

Life Cycle Assessment in the Design of Plant Oil-Based Latex Adhesives

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Synthetic method for developing plant oil-based monomers (POBMs) using direct transesterification reaction of oil triglycerides with *N*-(Hydroxyethyl) acrylamide was created and widely used by our group. Resulted acrylic monomers undergo free-radical polymerization, including in emulsion process, to yield latex polymers, suitable for application as adhesives.

This study aims to improve the performance and sustainability of POBM-based latex adhesives. Latex adhesives were synthesized from combination of methyl methacrylate (MMA), butyl acrylate (BA) and POBMs at various monomer ratios. Depending on the plant oil(s) used in monomer synthesis, properties of resulted latex adhesives can be tuned based on the unsaturation of fatty acids constituents presented in the oil. Fragments of camelina oil-based (CMM) and high oleic soybean oil-based (HOSBM) monomers were incorporated into latexes to evaluate their effect on the adhesive performance. The MMA content in monomer feed was kept at 55 wt%, while BA (within remaining 45 wt% of the feed) has been gradually replaced by POBM, yielding latexes which were found feasible as adhesives on various model substrates. Adhesive performance was evaluated using peel testing (ASTM D 1876-08). The obtained results indicate that presence of CMM- or HOSBM-based fragments in latexes overall enhances peel strength.

Life cycle assessment (LCA) is used as a guide, early in the design of the POBMs to evaluate their environmental performance and find ways to optimize the POBMs synthesis. We built the preliminary LCA model for POBMs production based on experimental data in order to identify the hotspots in the monomer synthesis in the early design stages. To improve the environmental performance of monomer synthesis on lab-scale, 2 solvents were proposed as potential replacements of dichloromethane, such as hexane and 2-methyl-tetrahydrofuran (Me-THF). These 3 solvents were used during the purification step. It was observed that by using hexane and Me-THF higher yield and up 30% lower environmental impact in most categories can be obtained, making these solvents promising alternatives for potential monomer production at the industrial scale. In addition to optimizing the environmental performance of the POBMs, we compared the life cycle environmental impacts of monomers used in synthesis of latex adhesives.

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