SPECIAL LECTURE

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Speaker

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Title

Use of zeolites in petroleum refining and petrochemical processes – Recent advances

Abstract

Zeolites and molecular sieves have revolutionized oil refining and petrochemical processes with a step change in product selectivity and operation parameters. Owing to this, emerging stringent emission norms and depleting refinery gross margins in view of volatile crude oil price and its quality, has added impetus for search of novel zeolytic materials either to improve existing zeolite based processes or to develop new and energy efficient processes to enhance the product yields and quality in oil refining and petrochemical processes, respectively. As a result, focused and sustained efforts have led to discovery of novel zeolite molecular sieves in recent time. A brief overview of such developments is given below: Fluidized Catalytic Cracking (FCC) is one of the important secondary processes primarily practiced to improve yields of gasoline, diesel, LPG distillate and C3 olefin in the presence of Zeolite Y and ZSM-5 based catalyst and additive, respectively. However, FCC gasoline lacks stability due to its high olefin content. Likewise, growing demand for light olefins enforces refiners to improve the C3 olefin yield for impr ovement in gross refinery margin. As a result, attempts have been made to improve product yield/quality against FCC operation. Thus, recently disclosed molecular sieves namely ITQ-21/17, and ITQ-13 can be envisaged to offer leverage to minimize olefin content in gasoline, and improvement in C3 yield, respectively, vis-à-vis conventional FCC catalyst and additives. Furthermore, increasing demand for middle distillate in Asia and Europe in recent time has become a driver to formulate novel zeolytic framework for diesel maximization during FCC operation. This has led to addition of ITQ-33 framework in zeolite family which offers platform to develop diesel maximization catalyst formulation for FCC operation. With an increased demand for light olefins, the need for development of energy efficient and cost effective separation of C3/C2 olefins from C3/C2 rich streams, obtained from various oil refining processes, has been envisaged to be of significant importance. In view of this, adsorptive separation of light olefin could offer a possible solution. Recent disclosure of Si-CHA, DD3R/ITQ-3, ITQ-12, and -32 molecular sieves offers significant advantage to develop adsorptive separation process for light olefin/paraffin separation. Typically, ITQ-12, Si-CHA/DD3R frameworks offer primary key for separation propane / propylene based on molecular gate effect and differential diffusion concepts, respectively. Similarly, recently reported ITQ-32 framework is found to be a

potential candidate for separation of C4 olefins based molecular gate effect principle. Likewise, demand for lube oils with high viscosity index (VI) and excellent low temperature properties has led to continuous improvement in zeolite based catalyst technology adopted in hydroisomerization of lube oil. This has not only offered improvement in process yields but also offered greater feedstock flexibility for lube oil production. As a result, molecular sieves with MTW and TON-MTT intergrowth topology are found to be promising candidates along with AEL and MTT/TON zeolite frameworks. Apart from conventional oil refining processes, alternate processes for production of transportation fuel and light olefin from alternate energy sources such as coal and natural gas are gaining significant importance in recent time.

Thus, methanol to olefin/gasoline (MTO/G) process based on SAPO-34 based catalyst has witnessed significant developments in terms of catalyst chemistry. Primarily, recent disclosure of CHA type EMM-2 and UiO-n frameworks can offer possible remedy to overcome the limitationsof SAPO-34 framework in terms of its rapid deactivation. In view of the above, it is imperative that the advent of the aforementioned molecular sieves has offered unique opportunity for not only improving the product yields and quality in processes such as catalytic cracking, oil dewaxing etc, but also offered platform to develop energy efficient processes for light olefin/paraffin separation. Thus, the entitled presentation is aimed to understand such developments in terms of novel zeolite chemistry and its structural-property aspects from oil refining point of view.
