Continuous Enzymatic Production of Biodiesel in CSTRs in Series

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The demand for biodiesel (BD) is growing as a result of increased focus on reducing greenhouse gas emissions. However, today most biodiesel is produced from edible vegetable oils such as rapeseed oil. In order to use more sustainable raw materials new processes has to be developed, since the traditionally chemical catalyzed processes has difficulties handling the high free fatty acid (FFA) content of low grade oils, such as used cooking oil, algae oil or jatropha oil.

An enzymatic catalyzed reaction could solve the problems handling high FFA content feedstock and would furthermore result in lower costs e.g. fewer process steps, and improved glycerol quality. To date, soluble liquid lipases have not drawn much attention in the scientific literature, unlike their immobilized counterparts, because of the requirements to reusability to make the process cost-effective. However, soluble enzymes are cheaper, and not inactivated by glycerol and colloids [1]. In this study soluble liquid lipases have been used to catalyze the transesterification of rapeseed oil with ethanol into fatty acid ethyl esters (BD). Since BD is produced in huge quantities a continuous production is necessary and a suitable process layout could include several continuous stirred tank reactors (CSTRs) in series. In order to determine the optimal configuration of three CSTRs in series, reaction kinetic data has been collected in batch experiments and based on a Levenspiel plot the reactor volumes have been calculated. The calculations have been validated experimentally and the steady-state conversions in the three reactors found to be 61%, 80% and 93% respectively, with a total residence time of 24h. A way to make the productivity of the enzymes higher is by recirculating the aqueous phase containing the enzymes, but this is only worthwhile if enzyme activity is retained. It was found that 78% enzyme activity was preserved even after four reuses of the enzymes, proving that recirculation of the aqueous phase is possible and should be further investigated in an effort to make the enzymatic biodiesel process profitable.

REFERENCES

[1] Nielsen, P.M., Brask, J., Fjerbeak, L. (2008). Enzymatic biodiesel production: Technical and economical considerations. Eur. J. Lipid Sci. Technol., 110, 692-700.