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Extreme pressure properties of garlic oil: comparative investigations with PAO4 base oil and PAO/garlic oil blend

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Abstract

This study aims at exploring the improvement in extreme pressure (EP) properties with addition of natural Garlic oil as EP additive. Comparative investigations were conducted on PAO4 base oil, Natural Garlic oil (NGO) and PAO_4 + 1 wt% NGO (Natural Garlic Oil) for evaluating the extreme pressure properties. The EP tests were conducted on a four ball tester according to ASTM D 2783. The results revealed that NGO possesses significantly good extreme pressure properties having a weld load of 3087N and load wear index of 513N. The results also revealed that NGO could significantly improve the weld load and load wear index of PAO_4 base oil. After adding 1 wt% garlic oil to PAO_4 the load wear index increased by 62.51% and weld load increased by 25%. This study proposes garlic oil as a replacement to the use of nano-particles as EP additives and aims to eliminate the disadvantages that are prominent with nano-particles without comprising the performance.

1. Introduction

EP additives may be defined as products effective at reducing wear and increasing seizure loads the boundary lubrication conditions. EP additives may also be defined as load-carrying additives, film-strength additives, load-carrying additives, and anti-seizure additives anti-scuffing additives, so in this way, they increase the load at which scuffing, scoring or seizure may occur. EP additives are used in mechanical applications that may experience heavy shock or loading, for example gears, turbines, ball and roller bearings etc [1]. When natural protective oxide films are removed other surface active species in the oil are not reactive enough to deposit a protective film, EP additives are used to prevent metal-to-metal adhesion or welding. EP additives find application in gear oils, and engine oils, and are even added in cutting fluids to increase their machinability characteristics [2]. To avoid sticking defects during the rolling of ferrite stainless steel, EP additive ZDDP in lubricant has shown very phenomenal scratch resistance [3].

From different research studies in the literature it was found that a lot of work has been done on different EP additives. Extreme-pressure protection is provided by reactive compounds containing sulphur, phosphorus, or chlorine or combinations of these elements. Oils containing sulfur/Phosphorus EP additives when compared with the base oils, the S/P EP generally have shown high discoloration [4]. High local temperatures are generated when opposing metal surfaces come into contact with each other under high loads, allowing an extreme-pressure (EP) agent to react with the metal surfaces, forming a surface film that prevents the joining of opposing asperities. In their study of EP properties, the mechanism of phosphate glasses in lubricating greases, the authors compared phosphate glasses to molybdenum disulfide, graphite, molybdenum dithiocarbamate, polytrifluoroethylene, boron nitride [5]. Long vacuum run times of 10^{-4} to 10^{-5} Pa at 2000 rpm have been reported in studies involving deep-groove ball bearings stuffed with PFPAE-based grease [6]. Organic sulphur