# Synthesis and Characterization of Novel Terpolymers as Viscosity Index Improvers Using Industrial Waste for Iraqi Lubricating Oil

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***Abstract:*** *The potential utilization of industrial waste, specifically polyethylene wax, to enhance the efficiency of alkyl acrylate polymers as viscosity index improver (VII) additives in lubricating compositions has been investigated. Four terpolymers (w1, w2, w3, and w4) were synthesized via free radical polymerization, incorporating hexyl acrylate, 1-tetradecene, and industrial waste-sourced polyethylene wax at varying molar ratios. These terpolymers were characterized through gel permeation chromatography (GPC) for molecular weight determination, Fourier-transform infrared spectroscopy (FTIR), proton nuclear magnetic resonance ($^1$H-NMR) spectroscopy for chemical structure analysis, and thermal gravimetric analysis (TGA) for thermal stability assessment. The study evaluated the efficiency of these terpolymers as VII in combination with free additives Iraqi lubricating oil (base oil 60). Our results demonstrate the feasibility of significantly enhancing the efficiency of viscosity improvers through the utilization of industrial waste, with improvements proportional to terpolymer concentration. The terpolymer w3, characterized by a balanced molar ratio of 1:1:1, exhibited the highest degree of efficacy, which gave VI of 206 at 5 wt.% concentration compared with free additive lubricating oil, which gives a VI of 98. This study offers promising insights into the sustainable use of industrial waste to improve lubricating compositions.*

***Keywords:*** *kinematic viscosity; lubricating oil; polyethylene wax; terpolymer; viscosity index improvers*

## ■ INTRODUCTION

Lubricating oils include a wide range of substances known for their crucial role in reducing friction and ensuring the efficient operation of machinery and engines. These oils consist of various components derived primarily from the residual, highly viscous fraction of crude oil after the distillation process [1-2]. To meet the rigorous standards of original equipment manufacturers, modern lubricants undergo meticulous engineering involving the incorporation of various crucial liquids and chemical additives [3-7]. Most commercially available lubricants are constructed as formulated oils, consisting of base stocks alongside performance-enhancing additives. When these constituents are appropriately present in their specified proportions, they bestow upon the formulated lubricant the requisite properties essential for effective performance within the designated application. Beyond their primary roles encompassing lubrication, cooling, containment/suspension, corrosion prevention, and power transmission, these lubricants are further obligated to fulfill specific functions that are distinctive to the particular application [3].

Several additives can be utilized in diverse applications to raise the performance of lubricants. These additives encompass corrosion inhibitors, viscosity index improvers (VII), antioxidants, pour point depressants (PPD), dispersants, and detergents [7-11]. The lubricant's viscosity is one of the most essential factors to consider when choosing a lubricant. If the lube oil's viscosity is very low at the working temperature, the lube