Effect of using anti-wear and friction modifier-based additives on tribological performance of engine lubricants

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Abstract: Lubricant is used to decrease wear on two surfaces that come into contact with each other, and additives can aid to improve the lubricant's performance. Engine oil is the lubricant that we use in combustion engines, and ex-ternal additives that are available on the market can be added to the engine oil to improve its performance. The purpose of this study is to see how ex-ternal additives affect the tribological performance of engine lubricants. The performance of three lubricant samples was investigated in this study: commercial engine oil (SAE10W-30), engine oil mixed with friction modifier additives, and engine oil mixed with anti-wear and extreme pressure additives. The mixtures' viscosity, coefficient of friction (COF), and wear scar diameter (WSD) were determined using viscometer, four-ball tester, and high-performance microscope. The findings show that the mixes behave differently than commercial oil. Even though adding additives to engine oil is sup-posed to boost performance, the flash temperature parameter (FTP) deter-mined from WSD, and the frictional behaviour analysis demonstrate otherwise. Chemical interactions between additives may occur because of the mixing, causing the oil's structure to change. Using commercial oil alone, according to this study, is optimal for extending the life of a combustion engine.

1. Introduction

The combustion engine has a lot of moving components and when contacting surfaces are in motion, friction and wear develop. Friction is a force that opposes the motion, resulting in heat and an increase in surface temperature. In the case of combustion engines, friction is undesirable and should be minimized to the greatest extent possible. Increased friction in a combustion engine results in mechanical energy loss, higher fuel consumption, and wear **[1]**. Wear is the surface removal and deformation that occur when contacting surfaces are in motion. The most typical source of wear is surface contact at asperities. When merely a small quantity of material on the surface has been lost or the surface finish has gotten roughened owing to severe wear, parts in an internal combustion engine may malfunction and require replacement **[2]**.

To reduce friction and wear, usually lubricant is interposed between two surfaces. In combustion engines, to maintain optimum engine efficiency and wear protection, engine oil is used to lubricate the piston ring, the cylinder, and parts that need less friction. By lowering frictional heating and facilitating heat transfer, engine oil aids in the cooling of engine parts **[3]**. Engine oil also cleans the components of an internal combustion engine of small metal and dirt particles **[4]**. A well-designed lubrication condition can result in serene engine running and prolonged engine life.

Commercial engine oil is made up of mineral base oil and additives. Additives usually contain around 15-30% in the engine oil **[5]**. Base oil is processed oil from crude petroleum oil and additives are chemical compounds added to impart specific properties to the finished oil. Some additives give the lubricant new and valuable features, while others improve existing properties and slow down the rate at which unwanted changes occur in the product during its service life. However, external additives also available in the market. These commercial additives are sold separately which require users to add the additive into the engine by themselves.

The external additives manufacturer boasts that adding additives will help solve the problems of their engine. However, since the commercial engine oil already embedded with additives, will it be necessary to add the external additives? There are many types of external additives with the specific problem to solve such as friction modifier to reduce friction, anti-wear and extreme pressure (AWEP) for wear reduction, antioxidants to reduce oxidation, dispersants to clean the oil, and many more **[6-7]**. These sounds convincing to a lot of people. Despite the marketing of the manufacturers, lots of mechanics and automotive workshops do not recommend the use of external additives and claiming it is not good for the engine and recommend only to use engine oil with proper changes duration. Therefore, this study is to investigate the effect of using external additives on the tribological performance of engine lubricants. On top of that, the types of external additives used in this study are limited to the friction modifier (FM), and anti-wear and extreme pressure (AWEP) additive.

2. Methodology

2.1. Oil samples preparation

For this study, we use three engine oil samples, which are fully formulated commercial mineral SAE 10W-30 engine oil and two external-additive-blended engine oils, one of it has molybdenum disulfide, MoS2, which act as friction modifier (FM) additive and the other has zinc dialkyl dithiophosphate, ZDDP, which acts as anti-wear and extreme