Ir/Pt-HZSM5 for \(n\)-pentane isomerization: Effect of Si/Al ratio and reaction optimization by response surface methodology

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High activity of catalyst was observed for Ir/Pt-HZSM5 with Si/Al ratio of 23.
Isomerization of \(n\)-pentane over Ir/Pt-HZSM5 was optimized by RSM.
The largest effect on \(n\)-pentane isomerization was reaction temperature.
The least important effect on \(n\)-pentane isomerization was \(F/W\).
The yield of isopentane could reach 61.9% under the optimum conditions.

The effects of Si/Al ratio on the properties of Ir/Pt-HZSM5 and \(n\)-pentane isomerization were studied. XRD results indicated that the increasing Si/Al ratio increased the percentage crystallinity of the catalysts, whereas, FTIR results showed that the increasing Si/Al ratio decreased the number of strong Brönsted and Lewis acid sites which led to decrease the catalytic activity towards \(n\)-pentane isomerization. Ir/Pt-HZSM5 with Si/Al ratio of 23 showed highest activity towards \(n\)-pentane isomerization, and the operating condition was further optimized by using response surface methodology (RSM). The RSM experiments were designed by using face-centered central composite design (FCCCD) by applying \(2^4\) factorial points, 8 axial points and 2 replicates, with three response variables (\(n\)-pentane conversion, isopentane selectivity and isopentane yield). The Pareto chart indicated that the reaction temperature have largest effect for all responses. The optimum condition of \(n\)-pentane isomerization over Ir/Pt-HZSM5 was at treatment temperature of 723 K, treatment time of 6 h, reaction temperature of 548 K and \(F/W\) of 500 ml g\(^{-1}\) C\(^0\) \(1\) min\(^{-1}\) in which the predicted value for the \(n\)-pentane conversion, isopentane selectivity and isopentane yield was 63.0%, 98.2% and 61.9%, respectively.

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1. Introduction

Catalyzed isomerization of \(n\)-alkane is one of the important processes in petroleum refining to modify the octane number of gasoline. Isomerization reaction generally takes place over bifunctional catalyst containing metallic sites for hydrogenation/dehydrogenation and acid sites for skeletal isomerization. Several types of bifunctional heterogeneous catalyst, consisting of metal supported on metal oxides [1–3], mesoporous [4] and microporous [5,6] materials have been widely explored for the isomerization process [7]. In addition, the introduction of noble metal or transition metals to the catalysts and the presence of hydrogen in the gas phase markedly improved the activity and stability of the