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The use of ionic liquids and deep eutectic solvents for enhancing enzymatic biodiesel production

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When immobilized enzymes are used in biodiesel production, the addition of an organic solvent becomes inevitable to reduce the inhibitory effect of the reactant methanol and to enhance the diffusion of the by-product glycerol. However, most of these solvents are volatile, toxic and difficult to separate the product from them. In this work, ionic liquids (ILs) have been tested as safer and easier to recycle solvents. The effectiveness of several ILs was tested and compared to that of the conventional organic solvents, and the highest yield achieved was with [bmim][PF6]. Despite their clear advantages, the costs of both ILs and enzymes are relatively high, and their repeated use is essential from an economical point of view. Therefore, a process to enhance the stability and reusability of the enzyme-IL system was developed and tested at different methanol to oil molar ratios. In this process, the product biodiesel was selectively separated first, and then the by-product glycerol was removed, which allowed the enzyme-IL to be used successfully for several consecutive cycles. The reusability protocol was then tested on low-cost deep eutectic solvents (DESs). The effectiveness of using the DES, composed of chlorine-chloride and glycerol (ChCl:Gly) with 1:2 molar ratio, was found to be comparable to that found using [bmim][PF6]. The effectiveness was enhanced when water was included in the preparation of the DES, which reduced the viscosity of the solvent. The results found in this work provide important information, essential for the economic application of enzymatic catalyzed biodiesel production.

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