

Catalytic fast pyrolysis of rice straws over ZSM-5 catalysts using a Tandem μ-Reactor

[Background] About 9.6 million tons of domestic rice straws are produced annually, and about 10% of them are used for feedstuff, while the remaining 90% are used as organic fertilizer or disposed by incineration. On the other hand, rice straws can be used as feedstock to obtain value-added chemicals. In this report, the gases generated by the pyrolysis of rice straws were converted into aromatic hydrocarbons over ZSM-5 catalysts with varied SiO₂/Al₂O₃ ratios, and the amounts of the produced aromatic hydrocarbons were determined.

[Experimental] For the measurement, a Rapid Catalyst Screening System with a Tandem μ-Reactor (Rx-3050TR, Frontier Labs) directly interfaced to the injector of a GC/MS system was used (Fig. 1). The rice straws were flash-pyrolyzed in the 1st Reactor, and the generated gases were fed to the 2nd Reactor and upgraded by the catalytic reaction over a catalyst packed in a quartz tube. The products were temporarily trapped at the head of the GC column using a MicroJet Cryo-Trap (MJT-1035Ex), and then subjected to GC/MS analysis. Three types of ZSM-5 catalysts with varied ratios of SiO₂/Al₂O₃ (30, 80 and 230) were used.

[Results] The pyrogram obtained by flash pyrolysis of rice straws without catalyst is shown in Fig. 2a. The chromatogram of the catalytic reaction products is shown in Fig. 2b for the catalyst with SiO₂/Al₂O₃ = 30. It is found that the yields of aromatics and BTEXs are higher as the SiO₂/Al₂O₃ ratio becomes smaller, *i.e.*, 30 > 80 > 230 (Table 1). This may be due to the difference in the acidity and hydrophobicity of the ZSM-5 catalysts.

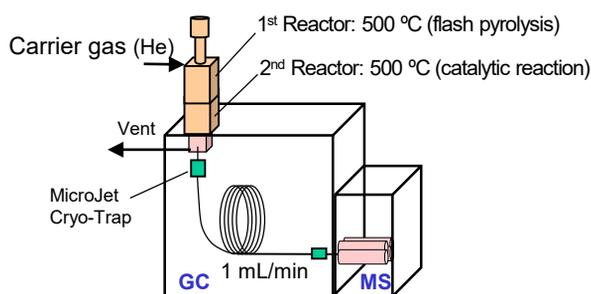


Fig. 1 Rapid Catalyst Screening System

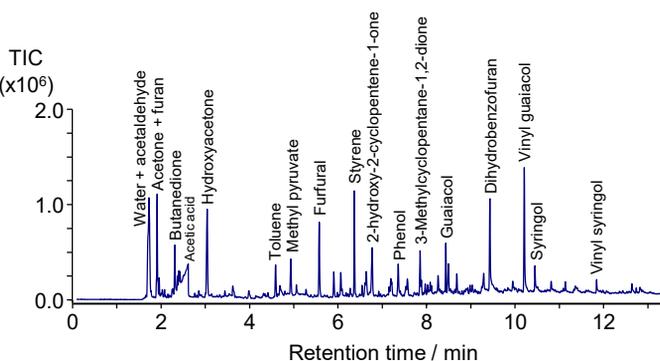
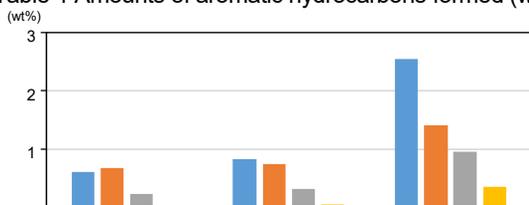


Fig. 2a Pyrogram of rice straws (no catalyst)

Table 1 Amounts of aromatic hydrocarbons formed (wt%)



	ZSM-5(230)	ZSM-5(80)	ZSM-5(30)
BTEXs	0.61	0.82	2.54
Other phenyl aromatic hydrocarbons	0.68	0.74	1.41
Naphthyl aromatic hydrocarbon	0.23	0.32	0.95
Other polycyclic aromatic hydrocarbons	0	0.05	0.35

BTEX: Benzene, Toluene, Ethylbenzene, and Xylene

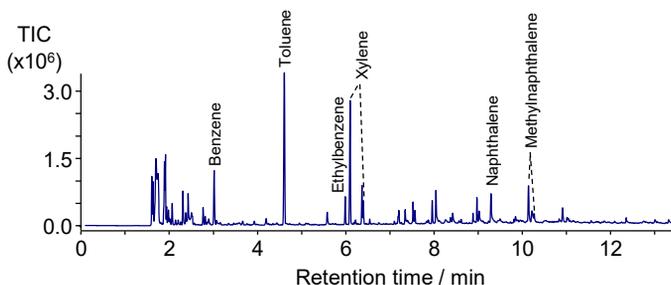


Fig. 2b Chromatogram of catalytic reaction products (ZSM-5 (30))

1st Reactor temp.: 500 °C, 2nd Reactor temp.: 500 °C, GC injector temp.: 320 °C, GC oven: 40 (2 min hold) - 320 °C (20 °C/min, 10 min hold), Separation column: UA⁺-5 (5 % diphenyl 95 % dimethylpolysiloxane), L=30 m, i.d.=0.25 mm, df=0.25 μm, Column flow rate: 1 mL/min, Split ratio: 1/200, Sample amount: Rice straws ca. 1 mg, Catalyst: ZSM-5 (SiO₂/Al₂O₃ ratios=30, 80, 230) ca.5 mg.

Keywords : Biomass, Zeolite catalyst, Catalytic reaction, Screening analysis

Products used : Tandem μ-Reactor, MicroJet Cryo-Trap, UA⁺-5, Vent free GC/MS adapter

Applications : Biomass, Catalyst screening

Related technical notes : RXA-003E

Please forward your inquiries via our webpage or send us a fax message.

R&D and manufactured by :
Frontier Laboratories Ltd.

Phone: (81)24-935-5100 Fax: (81)24-935-5102
<http://www.frontier-lab.com/>