SIIC119

REDUCIBILITY ANALYSIS CU-ZN BASED CATALYSTS FOR METHANOL SYNTHESIS VIA CO_2 HYDROGENATION REACTION

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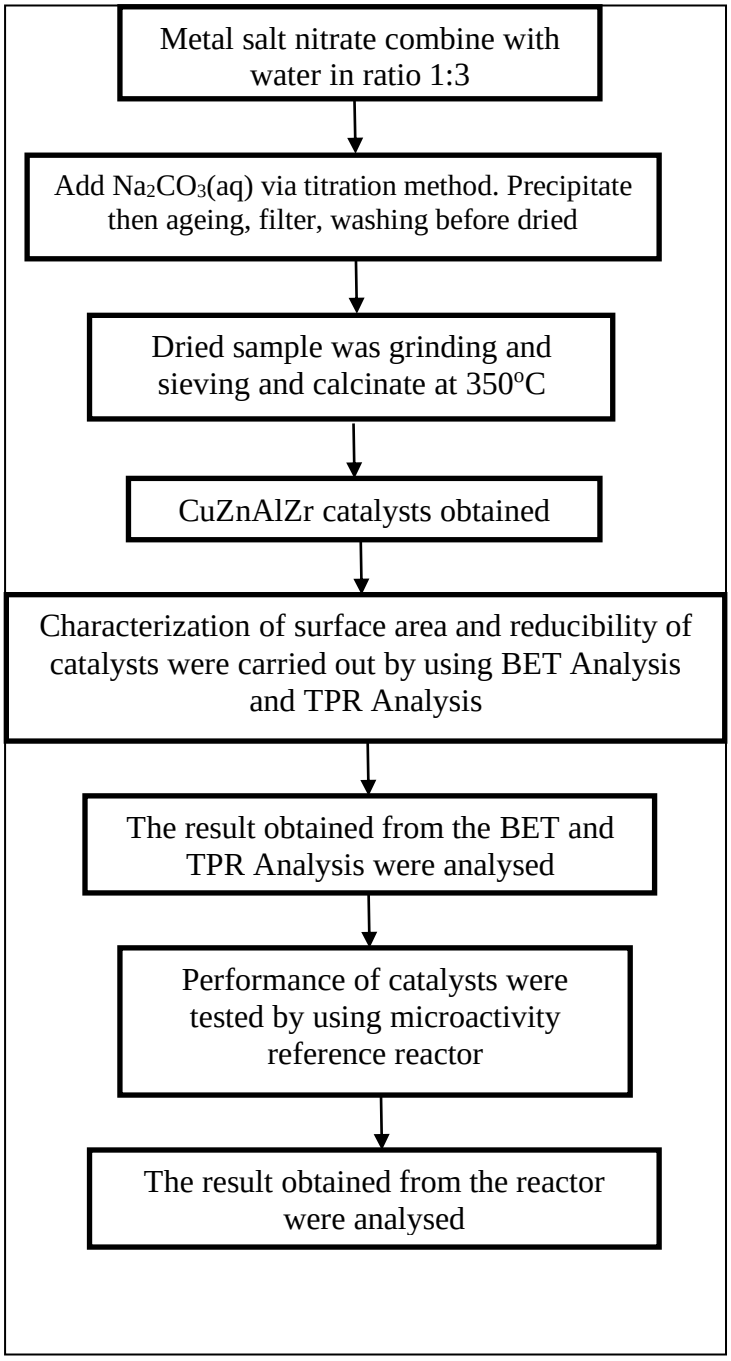
Abstract:
Greenhouse effect has always been a major concern in environment. One of the factors greenhouse effect is global warming. The rapid rate of global warming can raise the level of temperature in the atmosphere, thus producing gases which eventually would be a harmful substance for world's ecosystem. Carbon dioxide (CO2) hydrogenation for methanol synthesis is one of the common methods to reduce the emission. Therefore, the objective of this study is to prepare and characterize a various formulation of Cu-Zn based catalysts. Also investigate of reducibility behavior of Cu-Zn based catalysts and its relation towards methanol synthesis via CO_2 hydrogenation reaction. In this process, co –precipitation method are being applied to prepare the catalyst formulation. Three different types of catalyst which is CZZ, CZA and CZAZ are used in this experiment with same ratio of Cu-Zn and various ratios for promoters in each formulation. BET analysis is performed alongside in order to study the characteristic of surface area and pore distribution of the catalyst. As a result, CZAZ has higher BET surface area while resulted in lowest in pore volume and pore size. Normally, the reduction analysis is performed by using temperature programmed reduction (TPR). This method used to analyses and highlights the reduction profile of various formulation of catalyst. Based on the results shown, all catalyst used has performed an accurate result which is one peak of broad reduction profile with H_2 consumption quantity at maximum temperature. Hence, the addition of promoters such as Al, Zr affected the Cu dispersion in the catalyst thus reduction behavior of the catalysts was observed. CZAZ resulted to be the most effective catalysts observed in TPR analysis with lower maximum temperature 194.48^{o}C and higher quantity of H_2 consumption for 4.63%. Consequently, it also produced most CO_2 conversion and CH_3OH selectivity in the process reaction simultaneously generating higher yield compares to others proposed samples. It is believed that the improved performance of methanol synthesis are largely affected by the active site that available in the catalyst which enable Cu reduce more for exhibits the best yield in the process reaction.

***Keywords*:**
CO_2 hydrogenation, co-precipitation, methanol synthesis, reducibility, Cu-Zn-Al-Zr catalyst.

Objectives:

- To prepare and characterize a various formulation of Cu-Zn based catalysts.
- To investigate the reducibility behavior of Cu-Zn based catalyst and its relation towards methanol synthesis via CO_2 hydrogenation reaction.

Methodology:

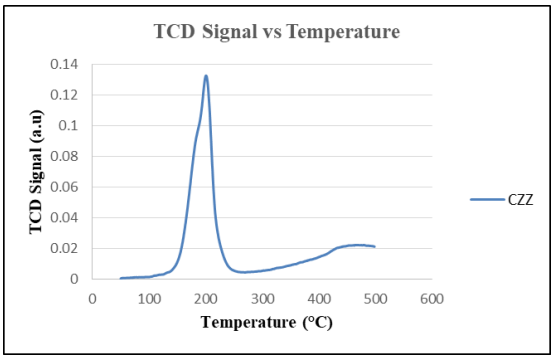


Results:

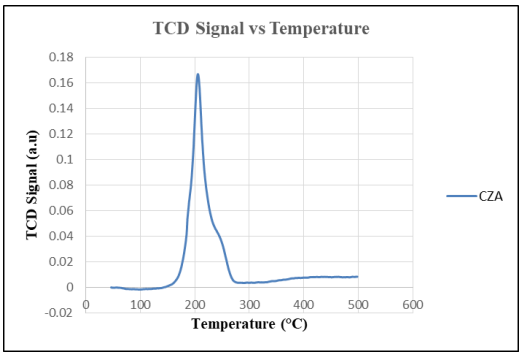
Characteristics of the catalysts on BET analysis

Catalysts	SA_{BET} (m^2/g)	Pore volume (cm^3/g)	Pore size (nm)
CZZ	96.4642	0.3615	14.9924
CZA	106.4511	0.4404	16.5490
CZAZ	131.7101	0.3538	10.7443

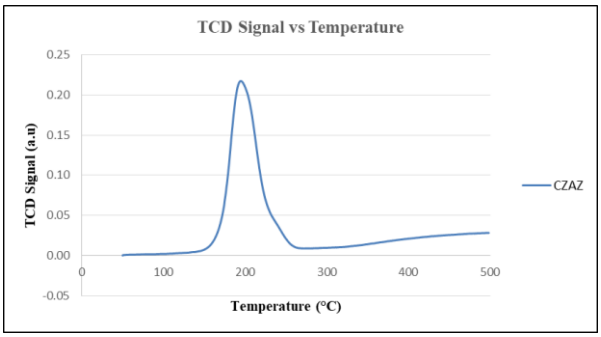
CZZ-TPR



CZA-TPR



CZAZ-TPR



Performance of catalysts

Catalysts	CO_2 conversion (%)	Selectivity (%)				STY
		MeOH	CH_4	H_2O	CO	
CZZ	19.3	9.3	0.2	29.7	60.7	0.1287
CZA	17.8	5.9	0.2	12.4	81.6	0.2478
CZAZ	20.1	8.0	0.1	16.5	75.4	0.4530

Conclusion:

As a conclusion, the addition of promoters resulted in increase of BET surface area and decreased the average pore size of the catalyst showed by CZAZ catalyst. The results showed all catalysts formed a broad peak in TPR analysis. However, from the results observation, the CZAZ catalyst exhibits the highest reducibility of Cu dispersion and faster catalyst reduced. A better CO_2 hydrogenation to methanol, CZAZ catalyst also was obtained as an effective catalyst. The promoter addition gives more interaction for Cu reduced thus produced more products yield. Both activity and methanol selectivity and CO_2 conversion were improved by using two element promoter compare to other catalysts that have single promoter such as CZZ and CZA which is 8% and 20.1% respectively.