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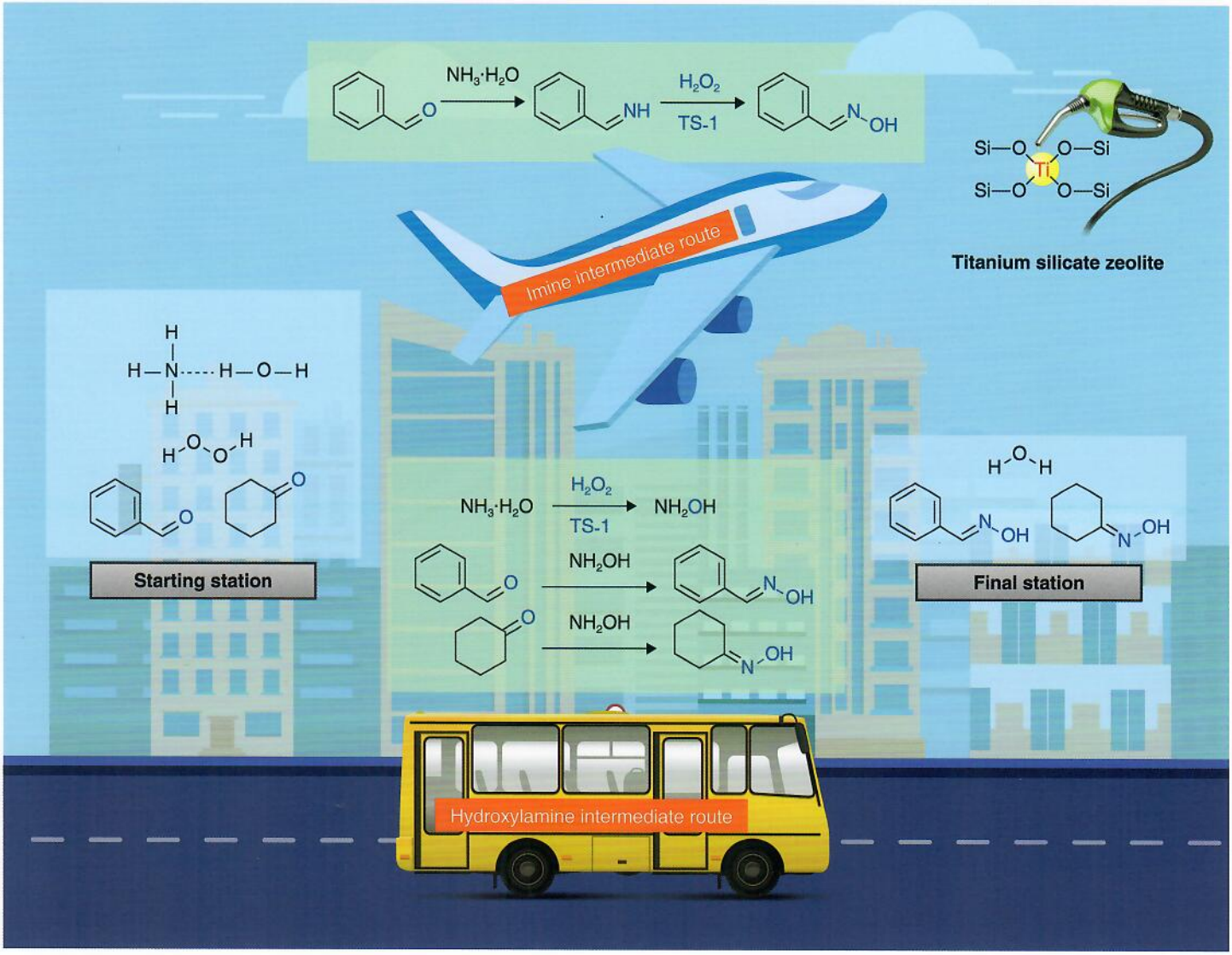
(PETROLEUM PROCESSING SECTION)



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（石油加工）

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研究报道

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ACTA PETROLEI SINICA

(PETROLEUM PROCESSING SECTION)

Vol .36 No .4 Jul .2020

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Research Articles

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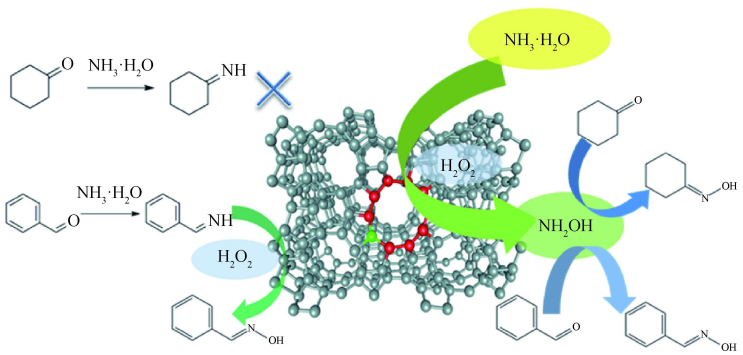
Ammoximation Reaction Mechanisms of Benzaldehyde or Cyclohexanone Catalyzed by TS-1 Zeolite

YANG Yongjia XIA Changjiu LIN Min ZHU Bin PENG Xinxin LUO Yibin SHU Xingtian

Ammoximation reaction mechanisms vary with reactants. Since there was no imine intermediate formed from cyclohexanone and $NH_3 \cdot H_2O$, cyclohexanone ammoximation mainly proceeds with hydroxylamine route. Hydroxylamine intermediate (NH_2OH) was formed by $NH_3 \cdot H_2O$ oxidation by TS-1/H_2O_2. For benzaldehyde ammoximation, both hydroxylamine route and imine route occur, because imine intermediate can be formed by in-situ condensation of benzaldehyde with $NH_3 \cdot H_2O$, and then it is further oxidized to benzaldehyde oxime.

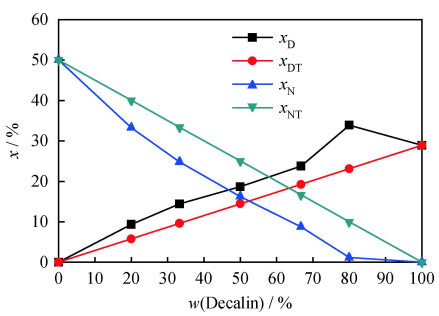


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0661-0666 **doi**: 10.3969/j.issn.1001-8719.2020.04.002

Effects of Molecular Structure on Hydrocarbon Catalytic Cracking Performance

LI Fuchao YUAN Qimin WEI Xiaoli

Interaction between alkanes with cycloalkanes was studied in this work. Experimental results show that competitive adsorption of cycloalkanes depressed the reactivity of linear alkanes, but the intermediates, such as carbocation or olefins formed by cracking of alkanes, can promote conversion of cycloalkanes. Therefore, propylene yield produced by mixture of decalin and *n*-dodecane is lower than that of *n*-dodecane.



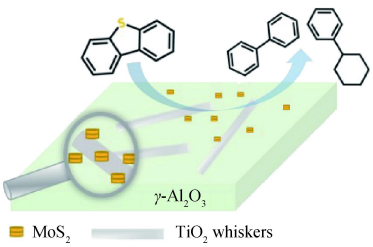
x_D—Conversion of decalin; x_{DT}—Theoretical conversion of decalin; x_N—Conversion of *n*-dodecane; x_{NT}—Theoretical conversion of *n*-dodecane

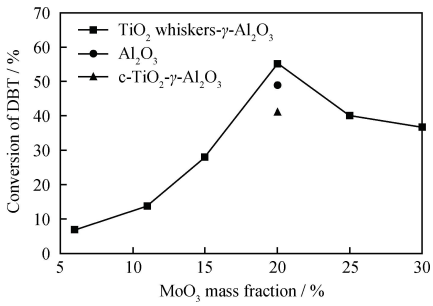
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0667-0676 **doi**: 10.3969/j.issn.1001-8719.2020.04.003

Preparation of Mesoporous TiO_2 Whisker-γ-Al_2O_3 Composite Supported Catalyst and Its Catalytic Performance in Dibenzothiophene Hydrodesulfurization

YUE Fan LI Meng YANG Zhuhong HUA Zelin LI Long LI Licheng

The mesoporous TiO_2 whisker-Al_2O_3 composite support maintains good pore structure, and the introduction of Ti reduces the interaction between Mo and Al_2O_3, hence improving the catalytic performance in hydrodesulfurization.



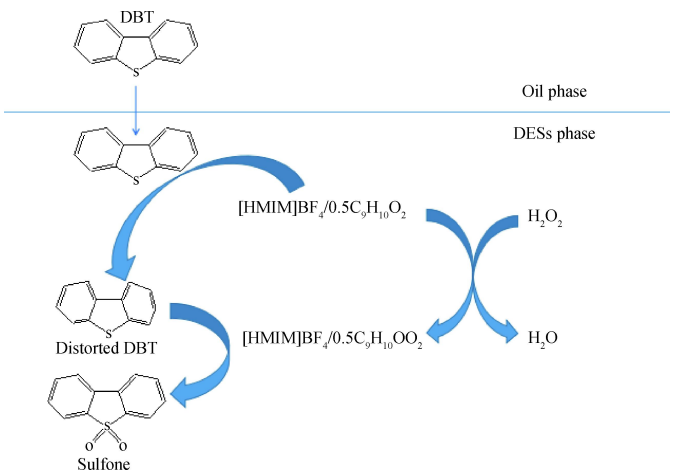


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0677-0687 **doi**: 10.3969/j.issn.1001-8719.2020.04.004

Preparation of *N*-Methylimidazoliun Fluoroborate-Based Deep Eutectic Solvent and Its Oxidative Desulfurization Performance

LIU Haoran CHEN Siyu LI Xiuping ZHAO Rongxiang MAO Wei

A series of $[HMIM]BF_4/xC_9H_{10}O_2$ (x=0.5, 1, 2) deep eutectic solvents (DESs) were synthesized through heating the mixture of *N*-methylimidazoliun fluoroborate ($[HMIM]BF_4$) and phenylpropionic acid ($C_9H_{10}O_2$). Synthetic method of $[HMIM]BF_4/0.5C_9H_{10}O_2$ is simple and reaction conditions are mild. Interaction forces between DBT and $[HMIM]BF_4/0.5C_9H_{10}O_2$ can reduce the aromaticity of DBT and thus make it easy to be oxidized.

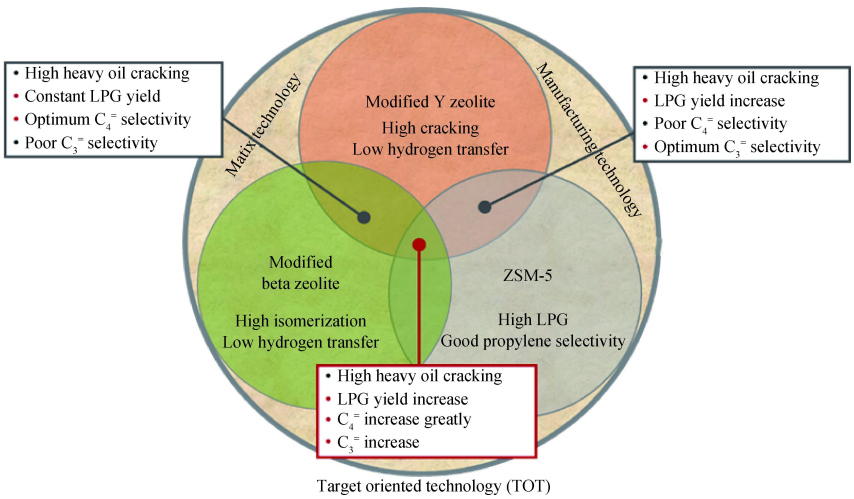


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0688-0695 **doi**: 10.3969/j.issn.1001-8719.2020.04.005

Study on High Butylene Selective Catalytic Cracking Catalyst

YU Shanqing YAN Jiasong GUO Yaoqing WANG Zhongxia ZHANG Jiexiao TIAN Huiping LIN Wei

High butylene selectivity catalytic cracking catalyst named HBC was developed based on high Si/Al ratio Y zeolite combining with modified Beta zeolite. Commercial application results show the butylenes yield increases by 0.52—0.82 percentage points, and the mass fraction of butylenes in LPG increases by 1.89—3.08 percentage points with an increase of above 10% .

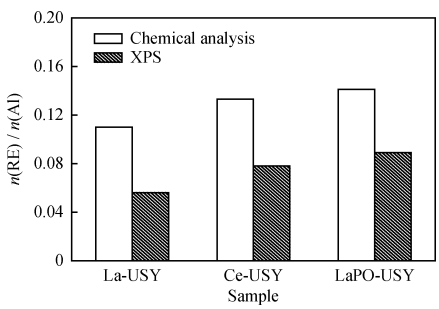


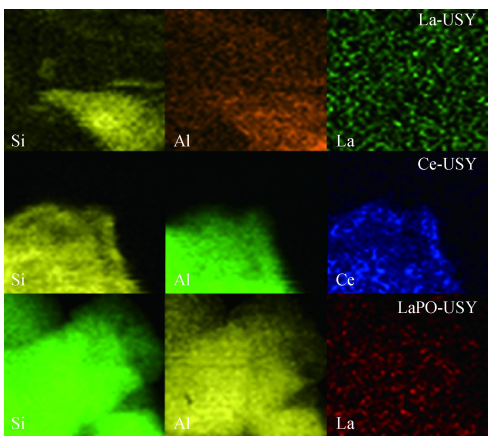
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0696-0701 **doi**: 10.3969/j.issn.1001-8719.2020.04.006

Effect of Rare Earth Composition Introduction on Vanadium Tolerance of FCC Catalyst

DU Xiaohui REN Shihong LIU Pusheng SUN Shuhong GAO Xionghou

Rare earth compounds, which are distributed on the zeolite surface and channels by precipitation method, show high tolerance to the vanadium, with lower zeolite damage in steaming.



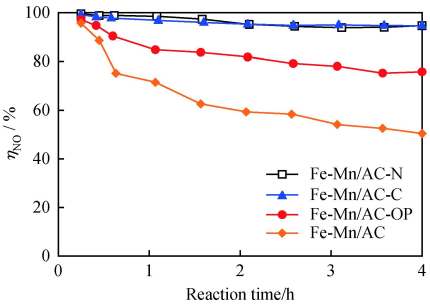


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0702-0711 **doi**: 10.3969/j.issn.1001-8719.2020.04.007

Influence of Support Modification of Fe-Mn/AC Catalyst on the Denitration Performance in Selective Catalytic Reduction at Low Temperature

FENG Yang YU Zhiquan YU Caiyuan WANG Yao

From the perspective of practical industrial production, modification methods of activated carbon-based denitration catalysts is of great meaning, and the citric acid-modified activated carbon-supported Fe-Mn catalyst exhibits excellent denitration performance.



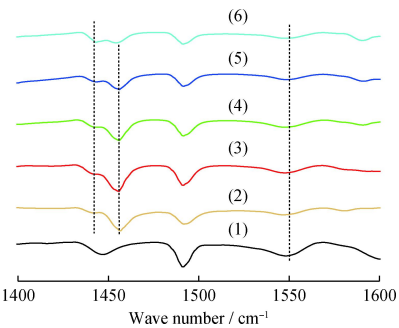
T=120 ℃; GHSV=8000 h^{-1}

Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0712-0719 **doi**: 10.3969/j.issn.1001-8719.2020.04.008

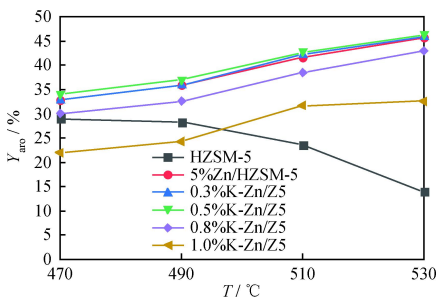
Study on HZSM-5 Catalyst Modified by Zn and K for Hydroaromatization

ZHANG Kongyuan WANG Chong FU Xingwang ZHENG Chuanfu LIU Chenguang

HZSM-5 zeolite was modified by Zn and K using equal volume impregnation method. The results showed that acid properties of modified catalyst were improved and the aromatization rate and the selectivity of BTX increase greatly with the increasing of K when the mass fraction of ZnO is 5% and the mass fraction of K_2O is not more than 0.5%.



(1) HZSM-5; (2) 5% Zn/HZSM-5; (3) 0.3% K-Zn/Z5; (4) 0.5% K-Zn/Z5; (5) 0.8% K-Zn/Z5; (6) 1.0% K-Zn/Z5



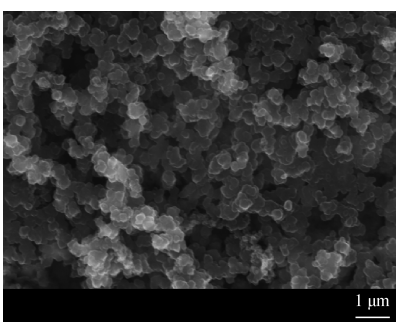
p=2.0 MPa; LHSV=1.5 h^{-1}; $V(H_2)/V(Oil)$=100

Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0720-0727 **doi**: 10.3969/j.issn.1001-8719.2020.04.009

Preparation and Properties of Nanometer Ammonium Persulfate Microcapsules

LI Xiaodan LI Guanghui ZHENG Jiazhen ZHOU Weikang

100 — 300 nm microcapsules with polypyrrole as shell and ammonium persulfate as core were prepared by in-situ polymerization. The results show that the microcapsule enables fracturing fluid to delay breaking gel for more than 4 h, and the fracturing fluid can break gel back to the discharge after the construction is completed.

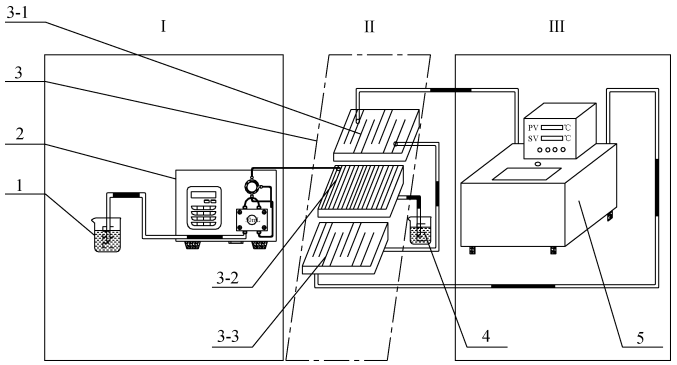


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0728-0735 **doi**: 10.3969/j.issn.1001-8719.2020.04.010

High-Efficiency Catalytic Synthesis of Tetradecyl Acrylate in Microchannel Reactor

YANG Zhe YE Jianlin XI Dalai LI Ning ZHOU Jun ZHANG Hongjiao

Compared with traditional batch reactor, synthesis of higher alcohol acrylate esters in the microchannel reactor has the advantage of high yield, accurate temperature control, continuous operation and simple post-treatment operation.



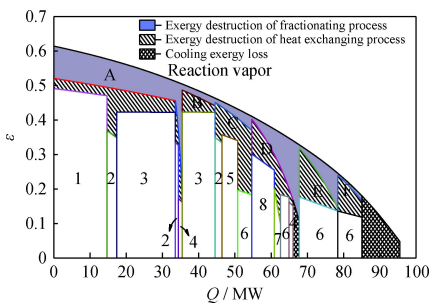
1—Raw material mixed liquid beaker; 2—Solvent delivery pump; 3—Microchannel reactor; 3-1—Upper heating module; 3-2—Microchannel reaction module; 3-3—Lower heating module; 4—Reaction product beaker; 5—High temperature circulator; Part Ⅰ—Feeding system; Part Ⅱ—Microchannel reaction module; Part Ⅲ—Oil bath heating system

Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0736-0745 **doi**: 10.3969/j.issn.1001-8719.2020.04.011

Simulation and Energy Optimization of Heat Exchange and Fractionation Processes for Fluid Catalytic Cracking Unit

GUO Weixin PENG Minyi GUAN Youliang LU Hangyu ZHANG Bingjian CHEN Qinglin

Exergy analysis (ε-Q diagram) of catalytic cracking process is performed quantitatively and qualitatively to find energy-using bottleneck. Based on the simulation results, the corresponding energy-saving methods are proposed. Simulation results show that heat exchanger network optimization can improve exergy efficiency of the heat exchanger network 11.5% compared with the original process.



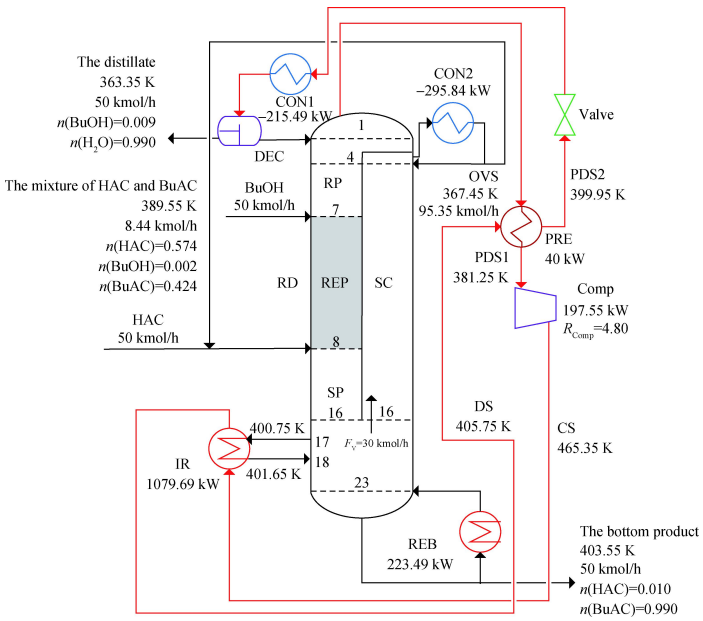
A—Slurry pumparound; B—Main fractionator middle pumparound-Ⅱ; C—Main fractionator middle pumparound-Ⅰ; D—Diesel; E—Main fractionator top pumparound; F—Main fractionator overhead vapors
1—Topped crude oil; 2—Feedstock oil; 3—3.5 MPa steam; 4—Desalted water; 5—Stabilizer reboiler; 6—Recycling medium water; 7—Rich absorption oil; 8—Desorber reboiler

Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0746-0755 **doi**: 10.3969/j.issn.1001-8719.2020.04.012

Energy-Saving Study for Butyl Acetate Synthesis in Reactive Divided-Wall Column via Vapor Recompression Heat Pump

CHEN Lijuan FENG Shenyao YE Qing

Three different schemes that integrated vapor recompression heat pump into reactive divided-wall column are proposed with large differential temperatures between top and bottom streams for butyl acetate synthesis. Calculation results indicate that RDWC-HP-PRE-IR scheme can save 35.18% TUC, 71.53% CO_2 emission and 35.35% TAC as compared with those from RDWC.



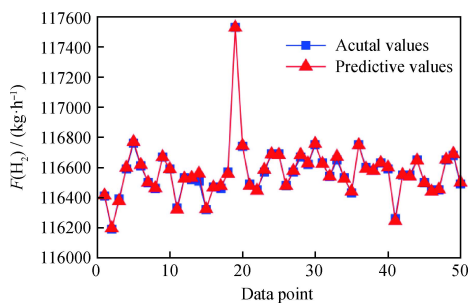
1,4,7,8,16,23—Number of stage; CON1—Condenser of RD; CON2—Condenser of SC; REB—Reboiler; IR—Interreboiler; DEC—Decanter; Comp—Compressor; OVS—Overhead vapor stream; CS—Compressed stream; DS—Discharge stream; PRE—Preheater; PDS1—Discharge stream of cold stream; PDS2—Discharge stream of hot stream; RD—Reaction distillation column; SC—Separation column; RP—Refining part; REP—Reaction part; SP—Stripping part

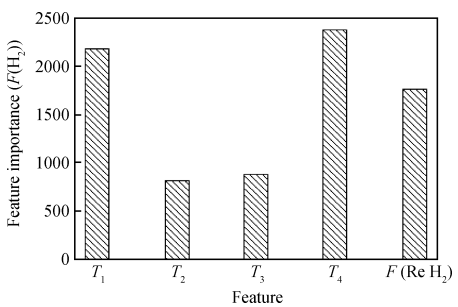
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0756-0766 **doi**: 10.3969/j.issn.1001-8719.2020.04.013

Product Prediction Technology and Optimal Operation Correlation Analysis for Catalytic Reforming Unit Based on LightGBM

LIU Yuhan CAO Cuiwen

Product prediction models were established for the catalytic reforming process unit using LightGBM decision tree. Finally, the ranks of feature importance were obtained by correlation analysis between characteristic variables and objectives. The simulation results could provide decision guidance for refinery online optimal operation.





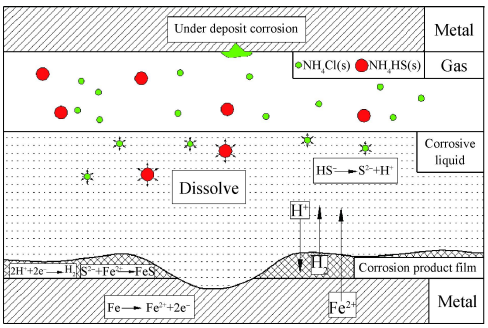
T_1, T_2, T_3, T_4—Temperature of reactor 1, 2, 3, 4; F(Re H_2)—Flow of recycle H_2

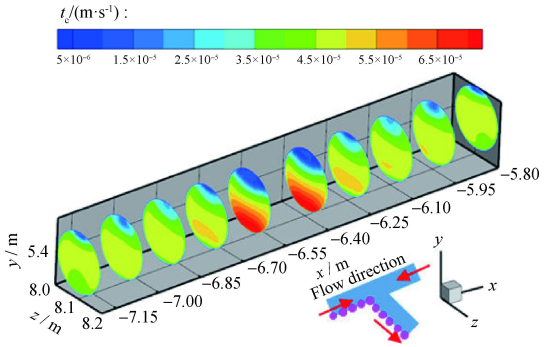
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0767-0776 **doi**: 10.3969/j.issn.1001-8719.2020.04.014

Evolution Mechanism of Flow-Induced Corrosion and Prediction of Erosion Characteristics Under NH_3-HCl-H_2S Environment in Hydrotreating Air Cooling System

JIN Haozhe QUAN Jianxun GONG Chengcheng ZHANG Lin LIU Xiaofei ZHANG Wei YANG Tao

With analyzing the multiphase flow properties in the pipeline, evolution pattern of the flow-induced corrosion mechanism and its key impact factors were identified. Based on the above results, the distribution of easy crystallization phase was confirmed. In addition, distribution of the characteristic parameters in the pipeline was further simulated to predict high-risk areas.



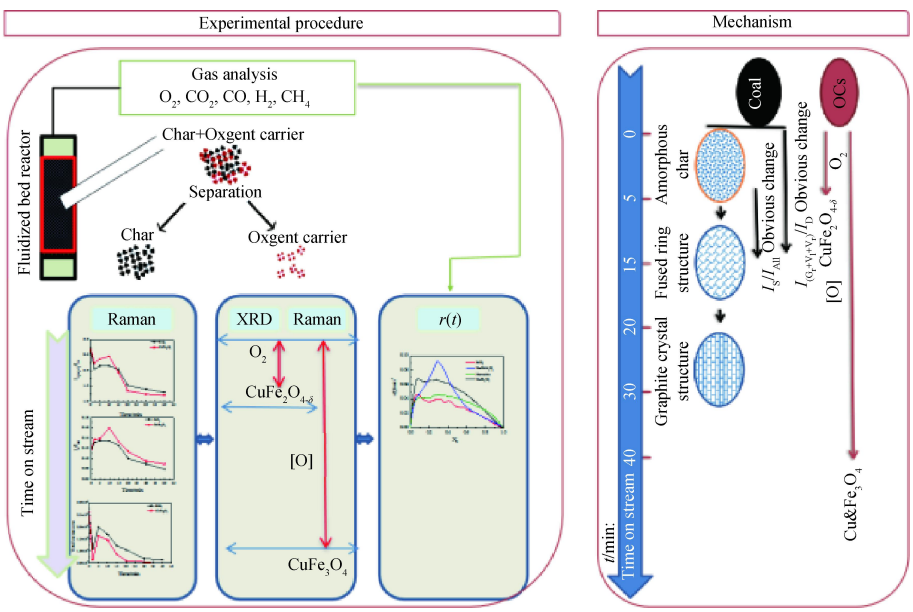


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0777-0783 **doi**: 10.3969/j.issn.1001-8719.2020.04.015

Reaction Characteristics and Structural Evolution of Coal With Oxygen Carriers $CuFe_2O_4/SiO_2$ in Chemical-Looping Gasification Process

AN Mei PAN Xin HU Xiude MA Jingjing GUO Qingjie

Reaction characteristics in chemical-looping gasification of sub-bituminous were studied with using $CuFe_2O_4/SiO_2$ as oxygen carriers and a batch fluidized bed. This work can help better understanding of the mechanism of how oxygen carriers $CuFe_2O_4/SiO_2$ can accelerate the chemical-looping gasification of bituminous.

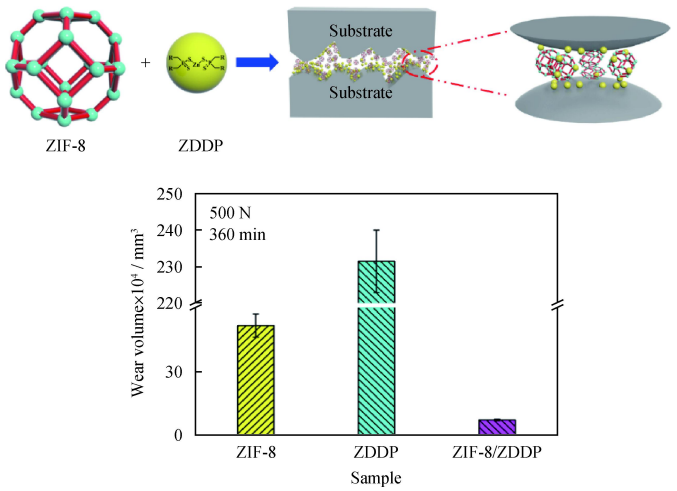


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0784-0793 **doi**: 10.3969/j.issn.1001-8719.2020.04.016

Tribological Behavior of ZIF-8/ZDDP as Grease Additives

NIU Wenxing YUAN Min SHI Qi XU Hong
DONG Jinxiang

ZIF-8/ZDDP as grease-based additives significantly improve the anti-wear performance and load-carrying capacity. During the rubbing process, ZIF-8 particles adhere to the surface of the friction pair to form a physical protective film, and synergistically with the chemical reaction film formed by ZDDP, showing excellent synergistic effect.

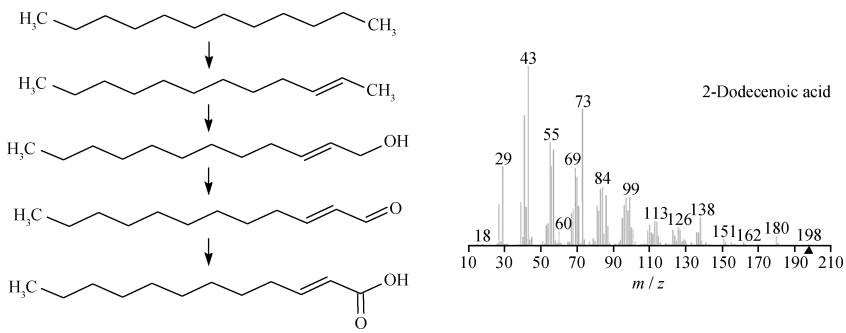


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0794-0800 **doi**: 10.3969/j.issn.1001-8719.2020.04.017

Effect of *Amorphotheca Resinae* on the Properties of Jet Fuel and Mechanism of Degradation of Alkanes

NIU Mingming SU Peng XIONG Yun XU Shihai SUN Xinfeng

The degradation mechanism of *n*-dodecane was investigated by gas chromatography-mass spectrometry. The results show that *A. resinae* degrades *n*-dodecane conformed to the terminal oxidation pathway, which oxidizes *n*-dodecane to 2-dodecene, 2-dodecen-1-ol, and 2-dodecenoic acid.

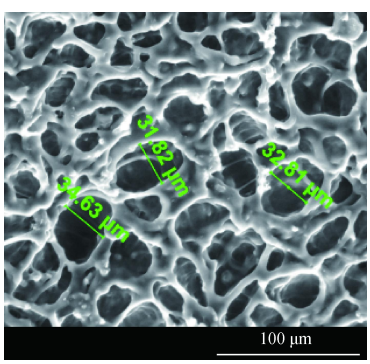


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0801-0811 **doi**: 10.3969/j.issn.1001-8719.2020.04.018

Rheological Properties of Starch Graft Polyacrylamide Gel

LIN Meiqin WEI Xianxian DONG Zhaoxia YANG Zihao SUN Feifei

Rheological properties and microstructures of the gels by hydroxypropyl starch graft were studied by HAAKE rheometer and ESEM. The results show that, the increase of the main agent mass fractions, AM/HPS mass ratio and the addition of nmSiO_2 cause increasing elastic modulus, viscosity modulus and yield stress.

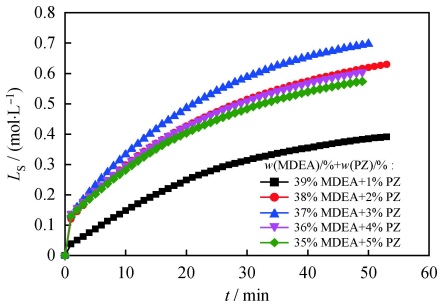


Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0812-0822 **doi**: 10.3969/j.issn.1001-8719.2020.04.019

Formula and Process Parameters Optimization of PZ-Activated MDEA Semi-Lean Solution Decarburization Process

HUA Yihuai LIU Qianyu DING Yu TANG Jianfeng
YIN Quansen FU Shenghong ZHOU Kai

The optimum formula of amine solution for semi-lean solution decarburization process is 37% MDEA+3% PZ, which is selected by absorption and desorption experiment, and the semi-lean solution decarburization process model is established by HYSYS software.



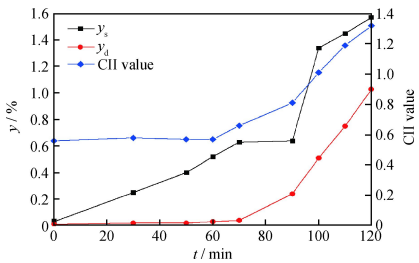
Research Notes

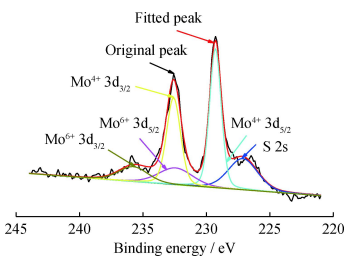
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0823-0831 **doi**: 10.3969/j.issn.1001-8719.2020.04.020

Effect of Reaction Time on Slurry-Bed Hydrocracking for Heavy Oils

CUI Min HAN Yapeng YANG Tengfei DENG Wenan LI Chuan

MRAR slurry-bed hydrocracking reactions with different reaction time were performed in an autoclave. Experimental results show that, at different stages of reaction time, reaction system exhibits different characteristics. Both system's colloidal stability and coke coverage degree on catalyst active center are important factors which impact catalyst activity.



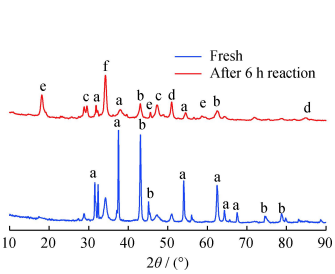


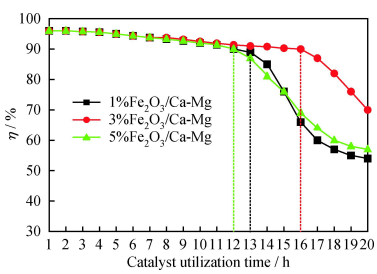
Acta Petrolei Sinica (*Petroleum Processing Section*), 2020, 36(4): 0832-0838 **doi**: 10.3969/j.issn.1001-8719.2020.04.021

Anti-Carbon Deposition Performance of Ca-Mg Catalyst in Coal Tar Catalytic Cracking Process

YAN Hao GONG Mingxin WANG Jinyu WANG Cuiping

Both of two-stage fixed bed gasification tar catalytic cracking experiments and physicochemical characteristics of the catalyst before and after reaction suggest that the main reason for catalyst deactivation is carbon deposition. Addition of Fe_2O_3 can improve anti-carbon capability of the catalyst and thus extend the catalyst life.





a—CaO; b—MgO; c—$CaCO_3$; d—C; e—$MgCO_3$; f—Calcium magnesium complex

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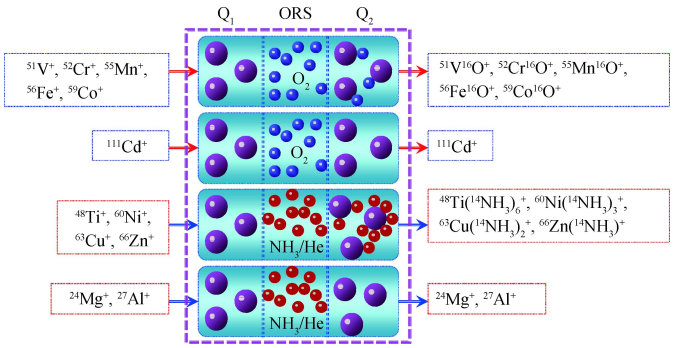
Tracing the Geographical Origin of Crude Oils Based on Inductively Coupled Plasma Tandem Mass Spectrometry Analysis of Trace Metal Elements

YANG Wenyi HAO Jing HUANG Jianhua NIE Xidu

The trace metal elements were accurately determined by ICP-MS/MS after microwave digestion in crude oils. The polyatomic interferences on the lighter mass elements were eliminated using O_2 or NH_3/He as reaction gas in the collision/reaction cell (CRC) of the ICP-MS/MS. Together with cluster analysis (CA), the origin of crude oils can be effectively traced and distinguished.



ORS—Octopole reaction system; Q_1—First quadrupole; Q_2—Second quadrupole

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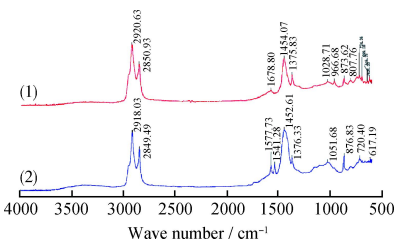
Preparation of Nano-Materials Modified Asphalt and the Dispersion Stabilization Mechanism

WANG Jia CAI Bin MA Huabao

The surfactant was used to modify the nanomaterials, forming reverse micelles on the surface of nanoparticles, improving the compatibility and stability of nanomaterials in asphalt. The results show that the high and low temperature properties and anti-aging properties of SBS asphalt with nanomaterials are enhanced.



(1) SBS-modified asphalt; (2) Nano-modified asphalt

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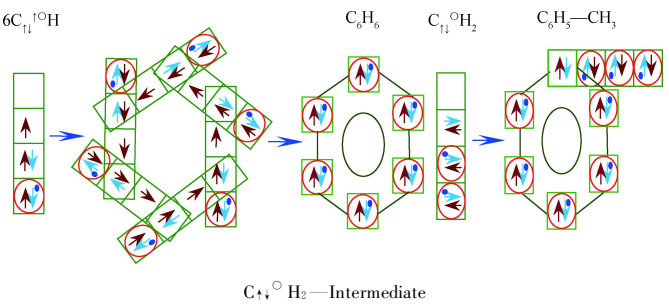
Reaction Mechanism of Aromatics Produced From Methanol and Carbon Monoxide

HE Zhenfu

Under the action of the B-acid center methanol reacts with carbon monoxide to form the intermediates $C_{\uparrow\downarrow}^{\circ}H_2$, $C_{\uparrow\downarrow}^{\uparrow\circ}H$ and $C_{\uparrow,\uparrow}^{\uparrow}H$. There are two ways to form a benzene ring. The first method is that six $C_{\uparrow\downarrow}^{\uparrow\circ}H$ structures form a benzene ring, and the second mode is that six $C_{\uparrow,\uparrow}^{\uparrow}H$ structures form a benzene ring. Benzene is coupled with one or several $C_{\uparrow\downarrow}^{\circ}H_2$ to form different structures and different carbon number aromatics.



$C_{\uparrow\downarrow}^{\circ}H_2$—Intermediate

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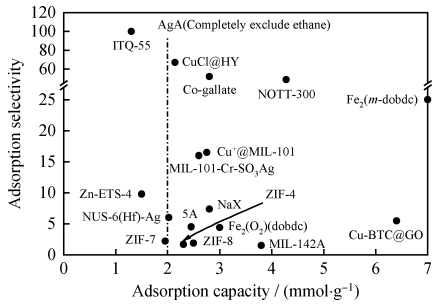
Reviews

Advances in Separation of Ethylene and Ethane With Molecular Sieve and Metal-Organic Frameworks

BIAN Qingmin XIN Mudi ZOU Kang XU Guangtong

The adsorptive separation using porous materials as adsorbents is found to be a promising energy-saving alternative in ethylene/ethane separation. The research progress of molecular sieves and metal-organic frameworks materials in the adsorptive separation of ethylene and ethane is summarized.



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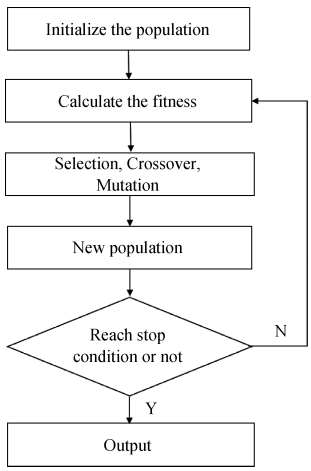
Research Progress on Application of Intelligent Optimization Algorithm and Artificial Neural Network in FCC Model Analysis

YANG Fan ZHOU Min JIN Jimin CAO Jun

Genetic algorithm is an evolutionary algorithm that searches for the best solution by simulating natural selection and biological evolution process. The solution of each optimization problem is called an individual, which is represented by a sequence of variables, i.e. a chromosome. Each value in the sequence is compared to a gene on the chromosome, and the fitness value of the individual is obtained by fitness function. The algorithm framework of GA is shown in TOC.



特约英文编审:范志明,加拿大不列颠哥伦比亚大学化学及生物工程博士,先后在加拿大自然资源部及加拿大国家研究院工作,现供职BP美国公司,研究领域包括重质油加工、石油加工过程中沥青质沉淀及石油化学等。

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