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Properties of the FCC Catalyst Additive Prepared from Guizhou Kaoline

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The properties of a FCC catalyst additive prepared from Guizhou kaoline were extensively investigated. The samples were characterized by N_2 adsorption, X-ray diffraction, IR spectrometry, and scanning electron microscope (SEM). The results showed that the crystallinity of NaY zeolite synthesized from this kaoline was 25 % and the silica alumina ratio was $r_{k/s \cdot m} = 5.05$. The catalyst additive prepared from above crystallization product exhibited excellent performance of nickel and vanadium passivation, offered 21 % lower coke versus base catalyst, while maintaining high bottoms upgrading selectivity.

Key words: *Kaoline*, in situ *crystalliazation technique, catalytic cracking, FCC additive, heavy metal, zeolite*

Introduction

Kaoline, also known as china clay, is composed mainly of the mineral kaolinite with the chemical composition $Al_2Si_2O_5(OH)_4$.[1] It is a hydrated aluminium silicate with a composition of approximately 46 % SiO_2, 40 % Al_2O_3, and 14 % H_2O.[2] Kaoline minerals has been widely used as a combined source of SiO_2 and Al_2O_3 for the synthesis of zeolites.[3,4] Low silica zeolites such as NaY has been prepared from kaoline.[5]

Because of the different behavior of nickel and vanadium, strategies for their passivation can differ significantly. In the case of nickel, for instance, the nickel could be trapped in a solid state compound such as spinel making it unavailable for reduction to the zero valent state and inaccessible or inactive for subsequent dehydrogenation reactions. On the other hand vanadium is best passivated by addition of adding metal oxides which will readily form metal vanadate. Metal vanadate formation reduces metal mobility, while at the same time prevents the vanadium catalytic activity for dehydrogenation reactions. Rare earth compounds, as well as alkaline earth compounds, can perform this task.

In prior art fluid catalytic cracking (FCC) catalysts, the active zeolite component is incorporated into the microspheres of the catalyst by one of two general techniques. In one technique, the zeolite component is crystallized and then incorporated into microspheres in a separate step. In a second technique, the *in situ* technique, microspheres are first formed and the zeolite component is then crystallized in the microspheres, providing microspheres containing both zeolite and non-zeolite components.[6] This unique synthesis process results in complete zeolite dispersion along the pore walls on the alumina rich matrix. The high surface area alumina matrix, high zeolite dispersion, and the accessibility of the zeolite are also responsible for the bottoms upgrading benefits. Growth of the zeolite within the microsphere pore structure causes a high degree of interaction between the zeolitic and matrix surfaces forming intense chemical bonds.[7,8] This matrix-zeolite bond stabilizes the zeolite and makes it extremely resistant to sintering or pore collapse providing outstanding hydrothermal stability.[9] Kaoline is the most important raw material in this process. The inherent properties of kaoline affects the resultant catalyst.[10]

In this paper, the properties of kaoline produced in Guizhou, China and a catalyst additive prepared from it, have been stuided.

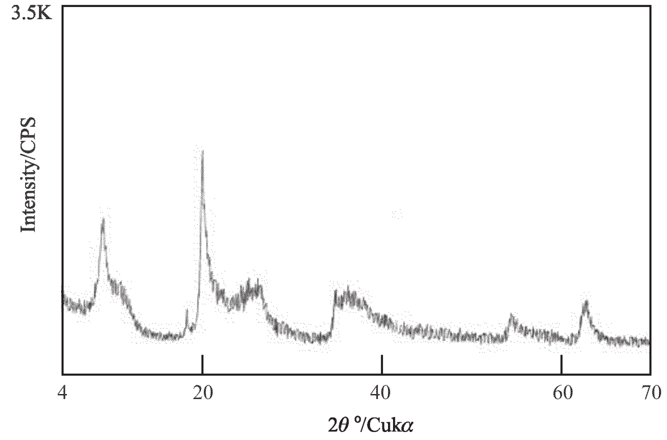
Experimental

Materials

Kaoline, composed mainly of halloysite (w = 92 %), quartz (w = 0.1 %), gibbsite and other components (w = 7.9 %) (see X-ray diffraction pattern in Fig. 1), having BET specific surface area s = 72.16 m^2 g^{-1}, total pore volume v = 0.211 cm^3 g^{-1} and chemical composition as show in Table 1, was provided from Guizhou deposit (P. R. China).

Sodium silicate solution (w = 6.98 % Na_2O, 19.85 % SiO_2) was supplied from the Catalyst Producing Factory of the Lanzhou Petrochemical Company.

Sodium hydroxide solution (w = 18.6 % Na_2O) was supplied from the Catalyst Producing Factory of the Lanzhou Petrochemical Company.



F i g. 1 – *XRD pattern of Guizhou kaoline*

S l i k a 1 – *Rendgenogram uzorka kaolina Guizhou*

T a b l e 1 – *The chemical composition of Guizhou kaoline*

T a b l i c a 1 – *Kemijski sastav kaolina Guizhou*

Chemical composition, *w*/%	Guizhou kaoline
SiO_2	46.81
Al_2O_3	37.68
Fe_2O_3	0.28
Na_2O	0.05
K_2O	0.17
CaO	0.16
MgO	0.08
TiO_2	0.03
Loss on ignition	14.82

Ammonim chloride (AR, 99.5 % NH_4Cl, anhydrous.), nickel nitrate (AR, 98.0 % $Ni(NO_3)_2$ hydrate.), and ammonium metavanadate (AR, 99.0 % of NH_4VO_3, anhydrous.) were supplied from the Beijing Chemical Industry Company.

Rare earth (lanthanum and cerium) chloride (mass concentration of Re_2O_3: γ = 226.7 g l^{-1}) was supplied from the Catalyst Producing Factory of the Lanzhou Petrochemical Company.

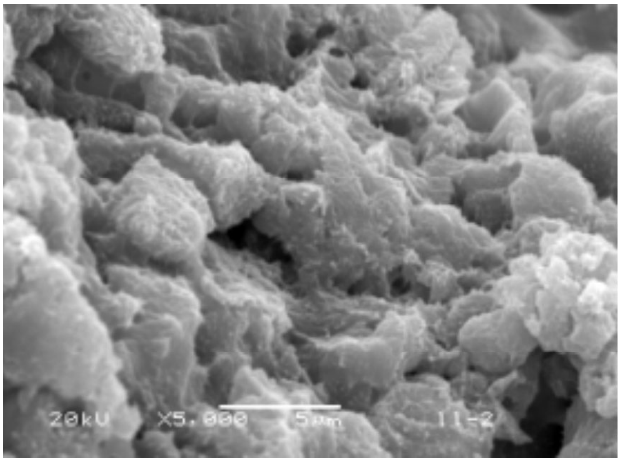
Base catalyst was supplied from the Catalyst Producing Factory of the Lanzhou Petrochemical Company. Its active zeolitic component is REUSY type.

Pyridine (99.0 %, anhydrous.) was supplied from the Beijing Chemical Industry Company.

Intiator was an amorphous gel for accelerating the formation of NaY zeolite. It has been synthesized from sodium silicate and sodium aluminate. Best results have been obtained, when a sodium silicate solution was added rapidly to a sodium aluminate solution, with rapid mixing. The synthesis is a typical inorganic reaction at the stoichiometry of $r_{Na_2O:SiO_2:Al_2O_3:N_2O}$ = 16:15:1:300, and aged at 30~40 °C for 12~30 h.

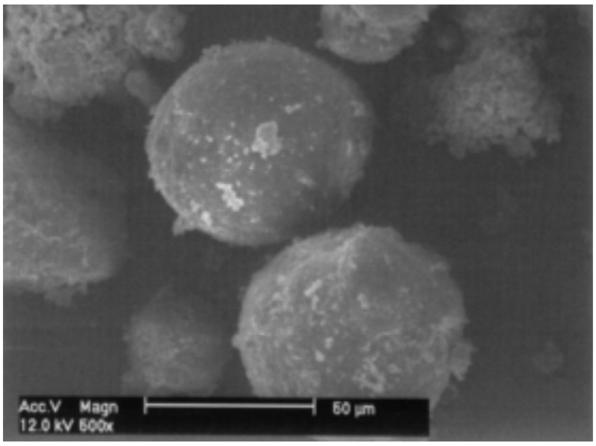
Additive preparation

The catalyst additive was prepared by the *in situ* crystallization technique. The starting material was kaoline from Guizhou, China (see SEM of raw Guizhou kaoline in Fig. 2(1)). About 1 to 10 mass fraction of dispersant (sodium silicate or sodium phosphate) were blended with kaoline to form an aqueous slurry with 30 to 50 mass fraction of solids, and precursor microspheres (PM) (see SEM of precursor microspheres in Fig. 2 (2)) with particle diameter dp = 20–110 μm produced by spray drying. The PM were divided into two parts. One was calcined at 940–1050 °C for 2–4 h to produce type A microspheres (CMA). The other was dehydroxylated at 550–850 °C for 2–4 h to form metakaolinite (CMB). The following ingredients were added to a 10 liter stainless steel kettle reactor configured for reflux operation, in order, with stirring; mixture was stirred at a rate sufficient to suspend the solids: a mixture of the two types of calcined microspheres (see SEM of calcined microspheres in Fig. 2 (3)), sodium silicate, sodium oxide and an initiator was heated to T = 85–95 °C for 20–36 h to synthesize NaY zeolite in the form of microspheres. In this hydrothermal crystallization system, the synthesis is a typical inorganic reaction at the stoichiometry of Na_2O:SiO_2:Al_2O_3:H_2O = 8:20:1:320. The microspheres with zeolite crystallized in them were separated from their mother liquor by vacuum filtration on 18.5 cm. diameter Buchner funnels, washed with water and dried at room temperature. After filtration and washing, crystallized microspheres (CMR) (see SEM of crystallized microspheres in Fig. 2 (4)) with about 7.0 of pH value were obtained. The subsequent ion exchange was conducted by different methods. Usually the microspheres were first exchanged one or more times with about 10 to 100 mass fraction of ammonium chloride to replace sodium in the CMR, after heating to 90–95 °C for 1–2 h at a pH of about 3.0–3.5. Each batch of microspheres was washed with water and dried at room temperature, and then the microspheres were exchanged with about 1 to 10 mass fraction of rare earth ions, after which they were calcined at 550–650 °C for 2–4 h. Finally, the catalyst additive was obtained by flash drying of the ion-exchanged microspheres.



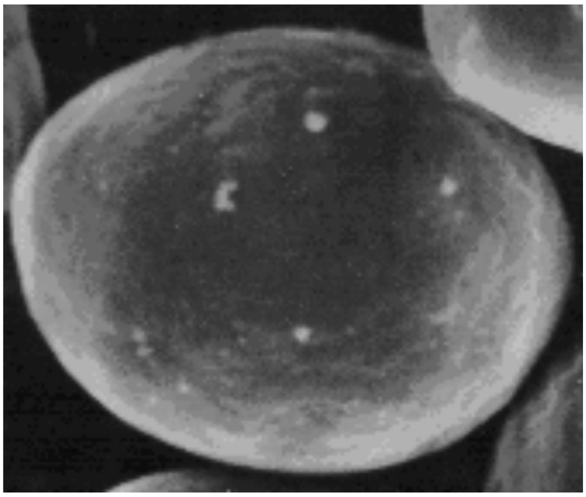
F i g. 2 (1) – *SEM of Guizhou kaoline, scale bar = 5 μm*

S l i k a 2 (1) – *Pretražna elektronska mikrofotografija uzorka kaolina Guizhou, mjerilo = 5 μm*



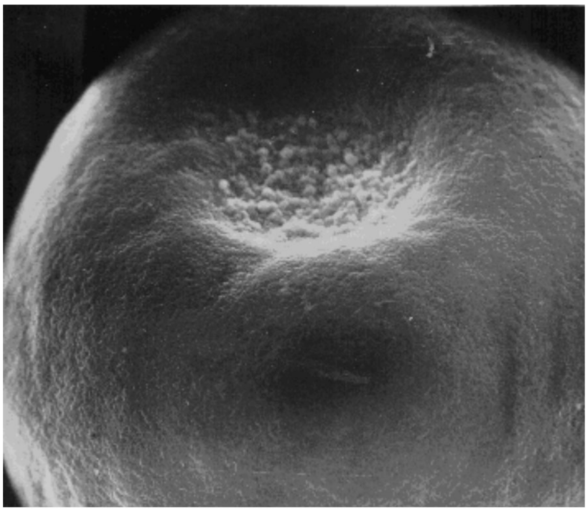
F i g. 2 (2) – *SEM of the precursor microspheres, scale bar = 50 µm*

S l i k a 2 (2) – *Pretražna elektronska mikrofotografija mikrosferičnog uzorka prekursora, mjerilo = 50 µm*



F i g. 2 (3) – *SEM of calcined microspheres, scale bar = 25 µm*

S l i k a 2 (3) – *Pretražna elektronska mikrofotografija kalciniranog mikrosferičnog uzorka prekursora, mjerilo = 25 µm*



F i g. 2 (4) – *SEM of crystallized microspheres, scale bar = 25 µm*

S l i k a 2 (4) – *Pretražna elektronska mikrofotografija kristaliziranih mikrosferičnih uzoraka, mjerilo = 25 µm*

Characterization

X-ray diffraction: Powder XRD patterns were recorded on a Rigaku D/max-3C diffractometer using Cu-kα radiation (35 kV, 15 mA). The samples were scanned at 0.2° min^{-1} 2θ. The reference sample was standard NaY. The crystallinity of zeolite Y was estimated according to the following equation:

$$\text{crystallinity (\%)} = \frac{\begin{array}{c}\text{peak height at 22–24.5° } 2\theta\\ \text{(product)}\end{array}}{\begin{array}{c}\text{peak height at 22–24.5° } 2\theta\\ \text{(reference)}\end{array}} \cdot 100$$

IR spectroscopy: IR spectra were recorded using a Nicolet 510P FTIR Spectrometer. The resolution was 0.2cm^{-1}, and the sample was pressed with a certain amount of KBr into disks 10 mm in diameter and 0.1 mm thick. Acid sites are often measured by IR spectroscopy using pyridine as the adsorbed base. In this evaluation, all spectra were vacuumized to 10^{-3}Pa at 350 °C for 4 h, and then the temperature was reduced to 200 °C, pyridine was adsorbed to saturation for 5min, and then pyridine of physical adsorption was eliminated at 10^{-2} Pa. Band areas at 1450 and 1550 (cm^{-1}) were used to estimate the amounts of pyridine adsorbed on Lewis and Bronsted sites, respectively.

SEM Micrographs: SEM were obtained using a JEM-1200 EX/S microscope and Pt coated samples.

Pore diameter distribution: Pore diameter distribution was recorded on USA Coulter Ltd, Omnisorp-360 using adsorption and desorption isotherm plots.

Catalytic performance testing: To test the cracking catalytic performances, the steamed catalyst additive prepared as described above (w = 20 %) was blended with steamed base catalyst (w = 80 %). The mixture was impregnated with a nickel-vanadium mixture (w = 1 %) as follows:[11] a dried catalyst sample is impregnated with ammonium meta vanadate dissolved in oxalic acid solution. The amount of solution used is enough to impregnated the catalyst to its puddle point, that is, the point where additional drops will result in formation of a puddle of solvent. The solvent is then evaporated at room temperature, carbonized at 540 °C, and the organic burned off at 800 °C leaving the bare metal deposited on the catalyst. The testing was carried out in small-scale fixed fluidized bed reactor. The conditions used were 500 °C, catalyst-to-oil ratio nominally = 4, WHSV(h^{-1}) = 15, and the feedstock used in this experiment was the mixture of 70 % wax oil and 30 % residual oil of XinJiang Refining Factory (Table 2).

Micro analytical testing (MAT) of catalyst performance was according to ASTM Method D-3907. The conditions used were 460 °C, catalyst-to-oil ratio nominally = 3, WHSV (h^{-1}) = 16, and the feedstock was a light diesel oil (Table 3).

Results and discussion

In situ **crystallization**

Hydrothermal reaction of calcined microspheres with sodium silicate, sodium hydroxide, and an initiator has been studied, and Fig. 3 shows the zeolite formation curves. It is observed, that the length of the induction period is different under various crystallization temperatures and after an in-

Table 2 – *The properties of feedstock for testing catalyst*

Tablica 2 – *Svojstva polaznog materijala za testiranje katalizatora*

	Feedstock (70 % Wax oil + 30 % Residual oil)	
	wax oil	residual oil
Conradson carbon residue, *w* %	0.29	9.76
Flash point, °C	136	316
Element composition, *w* %		
N	0.05	0.57
C	86.82	86.71
H	13.16	12.17
Metals, $w = \mu g\ g^{-1}$		
Cu	0.14	0.87
Pb	0.15	0.89
Fe	8.90	21.55
Ni	0.58	26.64
V	0.22	4.67
Type analysis, *w* %		
paraffins	86.7	45.7
aromatics	12.8	47.3
pectin	0.5	7.0
molar mass, *M*, g mol^{-1}	323	882

Table 3 – *Properties of Dagang diesel oil*

Tablica 3 – *Svojstva dizelskog ulja Dagang*

	Analysis results
Cetane number	54.5
Motorial glueyness (20 °C), mm^2 s^{-1}	7.73
Flash point, °C	87
Acidity, gKOH/100mL	25.24
Gluey value, *w* %	284.6
Solidifying point, T_s, °C	+2
Sulphur fraction, *w*, %	0.074
Distillation range, T_r, °C	
50 %	295
90 %	335
95 %	345

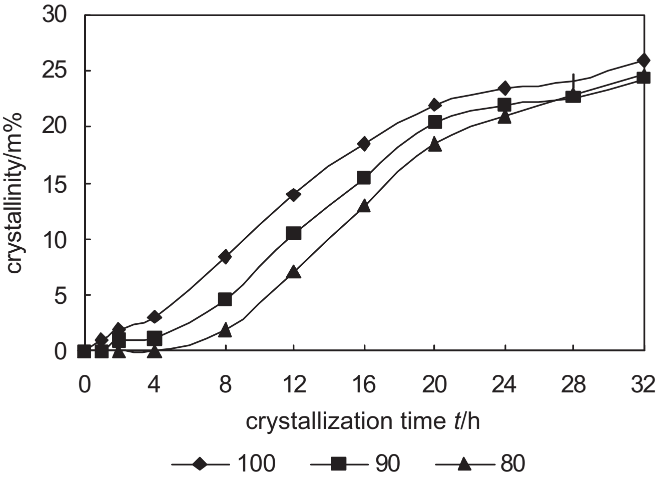
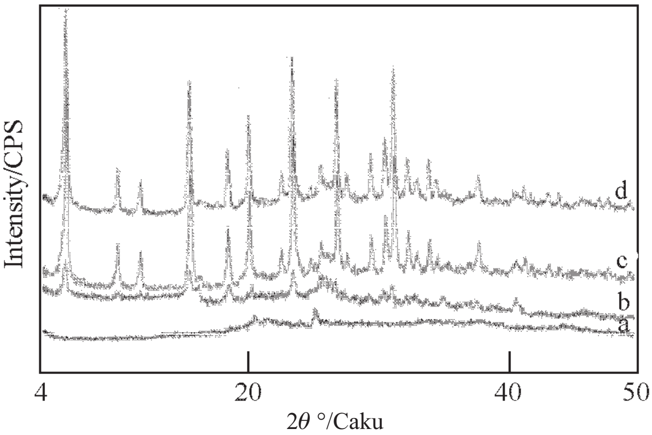


Fig. 3 – *NaY zeolite synthesized from kaoline by in situ crystallization at various temperatures*

Slika 3 – *Zeolit NaY pripravljen iz kaolina, kristalizacijom in-situ pri različitim temperaturama*



a – calcined microspheres; b – crystallization 0h;
c – crystallization 24h; d – crystallization 32 h

Fig. 4 – *XRD patterns of calcined microspheres and the solids drawn off the reaction mixture at various times*

Slika 4 – *Rendgenogram uzoraka kalciniranih mikrosfera i krutine, izoliranih iz reakcijske smjese tijekom vremena*

duction period, the rate of zeolite crystallization increases for the samples. The length of the induction period depends on temperature and origin of the reactants. This is followed by a period of rapid crystal growth which ends when the nutrients begin to get exhausted and crystal growth becomes difficult to maintain. Yet Fig. 3 shows that the more high crystallization temperature the shorteln is the time of induction period and high of crystallinity. X-ray diffraction patterns of the solids drawn off the reaction mixture at various times are given in Fig. 4. The NaY zeolite synthesized from this kaoline by in-situ crystallization technique, in its sodium form, has a crystallinity of 25 % mass fraction, a silica/alumina molar ratio of 5.05, a crystalline unit cell size of 24.72. ANG., the crystallized microspheres (CMR) including both zeolitic and non-zeolitic components have an attrition index of *w* = 0.7 mass fraction, a pore specific volume *v* = 0.25 ml g^{-1}, a specific surface area of *s* = 313 m^2 g^{-1}; a sodium oxide of 12.82 % mass fraction; the zeolite containing microspheres have a 14.38 % of pores having diameters in the range of 0–30. ANG; a 73.72 % of pores having diameters in the range of 30–100. ANG; a 12.02 % of pores having diameters more than 100. ANG.

Properties of catalyst additive

The additive is activated by ion-exchanging the sodium out of the zeolite. The sodium can be exchanged either with a hydrogen ion through ammonium chloride exchange or a rare earth metal ions through rare earth exchange. Rare earth exchange stabilizes the zeolite. Typical physicochemical properties of the FCC additive were shown in Tab. 4. Pore diameter distribution of Guizhou kaoline and additive was shown in Tab. 5.

Table 4 – *Physicochemical properties of catalyst additive from Guizhou kaoline*

Tablica 4 – *Fizikalno-kemijska svojstva aditiva katalizatora pripravljenog iz kaolina Guizhou*

Catalysts	Base catalyst	Additive
Na_2O, w %	0.37	0.39
Al_2O_3, w %	48.69	43.75
Fe_2O_3 , w %	0.42	0.56
SiO_2, w %	48.17	49.32
Re_2O_3, w %	2.0	5.5
Attrition Index, w %	1.4	1.5
Specific surface area, $s = \mathrm{m^2\ g^{-1}}$	306	289
Specific pore volume, $v = \mathrm{ml\ g^{-1}}$	0.13	0.23
MAT, w %[*]	73	82
MAT, w %[**]	46	68

[*] steamed in 800 °C,100 % steam for 4 h

[**] contaminated by 1.0 % (nickel + vanadium) on catalyst, steamed in 800 °C,100 % steam for 4 h

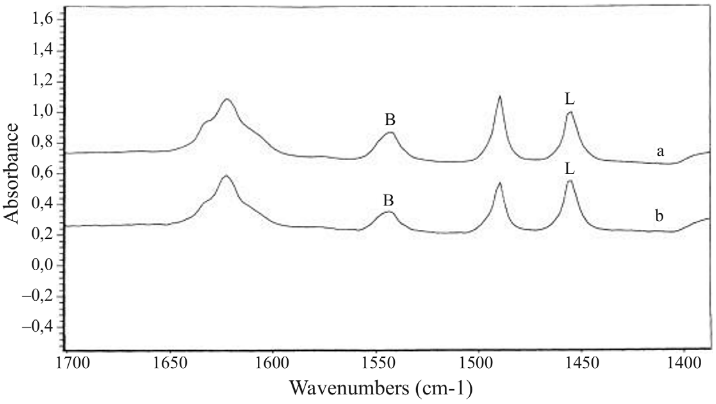
Table 5 – *Pore diameter distribution of Guizhou kaoline and additive*

Tablica 5 – *Raspodjela veličine pora uzoraka kaolina Guizhou i aditiva*

	Pore diameter nm	Pore diameter distribution %	Pore massic volume $v/\mathrm{mm^3\ g^{-1}}$
Guizhou kaoline	1– 3	20.17	0.0418
	3–10	46.55	0.0965
	>10	33.55	0.0695
Additive from Guizhou kaoline	1– 3	16.22	0.02019
	3–10	71.48	0.08997
	>10	12.47	0.01552

As shown in Tab. 4, the additive has high specific surface area, pore volume and strong strength. So lower fresh catalyst addition rates are required. This can mean substantial savings in catalyst costs as well as reduced stack opacity and particulate emissions. The results of MAT showed that the additive has very good hydrothermal stability.

The various reactions, that take place during fluid catalytic cracking, depend primarily on the distribution of acid sites on the matrix and within the Y zeolite. Bronsted sites are well known as being the important sites for the cracking process and most of these sites reside within the zeolite pore structure. Lewis acid sites play an important role in the formation of coke and in initiating the cracking process. Lewis acid sites can adsorb unsaturated hydrocarbons for sufficient tome for oligomers to form which then end up as coke and hydrogen.[12–14] IR spectra of additive exposed to pyridine are shown in Fig. 5. It was clear that the additive maintains sufficient Bronsted acid site and weak Lewis acid site contrast to the base catalyst. The result is a high bottoms upgrading catalyst additive with reduced coke and hydrogen yields.



a: additive; b: base catalyst

Fig. 5 – *IR spectra of samples*

Slika 5 – *Infracrveni spektar uzoraka*

Catalytic data

Twenty mass fraction of the steamed additive was blended with steamed base catalyst to test the catalytic cracking performance. The catalyst was artificial impregnation with 1 % (nickel + vanadium). The catalytic activity, cracking selectivity results, and the properties of the cracked gasoline are separately summarized in Tables 6,7 and 8.

Table 6 – *The evaluating results in small-scale fixed fluidized bed reactor*

Tablica 6 – *Rezultati krekiranja u reaktoru s fiksnim fluidiziranim slojem, umanjenog mjerila*

Catalysts	Base catalyst	+20 % additive
Product compasitic, w %		
dry gas	2.14	2.05
LPG	19.66	18.30
C5+gasoline	52.71	52.79
LCO	12.54	15.71
HCO	3.73	2.37
Coke	7.52	5.95
Conversion, X, %	82.03	79.09
Light oil, w %	65.25	68.50
Product Selectivity		
Dry Gas / Conversion	0.03	0.02
Gasoline / Conversion	0.64	0.67
Coke/ Conversion	0.09	0.08

[*] contaminated by 1.0 % (nickel + vanadium) on catalyst, steamed in 800°C,100 % steam for 4 h

Table 7 – Properties of cracked gasoline
Tablica 7 – *Svojstva krekiranog benzina*

Catalysts	Base catalyst	+20 % additive
Composition, φ, %		
n-paraffins	4.43	4.12
i-paraffins	40.64	35.34
olefins	15.42	13.74
naphthenes	9.15	8.20
aromatics	30.36	38.59
Research Octane Number	91.3	91.4
Motor Octane Number	80.6	80.1

(I) As shown in Tab. 6 and 7, under high levels of contaminant metals, addition of mass fraction $w = 20$ %: of the additive to the base catalyst led to a severe increment in activity of 20 % points; in the meanwhile, light oil and LCO increase; coke and HCO decrease. In addition, the gasoline and coke selectivity are improved.

In summary, the additive has a good advantage in bottoms conversion and excellent performance of nickel and vanadium passivation.

(II) As shown in Tab. 8, compared with base catalyst, addition of the mass fraction: $w = 20$ % additive, the additive results in a reduction of gasoline olefins, while the motor gasoline octane number drops by about 0.5, but the research gasoline octane number is almost unchanged.

Conclusions

The technical procedure of *in situ* crystallization adopted for the preparation of a FCC catalyst additive from kaoline was introduced. The NaY zeolite synthesized from Guizhou kaoline by *in situ* crystalliazation technique, in its sodium form, has a crystallinity of 25 mass fraction, a silica/alumina mole ratio of $r_{Si/Al} = 5.05{:}1$. The catalyst additive prepared from above crystallization product has higher activity, excellent performance of heavy metal passivation, better gasoline and coke selectivity, and strong ability of bottoms conversion.

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References
Literatura

1. *A. C. D. Newman,* Mineralogical Society Monogragh No. 6, Chemistry of Clays and Clay Minerals, London, 1987, p. p. 22-26.
2. *X. Q. Zhang*, Kaolin, Light Industry Publishing Company, Beijing, China, 1988, p. p. 10-15.
3. *R. M. Barrer*, Zeolites and Clay Minernals as Sorbents and Molecular sieves. Academic Press, London, 1978, p. p. 407-483.
4. *E. B. Drag, A. Miecznikowski, F. Abo-Lemon, M. Rutkowski*, Synthesis of A, X, Y Zeolite from Clay Minerals, Brzaj B., Hocevar S., Pejovnik S., Zeolite – Synthesis, Structure, Technology and Application, Elsevier, Amsterdam–Oxford–New York–Tokyo, 1995, p. p. 147-154.
5. *D. W. Breck*, Zeolites Molecular sieves-Structure, Chemistry and User, John Wiley & Sons Inc, New York, 1974, p. p. 313-320 and p. p. 731-738.
6. *M. B. Stanley, V. A. Durante, W. J. Reagan*, et al., Fluid catalytic cracking catalyst comprising microspheres containing more than about 40 percent by weight Y-faujasite and methods for making [P], USP4, 403, 902, 1985-01-15.
7. *M. Alfonse, F. Charles Keweshan, J. Rostam Madon*, Advanced FCC catalyst matrix technology for reduced coke and slurry yields [C], NPRA annual meeting, 1994, AM-94-59.
8. *J. B. Mclean, D. M. Stockwell,* NaphthaMax™ breakthrough FCC catalyst technology for short contact time applications [C], NPRA annual meeting, 2001, AM-01-58.
9. *Y. M. Zhang, H. H. Liu, S. Q. Zheng, J. H. Shen*, Journal of Molecular Catalysis (China) **9** (6) (1995) 424.
10. *Y. M. Zhang, R. R. Tang, S. Q. Zheng, H. H. Liu*, Relation between crystalline structure of kaolin and the performance of its in-situ crystallization cracking catalyst, Petroleum Processing and Petrochemicals (China) **28** (5) (1997) 51.
11. *B. R. Mitchell*, Metal Contamination of Cracking Catalyst 1. Synthetic Metals Deposition on Fresh Catalysts, Ind. Eng. Chem. Prod. Res. Dev. **19** (1980) 209.
12. *D. M. Brower,* Chemistry and Chemical Engineering of Catalytic Processes [M], Ed. R. Prins and G. C. A. Schuit, Sijthoff and Noordhoff, The Netherlands, 1980, p. p.137.
13. *G. B. McVicker, G. M. Kramer, J. J. Ziemiak*, Conversion of isobutene over solid acids – A sensitive mechanistic probe reaction, J. Catal. **83** (1983) 286-300.
14. *H. Hattori, O. Takahashi, M. Tagaki, K. Tanabe*, J. Catal. **68** (1981) 133.

List of symbols
Popis simbola

d – diameter, nm
d_p – particle diameter, μm
M – molar mass, g mol^{-1}
n – amount of subtance, mol
$r_{si/Al}$ – mole ratio, n_{si}/n_{Al}
s – specific surface area, m^2 g^{-1}
t – time, h
T – temperature, °C
v – specific volume, ml g^{-1}
w – mass fraction, %
X – conversion, %
γ – mass concentration, gl^{-1}
φ – volume fraction, %
θ – Bragg angle, 1
WHSV – weight hourly space velocity, h^{-1}
(mass feed flow per unit catalist mass, g g$^{-1}_{cat}$ h^{-1}

SAŽETAK

Svojstva aditiva FCC-katalizatora pripravljenih iz Guizhou kaolina

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U radu su opisana istraživanja svojstava aditiva FCC-katalizatora pripravljenih iz Guizhou kaolina. Aditivi su karakterizirani adsorpcijom N_2, rengenskom difrakcijom praškastih uzoraka, IR-spektroskopijom i pretražnom elektronskom mikroskopijom. Rezultati ukazuju da kristaliničnost zeolita NaY pripravljenog iz Guizhou kaolina iznosi 25 % te da je omjer silicijevog oksida (SiO_2) i aluminijevog oksida (Al_2O_3) 5,05 (mol/mol). Aditiv iskazuje prestižna svojstva FCC-katalizatora prvenstveno pasivizacije nikla i vanadija, proizvodi 21 % manje koksa, i održava visoku selektivnost destilacijskih ostataka.

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