Emerging Catalytic Light Olefin Production Technologies

Na Young Kang, Won Choon Choi, Yong-Ki Park[a],*

[a]*Korea Research Institute of Chemical Technology, 141 Gajeong-ro, Yuseong-gu, Daejeon, 305-600, Republic of Korea*

**Corresponding author: Fax number: +82 42 860 7388, E-mail address: ykpark@krict.re.kr*

Abstract:

Light olefins such as ethylene and propylene are valuable starting chemicals in the industrial production of various polymer and petrochemical products including polyethylene, polypropylene and co-polymers. Conventionally, the ethylene and propylene mostly have been from steam cracking of hydrocarbon feedstock such as naphtha at high temperature range (800-900 ℃).[1] Such high temperature process in the current steam cracking requires a large amount of energy that is over 40% consumed by the entire petrochemical industry, as the reaction is highly endothermic. Therefore, an alternative process has been greatly considered to maximize energy- and resources-saving.[2]

The naphtha catalytic cracking process in fluidized reactor (K-COT™ Process) has been investigated as an alternative to steam naphtha cracking by KBR, SK Innovation, and KRICT[1)] in order to produce the light olefins at lower reaction temperature (<700 ℃). It took 15 years to commercialize and 1st commercial plant was operated the end of 2017. In this process, ZSM-5 zeolite is used a solid acid catalyst after phosphorus modification.[3] Almost equal ratio of propylene/ethylene (*i.e.* ~1) could be obtained with increase of 30% of light olefin yields at the lower reaction temperature (600~650 ℃), compared to the conventional steam cracking. This K-COT™ technology has been implemented on KBR's recognized platforms of FCC and efficient ethylene and propylene recovery systems. Nevertheless, it is indispensable to supply considerable amount of reaction energy due to the endothermic reaction and still deactivation of catalyst is a critical issue in catalytic naphtha cracking.

In this talk I would like to introduce some approaches to improve thermal stability of K-COT™ catalyst and two emerging light olefin production technologies to minimize energy consumption; one is the hybridization of catalytic cracking and MTO (Methanol To Olefin) and the other is oxidative dehydrogenation of propane by oxygen carrying catalyst.

1. Hybridization of catalytic cracking and MTO: To compensate energy consumption in endothermic cracking reaction, hybridization with exothermic MTO has been tried. Recently, our group developed a new concept of catalyst working effectively for both of catalytic cracking and MTO reactions without the production of side products such as methane and carbon monoxide[4]. It brings more than 30% energy consumption in catalytic cracking by heat neutralization of exothermic and endothermic reaction and also the thermal stability of catalyst is improved by the reduction of regeneration temperature.
2. Oxydative dehydrogenation propane with oxygen carrying catalyst: Propane dehydrogenation reaction is also one of representative high endothermic reaction. It was tried to apply an oxygen carrying catalyst to induce dehydrogenation reaction and to supply reaction energy in circulating fluidized bed reactor. It brings benefits in increase of dehydrogenation rate and efficient supply of dehydrogenation energy.

1) Korea Research Institute of Chemical Technology

2) Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian

References

1. Y. Yoshimura, N. Kijima, T. Hayakawa, K.Murata, K. Suzuki, F. Mizukami, K. Matano, T. Konishi, T. Oikawa, M. Saito, T. Shiojima, K. Shiozawa, K. Wakui, G. Sawada, K. Sato, S. Matsuo, N. Yamaoka, Catal. Surv. Jpn. 4 (2000) 157.
2. N. Rahimi, R. Karimzadeh, Appl. Catal. A 398 (2011) 1.
3. K. Kubo, H. Iida, S. Namba, A. Igarashi, J. Jpn Petrol. Inst. 61 (2018) 10.

4. N. Y. Kang, Y. K. Park, W. C. Choi, D. J. Kim, H. M. Seo, S. Park, J. H. Oh, S. C. Kang, US 2017/0253811 A1 (2017).