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A Taguchi Approach on Influence of Graphite as an Anti-Wear Additive on the Performance of Lithium Grease

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Abstract

An Influence of graphite powder as an extreme anti-wear additive on the tribological performance of lithium grease was identified by conducting tests as per ASTM 2266 standard. 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. For optimum levels, wear scar diameter was predicted.

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Keywords: Antiwear additive; ASTM D 2266, Signal to noise ratio;Analysis of variance

1. Introduction

Greases are semi-solid substances composed of lubricating oils and soaps or thickeners. Soaps of lithium, calcium, sodium, aluminum are commonly used thickeners. Greases are popularly used as lubricant; however without additives greases cannot fulfill particular application lubrication requirements. For heavily loaded applications graphite can be effectively used as an extreme pressure and anti-wear additive in greases. The grease should have consistency to carry load during bearing operation and should not thin during entire operation cycle [3]. The lithium soap grease is resistant to water and oxidation. The lithium soap grease shows good shear stability at high temperature.

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One of the most important attempt in identifying graphite as an additive in grease was the work reported by Bartz [1] that 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. The effectiveness of lubrication with solid lubricants will depend on the formation of a complete film protecting the surfaces. Chu et al. [2] found that graphite existed on the rubbing surfaces stably and formed composition film with the oil-soluble additives. Further, Antony et al. [3] reported work on anti-wear/extreme pressure performance of graphite and molybdenum di sulphide combinations in lubricating greases. Both molybdenum di sulphide and graphite individually improve the anti-wear and extreme pressure characteristics of lithium and organo clay base greases. Combinations of molybdenum di sulphide and graphite had been found to exhibit synergistic effect in extreme pressure and anti-wear characteristics. However, the synergism depends on ratio of two components and type of grease. Huang et al. [4] reported that the wear resistance and load carrying capacity of paraffin oil can be improved and its friction coefficient can be decreased by the addition of the graphite nanosheets. There is an optimal content of graphite nanosheets in the lubricating oil, which gives the highest maximum nonseized load and antiwear ability.

The tribological properties of poly tetra fluoro ethylene (PTFE) by Reick [5], molybdenum disulfide by Gansheimer et al. [6], titanium oxide by Hu et al. [7] as lubricant additives had been investigated. Additives in lubricants influence tribological properties [8-12]. Nano particles size lubricant additives also enhance tribological properties [13, 14].

From literature, it was found that most of study of influence of graphite as an additive in greases was based on optimal concentration of graphite in liquid lubricants and greases. The aim of this work was to identify effect of concentration and effect of particle size of graphite as an anti- wear additive in lithium grease for the optimum wear scar diameter. The particle sizes of 0.5 micron, 1 micron and 1.5 micron of graphite was mixed in lithium soap grease in different volume proportions of 5%, 10% and 15%. A four ball tester was used to measure wear scar diameter by using ASTM D 2266 standard.

2. Experimental Study

2.1 Lithium Grease

Lithium soap grease is smooth or granular in appearance. Lithium soap grease provides water resistant property like calcium soap grease and high temperature property like sodium soap grease.

2.2 Selection of Graphite as an additive

For greases, additives enhance the existing desirable properties or suppress the existing undesirable properties and impart new properties. During selection of additive it is considered that the additive should be inorganic compound because inorganic compound shows excellent tribological properties. The other most important consideration is that solid lubricant shows better tribological properties at extreme conditions. From the objectives of research graphite was selected as an anti-wear additive.

2.3 Design of Experiments

Design of experiments was done on the basis of Taguchi technique. By this way, it was possible to achieve results with less number of experiments. The purpose of this research was to identify effect of particle size and concentration of graphite by volume in lithium grease on extreme pressure (EP) and anti-wear performance of the lithium grease. Therefore, particle sizes of 0.5 micron, 1 micron and 1.5 micron of graphite are used along with combination of 5%, 10% and 15% proportion of graphite by volume in lithium grease. Factors and their respective levels are listed in Table 1.