Purification of biodiesel in a laboratory Karr column

Aleksandra Sander, Ana Petračić, Domagoj Vrsaljko, Patricija Hršak, Antonija Jelavić

University of Zagreb, Faculty of Chemical Engineering and Technology, Marulićev trg 20, 10000 Zagreb, Croatia

Following the trend of transport decarbonization and development of new renewable energy sources, biodiesel emerged as one of the most market-ready alternative fuels of our time. It is already widely adopted and mixed with conventional diesel fuels across the globe. Its production includes multiple steps, such as pretreatment, transesterification and crude biodiesel purification, all of which can be time consuming and energy demanding. An improvement made to any of these processes can lead to large environmental and economic benefits, which is why this work aims to provide insight into an alternative method of continuous biodiesel purification. Extraction of glycerol from crude biodiesel with deep eutectic solvents has been mostly investigated as a batch laboratory process. Since continuous process have significant advantages over batch process, the aim of this work was to investigate continuous column extraction. Biodiesel was synthesized from waste cooking oil by means of chemical transesterification with methanol and KOH as catalyst (oil:methanol:KOH = 100:40:1, by weight). Glycerol was mechanically removed (decantation and centrifugation) prior column extraction. Deep eutectic solvent (DES), choline chloride – ethylene glycol (1:2.5, molar ratio) was used as a selective solvent. Extraction of glycerol have been performed in a laboratory Karr column at different DES to biodiesel mass ratio and pulsation frequencies. The influence of plate material (steel and PETG) and geometry on the extraction efficiency was analyzed. PETG plates were 3D modeled and printed. Free surface area of all used plates was the same. The surface free energy of steel and PETG and spreading ability of biodiesel and DES on both materials were determined by contact angle measurement. The extraction efficiency was analyzed by means of different analytical techniques (NMR, FTIR, GC). Both materials have similar surface properties. Due to the better spreading ability of biodiesel (significantly lower contact angle after 2 s) and to reduce the solvent consumption, biodiesel was selected as the continuous phase. Higher extraction efficiency was observed with steel plates triangular pitch hole arrangement. Increase in DES to biodiesel mass ratio and mixing intensity positively influenced extraction efficiency.