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Mo/HMCM-22 Catalyst: Effect of Si/Al Ratio and Mo content on Methane Dehydroaromatization Process

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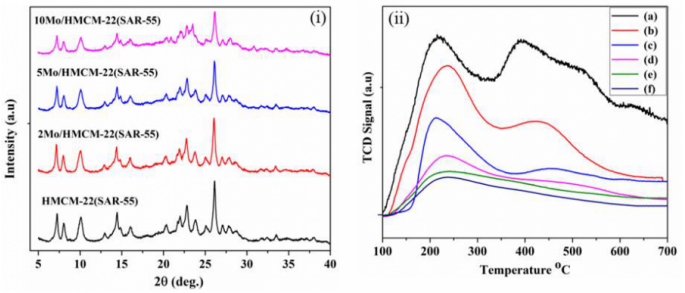
PURPOSE OF THE ABSTRACT

Natural gas has emerged as an attractive key feedstock for the production of liquid fuels and commodity chemicals. Methane which is the major component of natural gas can be effectively utilized by converting it into value added chemicals. In this reference, methane dehydroaromatization (MDA) is an efficient process for the direct conversion of methane into liquid aromatics1. However the process has not been yet commercialized due to fast deactivation (by coking) of MDA catalyst (Mo/Zeolite). Mo/HZSM-5 and Mo/HMCM-22 are the well known catalyst for MDA reaction2. Zeolite acidity, porosity and framework structure along with metal (Mo) content significantly affect the catalytic performance and thus catalyst preparation and its characterization plays a crucial role in the reaction. In this regard, Mo loading effect over zeolite support (HMCM-22), SiO2/Al2O3 (SAR) effect of MCM-22 zeolite varying the acidity of the catalyst, and also reaction parameters have been studied for the reaction. It was observed that Mo loading does not affect the framework structure of the HMCM-22 zeolite as confirmed by XRD pattern (Figure. 1(i)) of the calcined catalysts; however crystallinity decreases slightly at higher loading. Acidity of Mo/HMCM-22 catalyst was determined by NH3-TPD analysis (Figure. 1(ii)) and it was observed that the acidity decreases on Mo loading over the HMCM-22 zeolite due to migration of Mo species into zeolite channels interacting with brønsted acid sites of HMCM-22 zeolite. In activity test, effect of Mo loading and SAR effect of HMCM-22 was studied at 700°C temperature under atmospheric pressure with 720 mL/g.h GHSV. It was observed that 5 wt% Mo loading is optimum for methane conversion into higher hydrocarbons (C6H6 selectivity 18%) as shown in Figure. 2(i). For SAR, it was also inferred that the selectivity of benzene increases up to 37% with SAR-30 as compared with SAR-55 (18%) as shown in Figure. 2 (ii). In conclusion, 5 wt% Mo laoding, lower SAR (30) of HMCM-22 zeolite are effective for the catalyst design in the MDA process.

FIGURES



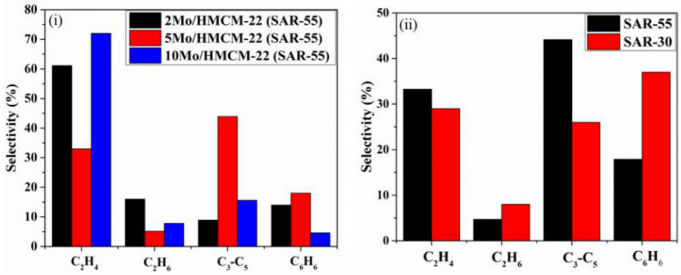


FIGURE 1

(i) XRD pattern of calcined catalysts and (ii) NH3-TPD profiles of calcined catalysts (a) HMCM-22 (SAR-30), (b) 5Mo/HMCM-22 (SAR-30), (c) HMCM-22 (SAR-55), (d) 2Mo/HMCM-22 (SAR-55), (e) 5Mo/HMCM-22 (SAR-55), (f) 10Mo/HMCM-22 (SAR-55)

(i) XRD reflects that crystallinity slightly decreases on higher Mo loading.

(ii) Acidity also decreases on Mo loading due to exchange with brønsted acid sites of HMCM-22 zeolite

FIGURE 2

Selectivity (i) for 2, 5, and 10 wt% Mo loaded MCM-22 (SAR-55) catalyst and (ii) for two different SAR of 5Mo/HMCM-22 catalyst

(i) 5 wt% Mo loading is effective for benzene formation

(ii) Lower SAR of MCM-22 zeolite gives higher selectivity of benzene

KEYWORDS

methane dehydroaromatization | MCM-22 | SiO2/Al2O3 (SAR)

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