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Oxidation of Benzene, Toluene and Hexane over Pt Modified Fly Ash Zeolite X

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Extended Abstract

The synthesis of zeolite from Fly Ash (FA) results in a product of highly added value, compared with the use of FA as additive to cement or other products. Due to the content of iron oxides in the fly ash, zeolites synthesized from ash also contain iron in various forms [1,2]. The presence of iron and traces of other metals in FA transferred into zeolites, contributes to the better catalytic performance of the catalysts, based on these zeolites, in oxidation reactions. Catalytic performance of FA zeolites can be improved further by loading of different novel metal species on the zeolite surface [3].

In the present study, by using of a two-stage process of zeolite synthesis (fusion and hydrothermal treatment) zeolite X has been synthesized from FA. The same amount of iron, which is contented in the FA zeolite, was loaded on the reference sample synthesized from pure chemicals in order to be compared with it. Both samples were modified with platinum and the catalytic activity for benzene, toluene and hexane oxidation of the obtained samples was investigated (Fig. 1). The obtained zeolites X and catalysts based on them, were characterized by scanning electron microscopy, X-ray diffraction, temperature programmed reduction (TPR), and X-ray photoelectron spectroscopy.

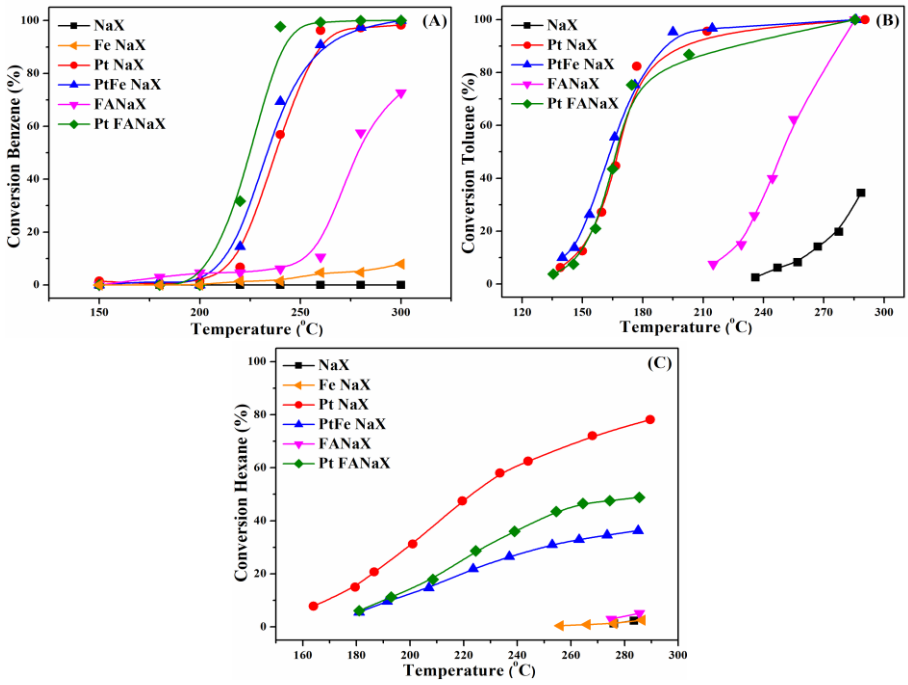

Figure 1 - Temperature dependence of benzene (A), toluene (B) and hexane (C) conversion over FANaX zeolite, NaX zeolite (from pure chemicals) and their counterparts modified with Fe and Pt.

The catalytic activity tests in benzene, toluene and hexane oxidation reaction were carried out in a continuous flow type of glass reactor at atmospheric pressure with a catalyst bed loading of about 0.5 cm3 (fraction 0.63–0.80 mm), inlet benzene concentration 42 g m−3 in air, space velocity 4000 h−1; inlet toluene concentration 200 ppm in 16% O2, space velocity 100 000 h−1; inlet hexane concentration 350 ppm in 16% O2, space velocity 100 000 h−1.

The most active samples in the benzene oxidation are platinum modified and among them the most active is Pt-loaded fly ash zeolite FANaX-0.5Pt (see Fig.1). The comparison of activity of the FANaX-0.5Pt with that of Pt modified reference counterpart NaX-4.5Fe0.5Pt synthesized from chemicals, shows that the difference of temperature for 50 % degree of benzene oxidation (T50) is 10°C and there is almost no difference in this parameter between NaX-4.5Fe0.5Pt and NaX-05Pt samples. This could be due to the different oxidation states of iron in FA zeolite and in iron loaded samples. High difference in catalytic activity of benzene oxidation on FANaX and NaX-4.5Fe is observed, in favour of FANaX. This fact also confirms the different states of iron on both samples.

In the oxidation reactions of toluene and hexane, the behaviour of catalysts is very similar to that of benzene oxidation. Again, the highest activity is shown by Pt-containing catalysts followed by FANaX and the lowest activity as it was expected has the starting supports (NaX and NaX-4.5Fe). From the obtained results, it can be concluded that the zeolite supports obtained from coal ash have all the characteristics and properties necessary to form some highly active catalysts competitive of these catalysts formed by pure chemicals. It has also been observed that the presence of Fe and/or other metallic components in coal ash in the oxidation of aromatic hydrocarbons (benzene and toluene) favours the conversion process. While in the oxidation of linear hydrocarbons (hexane) the catalyst synthesized by pure chemicals with applied Pt nanoparticles exhibits the highest activity.

These results are very promising and they open the option for utilization of FA by obtaining of a product with high value and finding of cheaper alternative of X zeolite as catalytic support.

Aknowledgment

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