Conversion of ethanol to ethylene using Tandem μ-Reactor GC/MS system – Part 2

[Background] Part 1 of this series of Technical Notes (RXA-001E) used the online catalytic conversion of ethanol to ethylene to illustrate how the Tandem μ-Reactor GC/MS can be used to study, real time, catalytic conversion processes. This note describes the conversion of ethanol to ethylene using a series of specific temperature steps. The reaction products formed at each temperature were analyzed by GC/MS.

[Experimental] The system configuration is the same as that used in the real time study described in RXA-001E - see Fig.1. Ethanol vapors in the carrier gas continuously flow through the 1st Reactor (100ºC isothermal). The 2nd Reactor was heated in discrete steps: 100ºC, 250ºC, 300ºC and 400ºC (Fig. 2). The reaction products present at each temperature were directed to the separation column using a Selective Sampler (SS-1010E)*1). The reaction products are trapped at the head of the GC column prior to starting the oven temperature program using a MicroJet Cryo-Trap (MJT-1035E)*2). The zeolite catalyst, H-ZSN-5 (3ϕ x 10 mm) is packed in a quartz tube located in 2nd reactor.

[Results] The chromatograms of the catalytic reaction products at each temperature are shown in Fig. 3. At 100ºC, ethanol the major component; however, as the temperature increases, the conversion to ethylene increases. Plots of the peak areas of products *vs.* temperature are shown in Fig. 4. As the temperature increases, the level of diethyl ether (DE) formed from the dehydration of ethanol increases, and reaches a maximum at 250ºC. At temperatures higher than 250ºC the concentrations of water and ethylene increase due to the dehydration of DE. This simple stepwise catalytic conversion illustrates one of the many operating modes of the Tandem μ-Reactor GC/MS system.

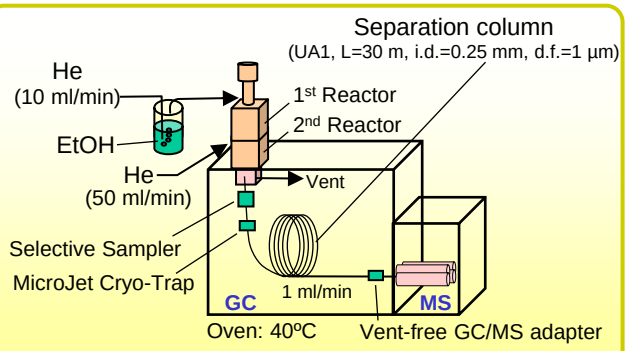

Fig. 1 Configuration of online analysis system

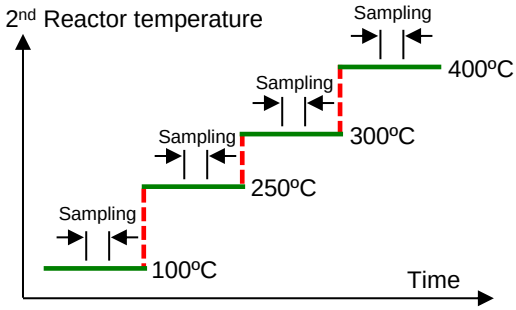

Fig. 2 Stepwise temperature mode and sample introduction to GC

1st Reactor: 100ºC; 2nd Reactor: 100, 250, 300, 400ºC Catalyst: H-ZSM-5 (20% coating on Al_2O_3, 20/30 mesh)

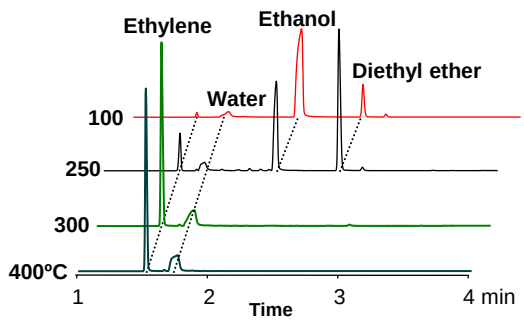

Fig. 3 Chromatograms of products formed in stepwise temperature mode.

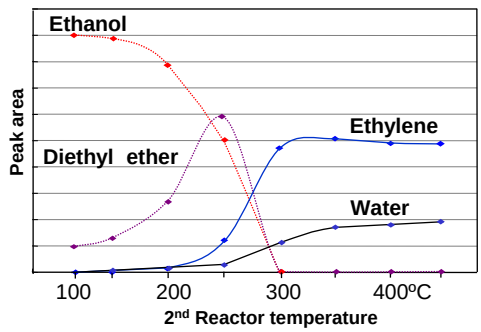

Fig. 4 Reaction temperature and peak areas of products

*1), 2) Please see the catalogue of each accessory for details.

Ref.: R. Freeman *et al.*, *J. Anal. Appl. Pyrolysis,* 111 (2015) 41-46

Keywords : Catalyst screening, Evaluation, Conversion of ethanol to ethylene

Products used : Tandem μ-Reactor, μ-Reactor, Selective Sampler, MicroJet Cryo-Trap, Vent-free GC/MS adapter, UA-1

Applications : Catalyst screening and evaluation

Related technical notes : RXT-001E, RXA-001E

Please forward your inquiries via our web page 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/