A continuous road towards sustainable biodiesel: extractive deacidification of waste edible oil in a Karr column

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The search for novel renewable energy sources is in full swing following the declining global fossil fuel availability and climate change related problems. Introducing alternative fuels to the transport sector is a vital step in combating the air pollution and securing reliable fuel supply across the market. Biodiesel is a great alternative fuel because it is readily available for mixing with conventional diesel fuel in existing cars, thus requiring no extra investment from the consumers.

To consider biodiesel production sustainable, it should be derived from sustainable feedstocks. Waste edible oils, originating from households and restaurants, make excellent feedstocks since they are available across the globe and would otherwise have to be disposed of. Their main drawback as feedstocks for base-catalysed transesterification is their often-high free fatty acid content, which hinders the biodiesel synthesis reaction. After successfully conducting a scale-up of batch extractive deacidification, the next step of the research was to move on to a continuous process, making it one step closer to commercialisation. This paper discusses the removal of free fatty acids via deep eutectic solvent assisted extractive deacidification in a continuous Karr column.

Deacidification of waste edible oil was done with potassium carbonate: ethylene glycol (1:10 mol.) deep eutectic solvent. The experiments were conducted at different solvent to oil mass ratios and pulsation rates to investigate the effect of process conditions on extraction efficiency. Samples were taken every five minutes, and the total acid value was determined. Steady state was achieved after 20 minutes. Mass transfer rates and volumetric mass transfer coefficients were calculated from the results.

For all experiments, oil was the continuous phase. Volumetric mass transfer coefficients were larger on the continuous phase when compared to the dispersed phase, meaning that the resistance to the mass transfer was on the side of the solvent. With increasing pulsation rate and solvent to oil ratio the extraction efficiency was increased, as well as the volumetric mass transfer coefficient of the dispersed phase. The results demonstrate the influence of hydrodynamic conditions on the rate of mass transfer. After 20 minutes of extraction, efficiencies of over 90% were achieved, proving that this method has great potential for continuous feedstock deacidification.