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A.K. Zhumabekova[1], L.K. Tastanova[2*], R.O. Orynbassar[3], G.D. Zakumbaeva[4]

[1]M. Kozybayev North Kazakhstan State University, Petropavlovsk, Kazakhstan;
[2]K. Zhubanov Aktobe Regional State University, Aktobe, Kazakhstan;
[3]Al-Farabi Kazakh National University, Almaty, Kazakhstan
[4]D.V. Sokolskii Institute of Fuel, Catalysis and Electrochemistry, Almaty, Kazakhstan
(Corresponding author's e-mail: lyazzatt@mail.ru)

Effect of modifiers on Fe-Pt/Al_2O_3 catalysts for alkanes hydrotreatment

Zeolite-containing polyfunctional catalysts Fe-Pt/Al_2O_3 (KT-17, KT-18), modified with additives of molybdenum, phosphorus and cerium, were synthesized. The developed catalytic systems were studied in treatment of C14 alkane obtaining a gasoline fraction. Reaction products contain C4-C9 iso-alkanes, C10-C14 iso-alkanes, C4-C10 alkanes, aromatic hydrocarbons and C1-C3 alkanes. In addition, 0.2–0.6 % of heavy hydrocarbons was found in reaction products. The yield of C4-C9 iso-alkanes at 380 °C reached 37.9 %. By means of physical and chemical methods it has been found that the zeolite containing catalysts Fe-Pt /Al_2O_3 modified by various additives are complex systems. Micro-diffraction and Mossbauer spectroscopy methods allowed detecting nanosized hetero clusters of Fe-Pt, Fe-Mo, Pt-Mo in catalysts structure. Depending on chemical composition of clusters, particle size varies between 20 and 80 Å. KT-18 catalyst demonstrates high activity in the process of heavy alkanes treatment; sizes of platinum (d = 200 Å) and iron (d = 30–50 Å) particles were determined by electron microscopy. Activity of KT-18 catalyst is higher than that of highly dispersed KT-17. The main feature of KT catalysts is their polyfunctionality. During alkanes processing simultaneous and consecutive reactions of hydrocracking, dehydrogenation, isomerization, dehydro-cyclization and hydro-desulfurization take place.

Keywords: hydro treatment, zeolite containing catalysts, modification, polyfunctionality, heavy alkanes, hydrocracking, hydrogenation, nanoclusters.

Introduction

The global trend in oil processing industry development is enhancing the depth of raw materials refining and to improve the quality and environmental characteristics of motor fuels through the use of catalytic systems, which allows obtaining valuable light fractions from heavy oil residues [1, 2].

Production of gasoline fractions from heavy oil is realized in several directions: thermal and catalytic cracking, hydrocracking [3, 4]. Currently, importance of hydrocracking process in oil treatment is relatively low [5]. Thermal and catalytic cracking of heavy oil is widely used in industry [6–9]. However, heavy oil cracking is characterized by obtaining great amount of olefins as a result of C-H bond breakdown [10].

According to the international regulations, content of olefins in gasoline must not exceed 15–18 % [11, 12]. In future, limitations of olefins and aromatic hydrocarbons content in gasoline, in particular benzene concentrations, will become even stricter [13]. Olefins, aromatic hydrocarbons, isoalkanes and oxygen-containing compounds in the form of methyl tert-butyl ether are octane components of gasoline. In this regard, catalytic methods of heavy alkanes hydro isomerization and hydrocracking are widely discussed in literature in recent years [14–18]. Catalysts based on various 3d metals (Ni, Mo, Co, W, Fe, etc.) are used in heavy oil feedstock treatment processes [19–22].

[*]Corresponding author.