

Thermal, Physicochemical and Rheological Properties of BiobasedPlasticizers Combinationsused inPoly (Vinyl Chloride)

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Abstract

Fundamentally, Poly (vinyl chloride) (PVC) should be processed with various additives such as thermal stabilizers, plasticizers, lubricants, fillers ...etc. Plasticizers are mainly used to modify the polymer chain flexibility and the glass transition temperature (T_g). Plasticizers based on phthalates as diethyl hexyl phthalate (DEHP) are most widely used in PVC. Unfortunately, these petroleum-based plasticizers reveal negative environmental and health effects. As an objective to substitute these dangerous products, the present study evaluates the performance of bio-based plasticizers combinations in polyvinylchloride (PVC). For this purpose, two natural secondary plasticizers were synthesized by the sunflower oil epoxidation reaction and the esterification of epoxidized sunflower oil to obtain epoxidized sunflower oil (ESO) and epoxidized sunflower oil methyl ester (ESOME) respectively. These new products were combined with two other primary bio-based plasticizers which are di-esterisorbide (DEI) and acetyl tributyl citrate (ATBC). The formulations are prepared by mixing plasticizers combination and other additives with PVC resin. Then, blends are mixed and heated; films of plasticized PVC are obtained. Several techniques such as thermogravimetric analysis (TGA) in isothermal mode, internal mixer test and light transmission have been used to study the thermal, physicochemical and rheological properties in order to search for a synergism of properties between these combinations of plasticizers.

According to thermo gravimetric analysis, formulations which contain ESO or ESOME have minimal weight losses. Therefore, the incorporation of these secondary plasticizers into the plasticizer system improves the thermal stability of the PVC blends, better than the DEI or ATBC alone and even better than DEHP. The results of the internal mixer show that the thermal stability improves with the increase of the rate of ESO or ESOME. This confirms the results of TGA. The light transmission test shows that the incorporation of the ESO or the ESOME leads to a difference in transparency, where the transmission of light decreased with the increase of the rate of the latter in the plasticizer system.

In conclusion, the mixtures of ESO and ESOME with DEI and with ATBC derived from renewable resources, show plasticization efficiency and can be applied as alternative plasticizers for conventional plasticizers based on a fossil source.

Keywords: Polymer, PVC, Biobased plasticizers combinations, Sunflower oil, Thermal stability.