Rapid analysis of heavy oil catalytic cracking products using pyrolysis GC

(2) Analysis of short-chain hydrocarbons (C2-C6) produced by different catalysts

[Background] In the previous report (PYA1-104E), the decomposition of long-chain hydrocarbons using varied mixing ratios of heavy oil and equilibrium catalyst was described. In this report, short-chain hydrocarbons (C2 to C6) produced from heavy oil using several types of zeolite catalysts are investigated.

[Experimental] A solution prepared by dissolving direct-desulfurized heavy oil in toluene was used as a sample. A pyrolysis GC/MS system with a Multi-Shot Pyrolyzer (EGA/PY-3030D: Frontier Labs) directly interfaced to the GC injector was used for measurements. The catalyst and heavy oil sample with catalyst/heavy oil mass ratio of 18/1 was placed in a glass sample cup. Toluene was evaporated off and then the sample cup was placed into the pyrolyzer. The products formed were temporarily cryo-focused at the head of a separation column using a MicroJet Cryo-Trap (Frontier Labs) and then were subjected to GC/MS analysis. Three types of catalysts were used; equilibrium catalyst, ZSM-5 (SiO_2/Al_2O_3 ratio 150), and beta zeolite (SiO_2/Al_2O_3 ratio 300).

[Results] The chromatograms of the products formed by the reaction of heavy oil with three different catalysts are shown in Fig. 1. The formation of C2 to C6 paraffins and olefins is observed in the reaction with each of the catalysts. Apparently, propylene is predominantly produced in each case. It is found that the peak intensities of the products are overall lower with ZSM-5 catalyst than with the equilibrium catalyst or beta zeolite.

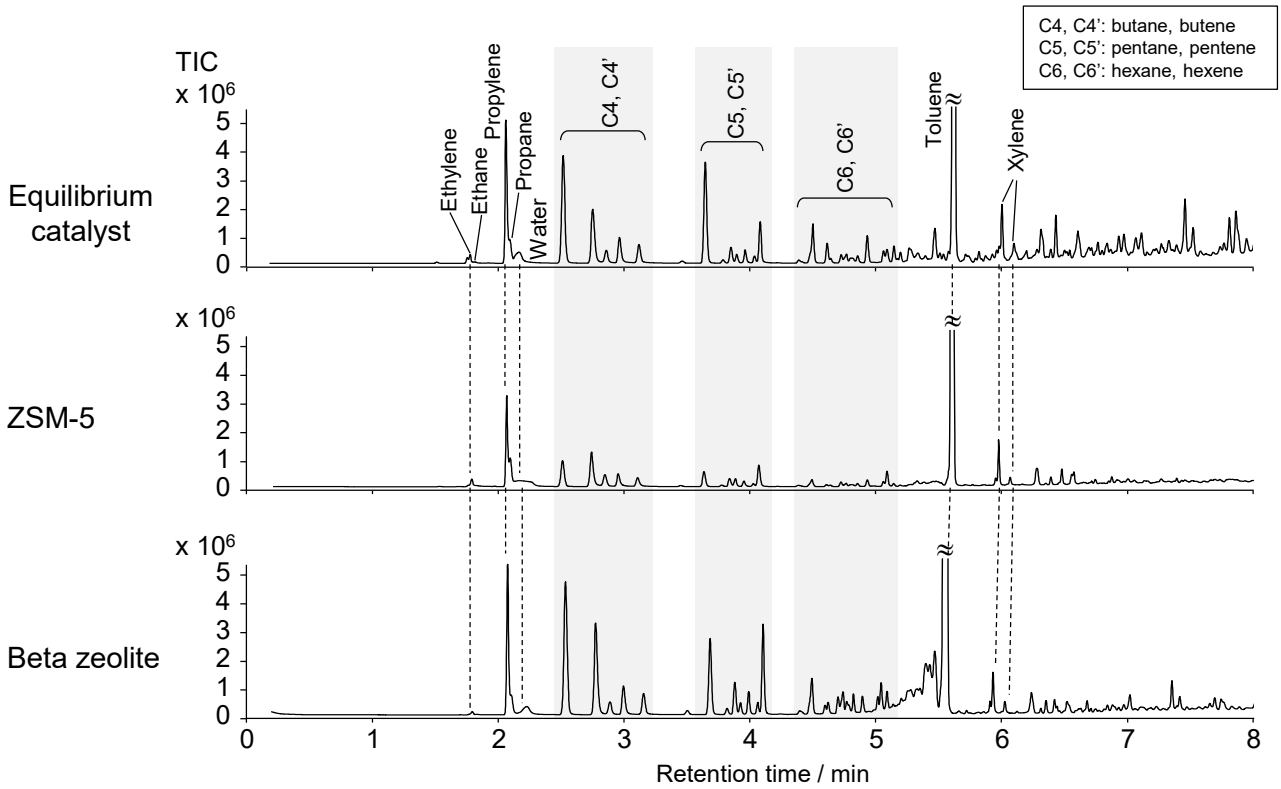

Fig. 1 Chromatograms of catalytic reaction products

Pyrolyzer furnace temp.: 500 ºC, GC injector temp.: 300 ºC, GC oven temp.: 30 (2.5 min hold) - 300 ºC (90 ºC/min, 3 min hold),
Separation column: UA$^+$-1 (dimethylpolysiloxane), *L*=30 m, i.d.=0.25 mm, df=2.0 µm
Column flow rate: 1 mL/min (He), Split ratio: 1/100, Scan range: *m/z* 10 – 200, Scan rate: 12.2 scan/sec
Sample: heavy oil ca. 0.5 mg, Catalyst: equilibrium catalyst, ZSM-5, Beta zeolite ca. 9 mg

Keywords : Heavy oil, Catalytic cracking, Catalytic reaction, GC/MS

Products used : Multi-functional pyrolyzer, MicroJet Cryo-Trap, UA$^+$-1, Vent-free GC/MS adapter, Eco-Cup GQ

Applications : Oil refining, Catalyst screening

Related technical notes : PYA1-104E

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R&D and manufactured by :

Frontier Laboratories Ltd.

Phone: (81)24-935-5100 Fax: (81)24-935-5102

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