PART-1

METHACRYLATE-BASED POLYMERS AS A LUBE OIL ADDITIVE

PART-1/CHAPTER-1

BACKGROUND AND OBJECTIVE OF THE PRESENT INVESTIGATION

Lube oil is introduced between metal surfaces in an engine to reduce friction and heat generated during prolong mechanical sheer. A good quality lube should protect itself from a destructive Thermo Oxidative environment inside the engine. protect the metal surface from corrosion, and have fair rheological properties. But base lube alone cannot satisfy all requirements of a modern multi-valve, multi-chamber gasoline or diesel engine. The base oils are, therefore, blended with different additives in an expectation to improve their lubrication properties[1]. Additives are generally of a different kind depending upon the requirements. They are selected according to the property need to be modified of base oil and can be blended as a single compound or even as a mixture to attain the desired result.

The success of a lubricant is to deliver the highest level of performance depends upon the interactions of the additives with the base oil following the particular requirement of an engine. Without aided by proper additives, the oil may not protect the engine properly and might lead to engine damage.

As discussed in the "General Introduction" chapter, different additives are of different chemical composition and are manufactured to perform certain functions inside the engine. Surface protector additives act as tribo improvers by forming film between metal parts either by adsorption or by the chemical bond formation and minimize surface contact and prevent wear. Detergent and dispersant additives neutralize corrosive acid and dispersed shoot particles and prevent them from deposition on metal surfaces respectively. Rheo improvers modify low-temperature flow (Pour Point Depressant) and modify viscosity for the proper functioning of lube

in a wide temperature variation (Viscosity index improver). An antioxidant is another kind of additive protecting lube from the oxidative environment. no single additive can satisfy the desirable performance necessary for the efficient working of an engine. Thus, several additives are required to satisfy the original equipment manufacturer (OEM) needs and also the consumer needs. Additives are used at different concentrations ranging from 0.05 % to more than 10% by weight of the lubricant. The proportion of additives may even reach 30%. It is obvious that A lubricant without the proper additive is bound to get contaminated by subsequent degradation products of the base oil and, therefore, more frequent systematic oil changes are required. (Zinc diethyl dithiophosphate) ZDDP is a kind of additive that can act as a friction modifier, viscosity improver, and pour point depressant, but it is associated with serious environmental hazards. Among the other desirable properties of additive Viscosity Index Improvers (VII) and Pour Point Depressant(PPD) are the two most important categories. Viscosity is defined as fluid resistance to moving. Viscosity drastically changes with temperature and it is measured with viscosity index. A higher viscosity index implies a lower change of viscosity with temperature and it is desirable inside the engine.VII added to lube to attain this property[11-23].PPD are substances that reduce wax crystal formation at low temperature maintaining a steady flow of lubricant at lower temperature regions [24-38]. These two properties discussed above are complementary to each other.

Our present study on methacrylate and vinyl acetate homo and copolymers was prepared with an objective to replace harmful additives as well as to ascertain the behavior of the prepared polymers as multifunctional additives.

Various studies of previous researchers following the present line of investigation regarding VII and PPD are being discussed in the following paragraphs.

1. In the year 1937, Rohm and Haas patented the first polymeric PPD, poly alkyl methacrylates (PAMAs) based on waxy alkyl groups. A few years later, Ruehrwein reported the action of n-alkyl polymethacrylate as PPD in the series of methacrylate containing 12 to 18 carbon chains. It was reported that the longer alkyl chain polymers were effective as PPD in the case of high-temperature pour oils, while the shorter alkyl chain polymers were efficient on lower temperature pour oils[39].
2. Gavlin et al. analyzed some acrylates and methacrylates for their PPD properties. Dodecyl methacrylate was chosen by the authors for their work and it was their first acrylic polymer to have excellent PPD properties[40].
3. Several copolymers based on alkyl fumarate and vinyl acetate were synthesized by Borthakur et al. and their effectiveness as PPD was tested on Indian crude oils[41].
4. El-Gamel et al. in the year 1997 reported the synthesis of α-olefin-alkyl methacrylate as PPD for waxy residue fuel. Their study suggested that the polymer containing alkyl group consisting of 21 carbon chain are superior as PPD[42].
5. Abdel-Azim et al. in the year 2006 reported additives based on different esters of acrylic acid and different ratios of styrene to be used as PPD. They reported that the effectiveness of the prepared additives as PPD decreases by increasing the styrene content in the feed[45].
6. Khidr, in the year 2007 prepared four copolymers made from 1-octene or 1-tetradecene and maleic anhydride and esterified them with dodecyl or NAFOL 1822B alcohol. The effectiveness of the copolymers as PPD was tested for crude

oil and it was found that the alkyl chains of the copolymers are a crucial factor for proper interaction of the additives with the crude oil[46].

7. In 2008, Farag prepared different copolymers by varying the molar concentration of cinnamoyloxy ethyl methacrylate and octadecyl acrylate and the PPD performance and rheological characteristics were studied using different concentrations of the prepared additives for two different waxy crude oils[47].
8. El-Ghazawy et al., in the year 2010 reported a novel PPD for waxy crude oil based on alkyl acrylate terpolymers[48]
9. In another work, Khidr reported the preparation of some copolymeric and terpolymeric additives of maleic anhydride and alkyl acrylates of different chain lengths. The polymers were tested for both PPD and wax dispersants for paraffin gas oils and satisfactory results were obtained for the additives[49].
10. Jung et al. in the year 2011, Synthesized and analyzed methacrylate-based polymers as effective flow improvers. Pour point results in doped lube oil were also promissing[50].
11. In the year 2014, Decyl acrylate and styrene-based polymers, synthesized by Ghosh et al. exhibit excellent PPD result in doped lube[51].
12. The effectiveness of the polymers like polyvinyl palmitate, polyvinyl caprylate, and copolymers of vinyl palmitate with vinyl acetate as VII were analyzed by Port et al. and found that the additives are efficient viscosity modifiers for lubricating oils[52].
13. Nassar et al. made a comparative study of some polymeric additives prepared by copolymerization of different moles of styrene with different acrylates (decyl, 1-dodecyl, 1-tetradecyl, and hexadecyl) as VIIs. The viscosity modification

properties of the additives were found to increase with the increasing molecular weight of the prepared copolymers[56].

14. Jukic et al. reported dodecyl methacrylate, octadecyl methacrylate, and styrene-based terpolymers as VII for lubricating oil. The amount of styrene in the additive was restricted to 25% by weight. The group reported that the viscosity index increased with increasing molar mass of the additive but the opposite effect was obtained by increasing the styrene percentage[57].
15. Ahmed et al. prepared some additives through polymerization of vinyl acetate and maleic anhydride with different acrylates and studied the effect of concentration, molecular weight, and alkyl chain length on the viscosity index and pour point values of the additives[60]
16. Ghosh et al. reported copolymers of styrene and decyl acrylate and their compatibility as PPD and VM[62].
17. In other work, polymers of myristyl acrylate were synthesized by two different methods viz. thermal method and microwave-assisted method, and their potential to act as PPD and VII were evaluated and compared[63].

REFERENCES

References are given in BIBLIOGRAPHY under "**Chapter-1 of Part-1**".