Esterification of Acrylic Acid with Butanol to Butyl Acrylate over Sulfonated Polystyrene

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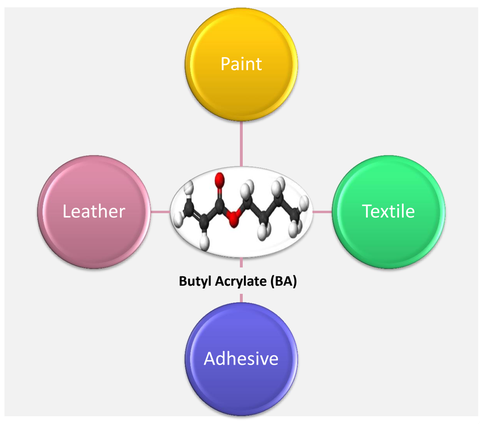
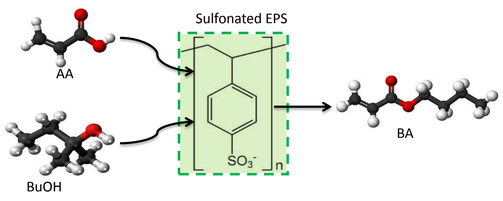
Introduction

BA was produced through homogeneously catalysed esterification reaction. These homogeneous catalysts were difficult to be separated, corrosive and hence requiring neutralization. Expanded polystyrene (EPS) was consumed in large quantity as packaging or insulating materials and disposed as waste. The unique sulfonated expanded polystyrene (SEP) was reported as the potential heterogeneous catalyst to overcome the shortcomings of homogeneous catalysts. It possesses strong Bronsted acid sites and water super-adsorbent properties.

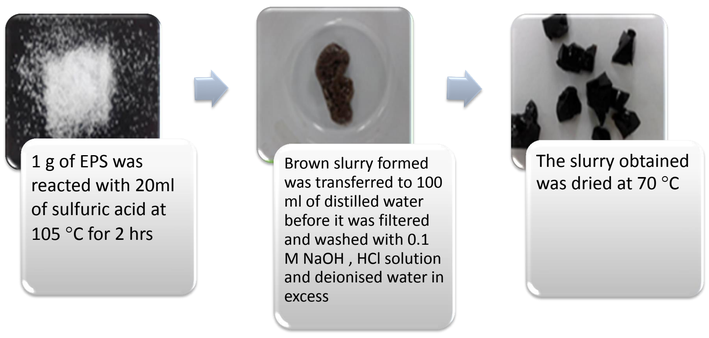


Objective

Considering the environmental and economic perspectives, the activity of sulfonated EPS (SEP) in the esterification of acrylic acid (AA) with butanol (BuOH) was investigated in the present study.



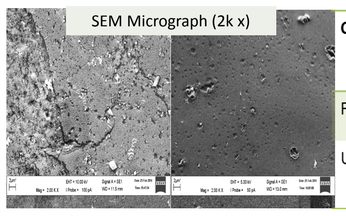
Methodology



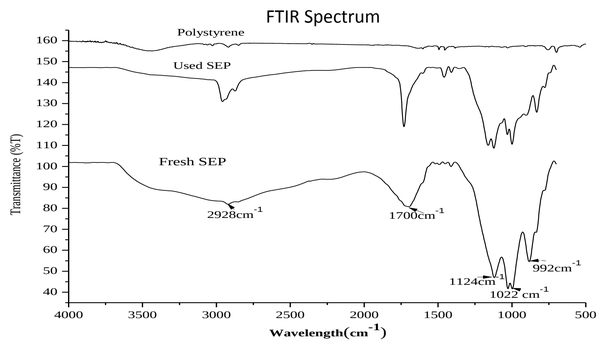
Catalyst Characteristic	Method/ Instrument
Morphology	The plate containing SEP was placed in the scanning electron microscope (Model Leo Supra 50VP, JEOL) for analysis.
Type functional group	The SEP-KBr pellet was prepared before it was analysed using Perkin Elmer (Model Spectrum 100) spectrophotometer.
Ion exchange capacity	SEP was immersed in NaCl solution for 24 hrs. The NaCl solution was titrated with 0.1 M KOH with phenolphthalein as indicator[1&2].

Results and Discussion

Catalyst Characterisation

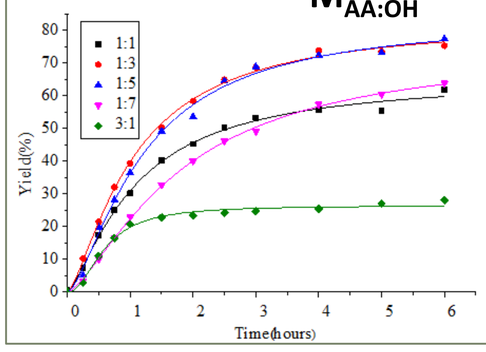


Catalyst	Ion Exchange Capacity (IEC), meq/g
Fresh SEP	8.23
Used SEP	7.79



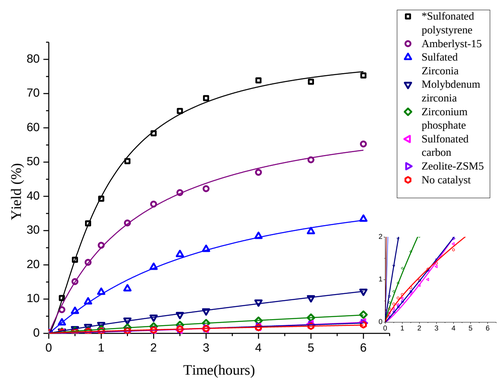
The presence of sulfonic acid group on SEP was proven. SEP has shown rough surface that eases reactant penetration. The high IEC indicates that SEP is a better proton source and donor.

Study on the Effect AA:BuOH Ratio, $M_{AA:OH}$



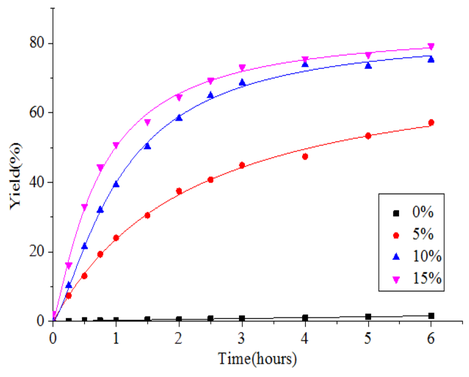
At the temperature of 80°C, catalyst loading of 10 wt% and stirring speed of 400rpm, the best $M_{AA:BuOH}$ was 1:3. Insufficient and excess BuOH would hinder the nucleophilic attack[3].

Catalyst Screening



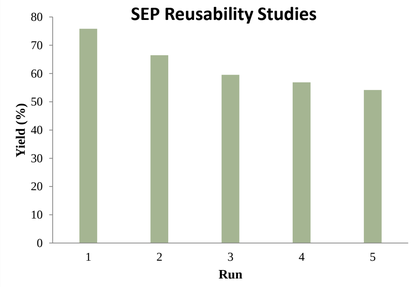
At the stirring rate of 600rpm, $M_{AA:BuOH}$ of 1:3, temperature of 80°C and catalyst loading of 40wt% (* catalyst loading of 10wt%), the SEP has given the highest yield due to its' stronger sulfonic acid sites and hydrophobicity than the commercial catalyst (Amberlyst-15).

Study on the Effect of SEP Loading



At the temperature of 80°C, $M_{AA:BuOH}$ of 1:3 and stirring rate of 400rpm. The best catalyst loading was 10wt% since the increment in BA yield was not significant when the catalyst loading was increased to 15wt%. The catalyst acid sites were in excess rather than required by reactant molecules[4].

SEP Reusability Studies



At the temperature of 100°C, $M_{AA:BuOH}$ of 1:3 and stirring speed of 500rpm. The BA yield reduction was not significant after the 3rd consecutive run. The reused catalyst has reduced acid site concentration due to the sulfonic group hydrolysis or deposition of polymerised AA on the active site.

Conclusion and Recommendations

SEP is a potential catalyst for the esterification of AA with BuOH due to its high catalytic activity. The use of SEP as the heterogeneous catalyst could overcome the shortcomings of the homogeneously catalysed esterification process while converting the waste to wealth.

The deactivation occurred should be reasoned and a thorough study to strengthen the bonding of sulfonic acid with the EPS should be carried out in future.

Acknowledgement

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