Ion-exchange resins as green catalysts for industial transesterification applications.

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INTRODUCTION

Transesterification of alkyl esters has many industrial applications, e.g., in the fine-chemicals, food and biofuel industry. Transesterification is generally performed as a homogeneously catalyzed process, however the development of heterogeneous catalysts is currently a hot topic because of the several advantages over homogeneous ones: (1) the reduction of possible equipment corrosion, (2) ease of product separation, (3) less potential contamination in waste streams, and (4) recycling of the catalyst.

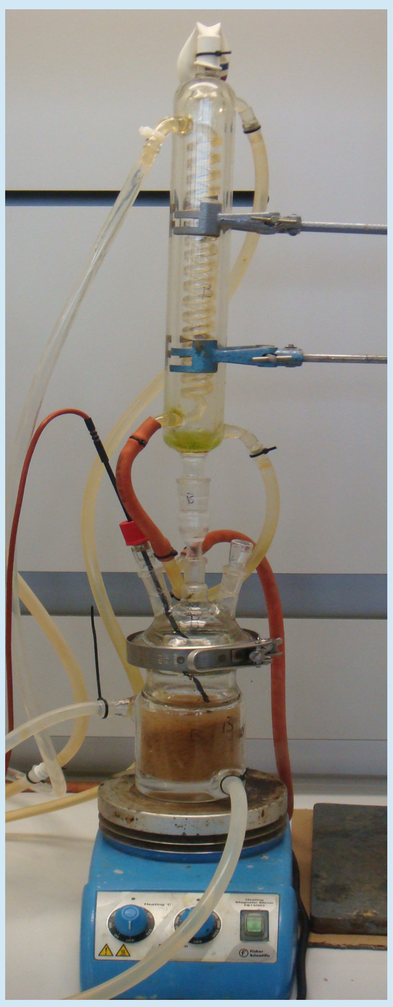
Transesterification can be base or acid catalysed. Base catalysts will increase the reaction rate, but the process is very sensitive to the presence of water and FFA's which lead to undesired site reactions.

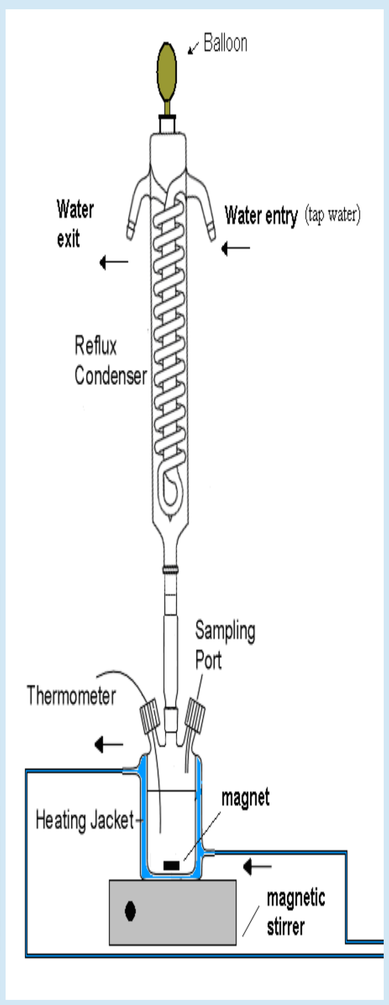
The potential use of Lewatit K1221 and Lewatit K2629 – both acid ion-exchange resins with high catalytic acitvity and low toxicity – for transesterification has been investigated.

REACTION SET-UP

The transesterification of ethylacetate with methanol was used as a model reaction.

Temperature: 313 – 333 K
Molair ratio: Methanol:Ethylacetate: 5 – 20
Catalyst amount: 1 – 4 w%

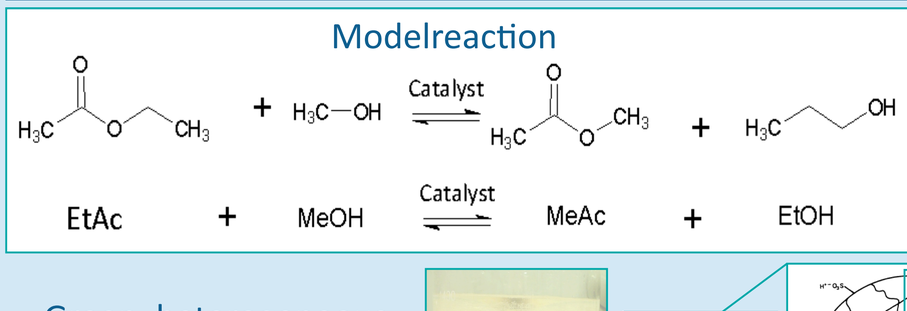




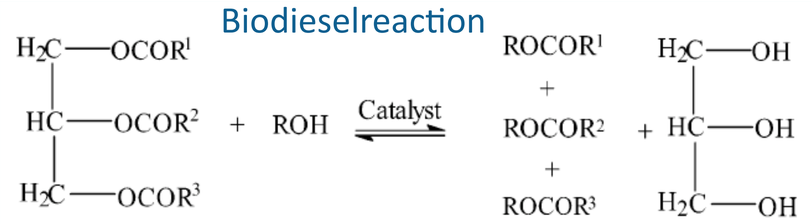
Measurement of concentration with time with GC-FID equipped with a capillary column (Stabilwax PN°10624). The experiments are reproducable with no internal/external diffusional limitations.

CATALYTIC REACTION

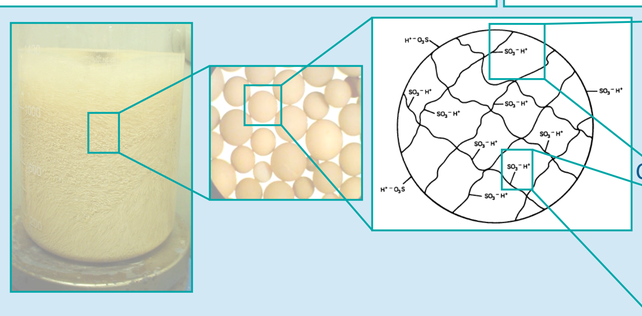
Modelreaction



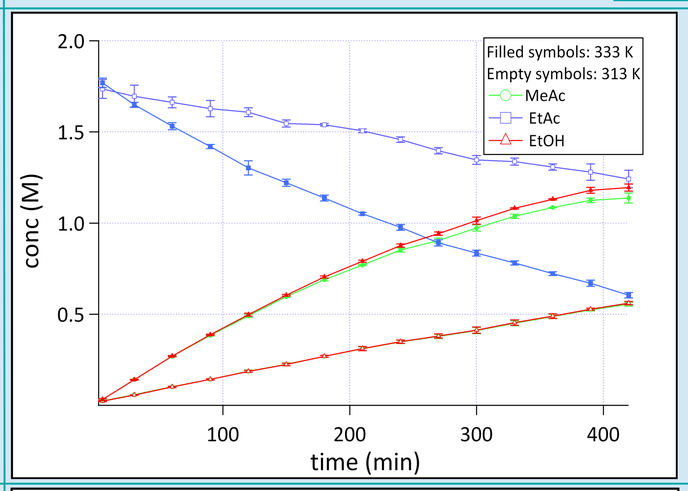
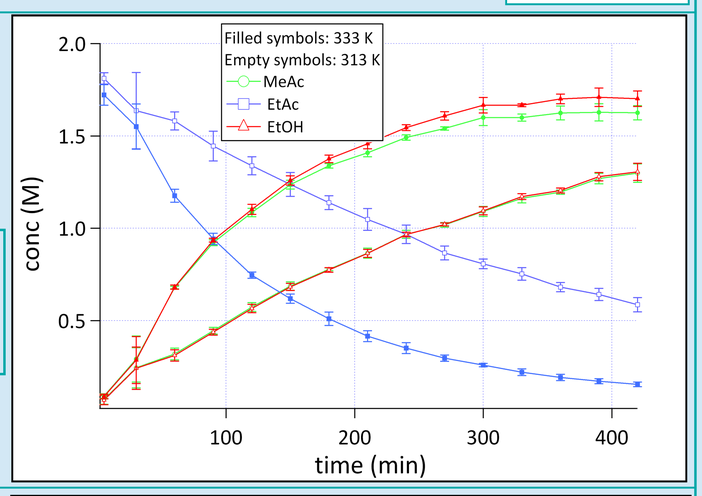
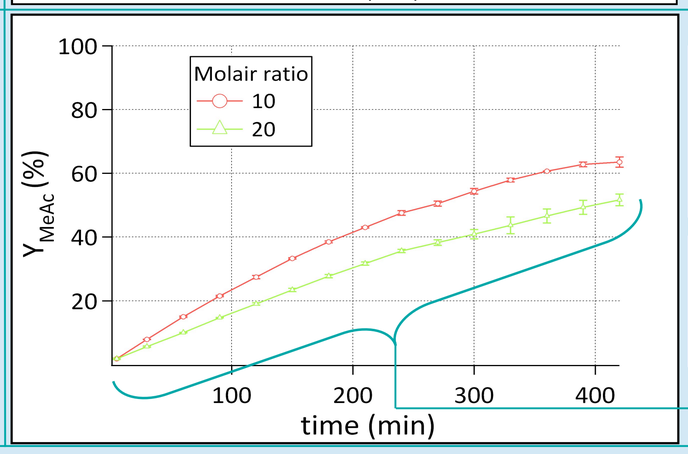
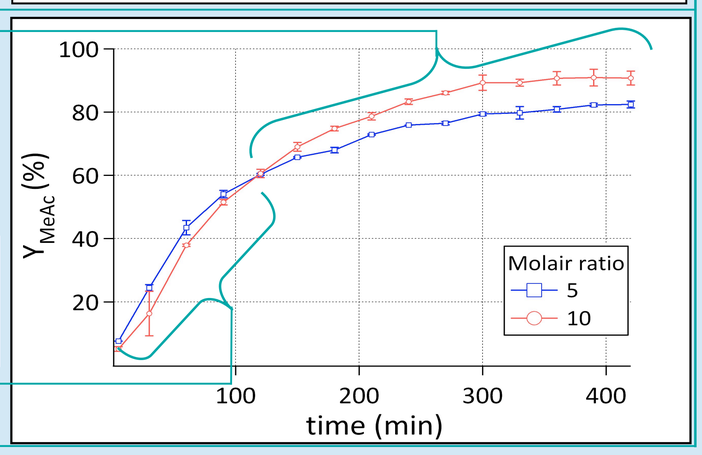
Biodieselreaction



Green, heterogeneous catalysts:
Acid ion exchange resins:
- Lewatit K1221
- Lewatit K2629



EXPERIMENTAL RESULTS

	Lewatit K2629	Lewatit K1221
Chemical Properties (provided by Lanxess)	Functional group: sulfonic acid Appearance: beige, opaque Matrix: higher crosslinked polystyrene Type: macroporous Total capacity: min. 1,6 eq/l Particle size: 400 – 1000 µm	Functional group: sulfonic acid Appearance: dark brown/translucent Matrix: moderate crosslinked polystyrene 4 % DVB Type: gel Total capacity: min. 0,7 eq/l Particle size: < 1000 µm
Influence of temperature (MR: 1:10; 4 w% catalyst)		
Influence of molar ratio (T = 333K ; 4 w% catalyst)		

$T \uparrow \Rightarrow X_{EtAc} \uparrow$

$act_{K2629} < act_{K1221}$

Higher MR favours equilibrium conversion

Lower MR favours faster kinetics

CONCLUSIONS & FURTHER RESEARCH

Experiments in a perfectly mixed batch reactor were reproducable and performed under conditions without internal or external diffusion limitations. The temperature was varied from 313 to 333 K, the ethylacetate to methanol ratio from 5 to 20 and the amount of catalyst from 1 to 4 %. An increase in temperature and molar ratio results in a higher conversion. At 333 K, 4 % of catalyst and a methanol to ethylacetate ratio of 10, after 7 hours of reaction, a conversion of 64 % and 90 % was obtained with K2629 and K1221 respectively. K1221 is more active than K2629.

These experimental data will be modelled to get more insight in the reaction mechanism and the rate-determining steps. The non-ideality of liquid can also be incorporated. These model results can subsequently be used to design full-scale reactors and to improve existing and design new, acid heterogeneous catalysts.

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