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## TWO-STEP APPROACH FOR PLASTIC WASTE VALORIZATION TO FUEL RANGE LIQUID HYDROCARBONS

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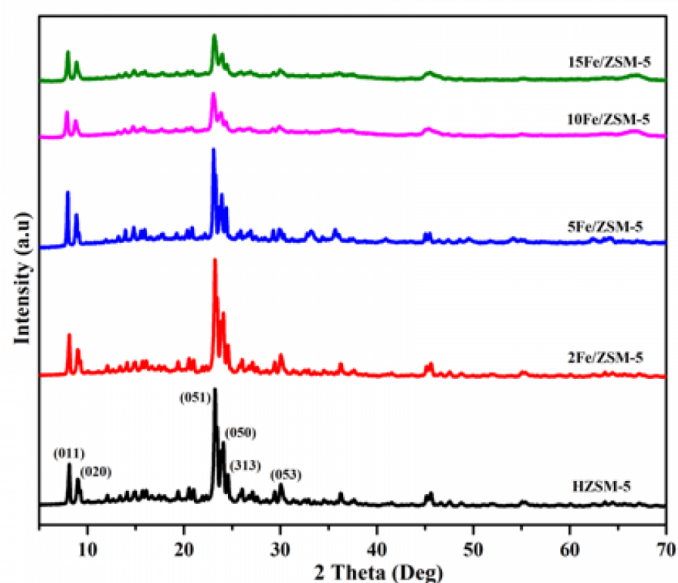
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### PURPOSE OF THE ABSTRACT

Valorisation of postconsumer waste plastic comprising polyethylene and polypropylene was carried out following two-step approach in a fixed bed reactor by metal impregnation over HZSM-5. The two-step approach has been investigated with thermal cracking of waste plastic followed by catalytic cracking of evolved hydrocarbon gases using solid acid catalysts for the formation of fuel range liquid hydrocarbons. A series of experiments were performed in an identical environment with the objective of comparing the end products for catalytic and thermo-catalytic process. The experimental work was carried out using fixed bed reactor operating under an inert atmosphere at 350 °C. Impregnation of Fe over HZSM-5 under optimized experimental conditions was used to enhance the cracking of polymer. The results obtained in this work showed that the liquid formed exhibited higher Paraffin/Olefin ratio where the amount of generated paraffins was greater than 60 wt. % of the total liquid product obtained. The carbon chain length was narrowed to C5-C28 range when thermo-catalytic process was employed resulting in significant yield of aromatics mainly consisting of naphthenes which indicated that the products obtained are fuel-like products. The zeolite surface modified with the loading of Fe is covered with small particulates as supported with SEM, confirms the impregnation of Fe on the zeolite surface. The addition of metal does not alter the morphology of the zeolite crystals with the size around 4 $\mu$ m, thus believed to retain the catalytic activity for longer period during the reaction as supported with the unspoiled morphology post reaction. The FTIR spectra of the product formed showed bands around 2940 and 2851 cm<sup>-1</sup> exhibiting common features of aliphatics CH<sub>3</sub> and CH<sub>2</sub>. The strong band at 1734 cm<sup>-1</sup> indicates carbonyl bond and the low intensity band positioned at 1465 cm<sup>-1</sup> represents the methylene C-C bond. Also, the GC-MS spectra confirm the presence of BTX group along with the comparable percentage of alkanes and alkenes in the liquid product obtained. The recovery of aromatic compounds especially naphthenes can be a potential source of fuel range compounds rather than as a chemical feedstock. Eventually it leads to the fact that the developed solid acid catalysts with nearly uniform channel size throughout the crystal can serve as a potential means for the cracking of polyolefinic plastic waste into liquid hydrocarbons.

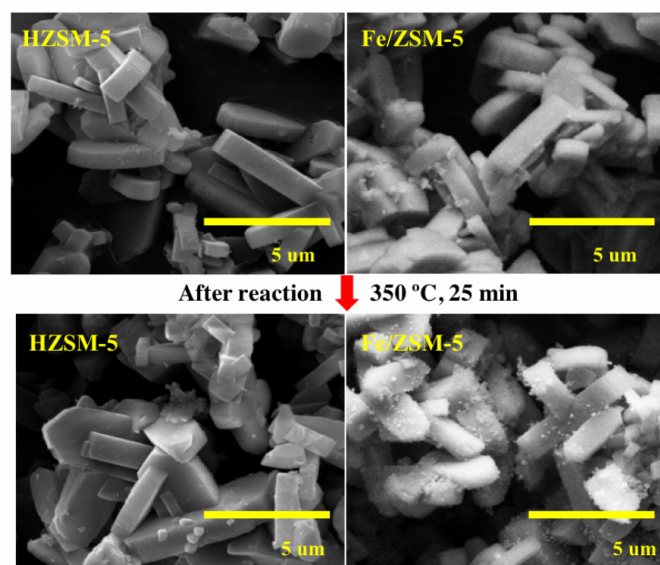
## FIGURES



**FIGURE 1**

X-Ray diffraction patterns for Fe loading over HZSM-5 (2-15% loading)

X-ray diffraction pattern was used to study the crystal structure of catalyst. Similar XRD patterns for HZSM-5 and Fe-HZSM-5 confirms that the framework is not affected after the functionalization by metal species.



**FIGURE 2**

Scanning Electron Micrographs for the fresh and spent catalyst. Experimental conditions: M(cat)/M(PM)=1/30, 350°C, 25 min, nitrogen at a flow rate of 10 mL/min

The SEM images show that zeolite particles were composed of small crystals with the size around 5 micron. It can be observed that the thermo-catalytic cracking of plastic did not alter the crystalline morphology of zeolites to greater extent.

## KEYWORDS

Plastic waste | Polypropylene-Polyethylene | Thermo-catalytic cracking | Liquid hydrocarbons

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