Solid Catalyst Improvement for Biodiesel Production

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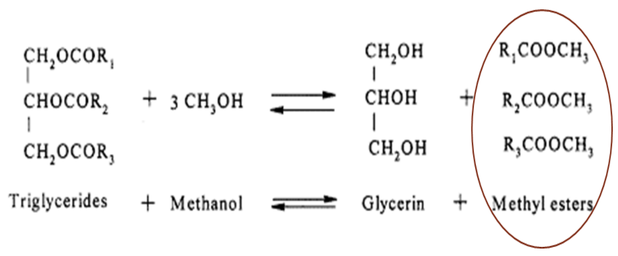
1. Introduction

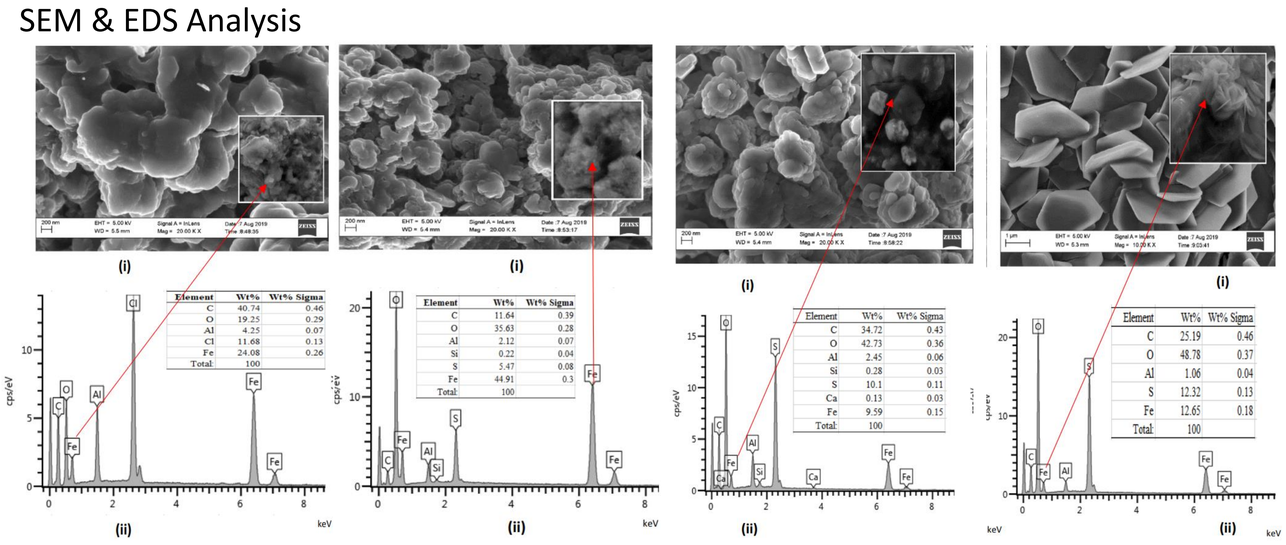


Abstract: As the Biden Government implements renewable energy focused policies, the interest in biodiesel production is also increased. In this project, our objective is investigating the catalyst's properties and finding a way to improve the catalyst for biodiesel production. To achieve the objective, we focused on the properties of catalyst such as particle size, surface area, pore volume, pore diameter, and acidity/basicity of catalyst based on various analysis methods. We could find some tendencies on the properties. We applied these properties to the solid catalyst and came up with the future studies of comparing which factor affects more and adapting our results to the real catalyst.

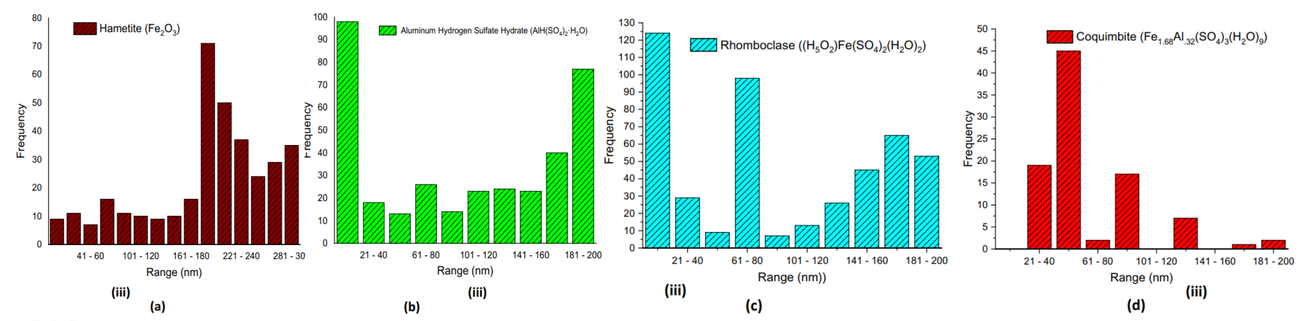
2. Result

Pore & Surface

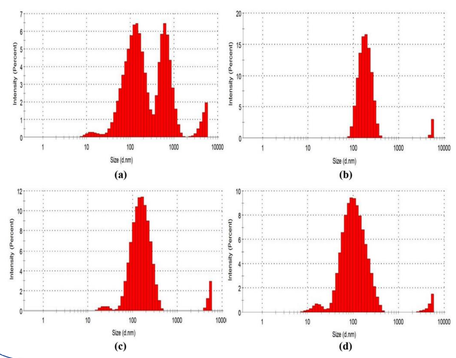
SEM & EDS Analysis



PSD



DLS



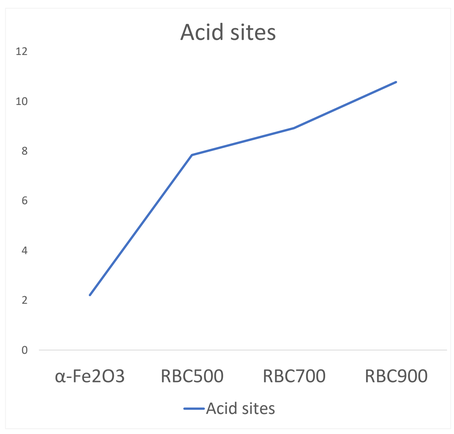
Sample	Crystallite size (XRD) (nm)	Average particle size (nm)	Surface area (BET) (m^2/g)	Pore volume (DFT) (cc/g)	Pore diameter (DR) (nm)
α-Fe_2O_3	16.43	304.4	107.1	0.541	9.236
RBC500	9.77	259.6	434.9	0.144	5.740
RBC700	10.25	169.5	457.5	0.153	5.766
RBC900	14.13	95.62	471.3	0.160	5.842

We calculated Particle Size(PS), Surface Area(SA), Pore Volume(PV), and Pore Diameter(PD) based on SEM & EDS analysis, PSD, and DLS. We found that the higher calcination temperature makes smaller PS, and larger SA, PV, and PD.

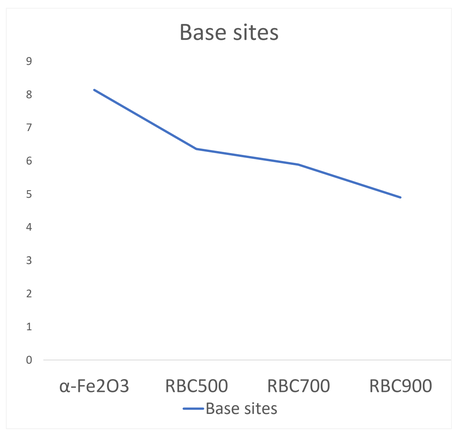
Acidity & Basicity

Acid-base characterization of the α-Fe_2O_3 and RBCs

Sample	Acid sites (As) (mmol g^{-1})	Base sites (Bs) (mmol g^{-1})
α-Fe_2O_3	2.21 ± 0.02	8.14 ± 0.6
RBC500	7.84 ± 0.1	6.36 ± 0.2
RBC700	8.92 ± 0.05	5.89 ± 0.4
RBC900	10.77 ± 0.1	4.90 ± 0.2



Acid sites of α-Fe_2O_3 and RBCs



Base sites of α-Fe_2O_3 and RBCs

Acidity and Basicity are determined by acid-base titration. Acidic sites are involved in activation of carbonyl group in triglyceride and stronger alkalinity in basic sites contribute to increasing biodiesel yield.

High acidic values obtained for the RBCs are due to the addition of sulfate groups in the form of SO_2 on the catalyst surface. The acidity of the RBCs confirmed that the sulfonic groups covalently attached on to α-Fe_2O_3 to produce stable solid superacid catalysts. Therefore, the acidic properties of the RBCs can improve the catalytic activity of the solid acid catalysts toward the trans-esterification reaction. On the other hand, the basic strength of the RBCs show a decreasing trend with respect to the addition of SO_4^{2-} loading.

In spite ofthe increase in acid sites and decrease in base sites, we found that efficiency of the reaction rose. The reason is that acid sites play a crucial role in efficiency because α-Fe_2O_3, RBC500, RBC700, RBC900 have sufficient base sites and lack of acid sites.

3. Summary & Discussion

Summary

- Solid catalysts have simpler process, more eco-friendly than acid, base catalysts and have various methods of catalyst synthesis and utilization
- We proved the particle size, surface area, pore size, pore diameter, acid-base properties of the solid catalyst that affect the reaction.

Discussion

- We found that the catalyst efficiency is better when the particle size is smaller, the surface area and pore size and pore diameter are larger, and the acidity and basicity is stronger.
- Because solid catalysts has various methods of catalyst synthesis, progressing the efficiency of solid catalyst has a lot of possibility due to variety of materials which can be used to synthesis of solid catalyst.