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Synthesis and characterization of ZSM-5 supported catalysts for the selective catalytic reduction of NO_x with hydrogen

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Highlights

- Crystalline size, BET surface area, and pore volume of ZSM-5 increased with increasing Si/Al ratio of ZSM-5
- ZSM-5 samples were identified by XRD patterns
- The shape selectivity and sharp distribution of acid strength is unique property of ZSM-5

1. Introduction

Upward environment awareness in recent years has caused institution of more and more series regulation. NO_x is one of the major air pollutant which may harm human, animal, vegetation and environment. Catalysts in vehicles exhaust play an important role in reduction of NO_x [1]. A large number of researches have been done in the field of hydrocarbon as reductant for selective catalytic reduction of NO_x in oxygen rich conditions. But it is found that practical applications of hydrocarbon SCR has been difficult due to poor performance in real life application. So researchers are currently focusing on H_2-SCR, which gives well performance at low temperature <200°C [2]. The preferred way for reduction of NO_x in diesel engine exhausts, requisite catalysts which operate in broad temperature windows (60-450°C). Besides metal oxides catalysts, ZSM-5 based catalysts have high activity and wide temperature window. ZSM-5 is one of the zeolite which have strong solid acidity is generated by aluminium atoms incorporated into the tetrahedral site framework [3].

2. Methods

Zeolites were prepared by hydrothermal method with different Si/Al molar ratios (15, 45, and 60).In a typical synthesis tetra propyl ammonium hydroxide (TPAOH) was used as structure directing agent and was dissolved in deionized water. The resulting mixture kept under stirring at room temperature, subsequently Tetra ethyl ortho silicate was added into the above solution, and the mixture was stirred to get homogeneous solution. The different amounts of aluminium isopoxide were added into the reaction mixture and were sonicated for dispersing the AIP in solution. Later the solution was aged without stirring. And then the homogeneous solution was transferred into a Teflon lined stainless steel autoclave for the crystallization reaction at 150°C for 2 days. The solid product was collected, centrifuged, filtered washed with deionized water, dried in oven overnight, and calcined.

3. Results and discussion

To identify structure of as prepared samples, XRD patterns of zeolite samples were investigated. As shows in Fig. 1, the four most intense peak of ZSM-5 detected as 7.92, 8.85, 23.12 and 23.34. All the samples gave similar XRD pattern as observed in literature [4] and Tetragonal phase was observed. The crystalline size of all the samples was calculated by Scherrer equation. BET results of ZSM-5 samples are presented in Table 1. The BET surface area and pore volume of samples increase with increasing the Si/Al ratio of ZSM-5 samples. The specific surface area of each sample was obtained by the BET method and the pore volume was calculated by BJH method.

Table-1

Catalysts	BET surface area (m^2 g^{-1})	t-plot area (m^2g^{-1})	Pore volume (cm^3g^{-1})	Average pore radius(nm)	Average crystalline size (nm)
ZSM-5 (15)	249.27	59.79	0.029	10.14	39
ZSM-5 (45)	274.55	139.93	0.077	4.40	47
ZSM-5 (60)	276.24	116.94	0.068	2.86	48

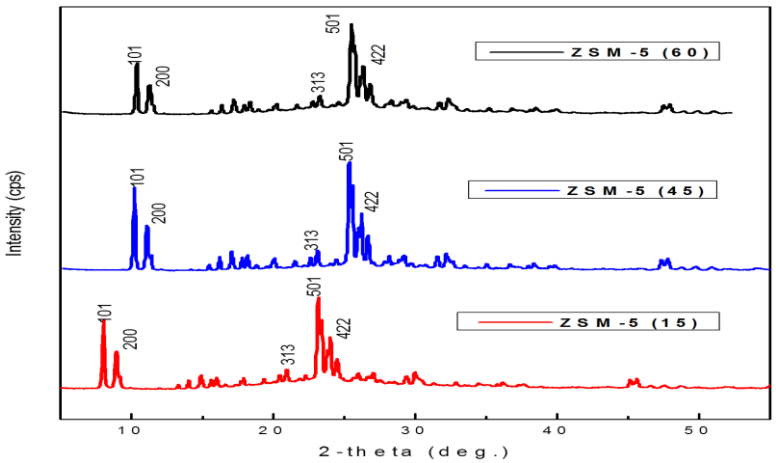

Figure.1, XRD pattern of ZSM-5

4. Conclusions

ZSM-5 catalysts were synthesized by hydrothermal method, which is confirmed by XRD characterization. Parameters such as molar ratios of Si/Al, phase of ZSM-5 and crystal size of the ZSM-5 zeolite are essential factor of catalysts. In this work, ZSM-5 zeolites with different molar ratios of Si/Al were synthesized and observed results shows that BET surface area, pore volume and average crystalline size were increases with increasing Si/Al ratio, but average pore radius decreases.

References

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Keywords
"Synthesis; ZSM-5; Characterization; H_2-SCR"