ABSTRACT

Lubricants are materials that are largely used to reduce friction and wear between interacting surfaces and to assist their relative motion. Lubricants usually contain a base oil and package of additives. The additives either enhance the already existing property of the base oil or introduce some new property into it.

The present work is concerned with the synthesis, characterization and performance evaluation of some multifunctional organic polymeric additives for lube oil. The additives explored in this study are typically based on acrylate and methacrylate moiety. Other molecules used in this study are α-pinene and 1-octene. Some biodegradable multifunctional lube oil additives based on vegetable oils (almond oil, olive oil and castor oil) have also been investigated. The additives (polymeric in nature) were synthesized either thermally or by microwave irradiation in presence of initiators like azobisisobutyronitrile (AIBN) or benzoyl peroxide (BZP). The additives were characterized by spectral techniques (^{1}H-NMR, ^{13}C-NMR and FT-IR), followed by molecular weight determination with gel permeation chromatography (GPC) and finally assessment of their thermal stability was done by thermo gravimetric analysis (TGA). The additives were investigated for their performances in different lube oils as pour point depressant (PPD) and viscosity index improver (VII) as per the standard ASTM (American society for testing and materials) methods. Biodegradability analyses were also conducted for the vegetable oil based additives by soil burial method and disc diffusion method to test their biocompatible nature.

The detailed research work here has been divided in two parts: Part I and Part II. The Part I, "Acrylate and methacrylate based polymers as multifunctional lube oil

additives" is then divided into four chapters, chapter I, chapter II, chapter III and chapter IV.

The chapter I, of part I, portrays the progresses and developments made on acrylate and methacrylate based additives for lubricating oils. Chapter II describes the synthesis, characterization and performance evaluation of the homopolymer of myristyl methacrylate and a series of copolymers of myristyl methacrylate and 1-octene. All the polymers were characterized by spectral studies, their molecular weights were determined by GPC and they were assessed for their performances as cold flow improvers and viscosity modifiers in the base oil. The results showed that the copolymers have better viscosity modification properties while the homopolymer showed better flow improving efficiency. Chapter III discusses the application of homopolymers of undecyl methacrylate and behenyl acrylate and their corresponding copolymers as multifunctional additives for lubricant formulation. Four copolymers of undecyl methacrylate with behenyl acrylate at different molar ratios were synthesized by free radical polymerization method. Detailed comparative investigation on the homo and copolymers blended base oils confirmed better additive performance of homo behenyl acrylate as viscosity index improver while the copolymers were superior as pour point depressant among all the polymers. The copolymers were also found to be thermally more stable than the homopolymers. Chapter IV comprises the study of additive performances of polymers of mixed acrylate. Four terpolymers were synthesized by using different ratios of three acrylate monomers (octyl, decyl and dodecyl). Additive performances of each of the prepared terpolymers as viscosity modifiers and pour point depressants were evaluated by standard ASTM methods. Terpolymer prepared by using a higher ratio of dodecyl acrylate was found to be more effective as pour point depressant and also as a better viscosity modifier.

The part II, "Biodegradable multifunctional lube oil additives" is again divided into four parts, chapter I, chapter II, chapter III and chapter IV.

The chapter I, of part II, contains a brief review of the works done so far on biodegradable multifunctional lube oil additives. Chapter II deals with biodegradable lube oil additives obtained from the homopolymer of almond oil and its copolymers with decyl acrylate. The polymers were characterized by spectroscopy, their molecular weights were measured by GPC and their thermal stability was determined by TGA. All the investigated polymer samples showed excellent additive performances but the copolymer with highest acrylate content showed better viscosity modification and pour point depressant property along with significant biodegradability. Chapter III explores the potential of polymers synthesized from dodecylmethacrylate and olive oil to act as an environmentally benign multifunctional lubricant additive. Different copolymers of dodecyl methacrylate with olive oil were synthesized in a focused microwave oven using a radical initiator. The copolymer samples were found to be biodegradable viscosity index improver and pour point depressant additive for lube oil. Chapter IV explores the performance of homopolymer of castor oil and three of its copolymers with α-pinene as biodegradable multifunctional mineral lube oil additive. Copolymers of castor oil with different percentages (w/w) of α-pinene along with its homopolymer were prepared via radical polymerization taking AIBN as polymerization initiator. It was found that the most important viscosity increment was exhibited by the copolymer with highest α-pinene percentage while the homopolymer showed the superior performance as PPD for the lube oils under study.

All the additives synthesized in this research illustrated excellent additive performances and, therefore, the outcome of this study can give a new dimension in the field of multifunctional additive research.