [4]. Table 3 shows, percentage proportion gave more significant contribution of 81.10 % than particle size of molybdenum disulphide 16.55 % on wear scar diameter.

Table 3 ANOVA for wear scar diameters.

Factors	D O F	MS	F-Value	P-Value	P %
Particle size	2	7068	7.01	0.049	16.55
% Proportion	2	34645	34.37	0.003	81.10
Residual Error	4	1008			2.35
Total	8	42721			100
S = 31.7481 R-Sq = 95.39% R-Sq(adj) = 90.78%					

3.3 Comparison of wear scar diameter and frictional behaviours of plain lithium grease and lithium grease with optimal levels of molybdenum disulphide

The average wear scar diameter for plain lithium grease is as shown in Table 1. The average wear scar diameter at optimal levels of factors (1.5 micron and 5 % of molybdenum disulphide) is 536.33 microns. There is about 28.77 % of decrease in average wear scar diameter as compared to plain lithium grease.

The Figure 3 shows that the frictional torque for Lithium grease is higher as compared to lithium grease with 1.5 micron and 5 % molybdenum disulphide. The coefficient of friction for plain lithium grease (0.08832) is higher as compared to lithium grease with 1.5 micron and 5 % molybdenum disulphide (0.08146). Figure 4 (a) shows average wear scar diameter of plan lithium grease and Figure 4 (b) of lithium grease with 1.5 micron and 5 % of molybdenum disulphide

Figure 3 Comparison of frictional torque.

(a) (b)

Figure 4 Wear scar diameters.

4. CONCLUSION

S/N ratio analysis revealed that test 7 (1.5 micron and 5 % proportion by volume of molybdenum disulphide in lithium grease) is an optimum combination. Average S/N ratio analysis suggested that level 3 of factor particle size (1.5 micron) and level 1 of factor percentage proportion (5 %) respectively will give optimum wear scar diameter. ANOVA results revealed percentage volume proportion gave more significant contribution of 81.10 % than particle size of 16.55 % on wear scar diameter. The frictional torque for lithium grease is higher as compared to lithium grease with 1.5 micron and 5 % molybdenum disulphide. The coefficient of friction for plain lithium grease is higher as compared to lithium grease with 1.5 micron and 5 % molybdenum disulphide.

REFERENCES

[1] Bartz, W. J. (1971). Solid lubricant additives—effect of concentration and other additives on anti-wear performance. *Wear*, *17*(5-6), 421-432.

[2] Antony, J. P., Mittal, B. D., Naithani, K. P., Misra, A. K., & Bhatnagar, A. K. (1994). Antiwear/extreme pressure performance of graphite and molybdenum disulphide combinations in lubricating greases. *Wear*, *174*(1-2), 33-37.

[3] ASTM-D 2266 (2002). Standard Test method for wear preventive characteristics of lubricating grease (four-ball method). *ASTM International.*

[4] Ross, P. J. Taguchi techniques for quality engineering, 1996. *Mcgraw-hill International editions*.

[5] Neyman, A. (2002). Comparative investigation of lubricant properties in friction and wear tests. *Description of friction tests, KONES Internal Combustion Engine*, *1*, 204-210.

[6] Huang, H. D., Tu, J. P., Gan, L. P., & Li, C. Z. (2006). An investigation on tribological properties of graphite nanosheets as oil additive. *Wear*, *261*(2), 140-144.