diesel with a sustained growth in demand for petrochemicals. Demand reduction for transportation fuels can be attributed to increased motor vehicle fuel efficiency and use to alternative source of fuels such as hydrogen and chemically stored electricity (batteries and fuel cells). This lower demand for transportation fuels will result in its surplus availability in the marketplace. On the other hand, there will be growing demand for petrochemical products due to increasing population and consumer demand. Propylene is an important raw material in the production of polypropylene, acrylonitrile, propylene oxide, oxo- alcohols and a wide range of industrial products. Demand for propylene is increasing across all global regions, mainly driven by demand for polypropylene, which accounts for more than 60% of all propylene demand. The propylene market is forecast to grow by an average annual rate of 4% in the coming years.

[005] In recent years, FCC has played an increasing role in the production of propylene as a valuable by-product. Hence it is envisaged to use FCC to upgrade surplus transportation fuels such as naphtha, kerosene, diesel and oxygenates, etc., into light olefins such as propylene and ethylene. However, co-processing diesel, kerosene, and/or naphtha along with vacuum gasoil (VGO) or resid in a conventional single riser FCC is challenging because the conditions required to crack lower boiling distillates to propylene and ethylene are quite different than what is required for VGO and/or resid. If diesel is co-processed with VGO or resid in a single riser, most of the diesel will convert into Light Cycle Oil (LCO), which has a lower quality than diesel, without producing appreciable amounts of propylene. Likewise, co-processing kerosene in a single riser with VGO or Resid tends to produce primarily gasoline and (LCO).

[006] Accordingly, there is a need in the art to shift the product spectrum of FCC processes toward greater quantities of light olefins, such as propylene and ethylene.

SUMMARY

[006a] In an aspect, there is provided a process for cracking hydrocarbons using a multiple riser fluid catalytic cracking (FCC) reactor, the process comprising:

cracking a heavy hydrocarbon feed in a first riser using first FCC conditions to form a first effluent enriched in medium and/or light hydrocarbons, and

cracking one or more light and/or medium hydrocarbon feeds in two or more additional risers different than the first riser each additional riser under independently set additional FCC conditions different than the first FCC conditions to form one or more effluents enriched in light olefins,

wherein the independently set additional FCC conditions that differ from the first FCC conditions consist of temperature, residence time of one of the hydrocarbon feeds within a respective riser, partial pressure of one of the hydrocarbon feeds to the respective riser, and ratio of catalyst to one of the hydrocarbon fees within the respective riser.

[007] Disclosed herein is a process for cracking hydrocarbons using a multiple riser fluid catalytic cracking (FCC) reactor, the method comprising: cracking a heavy hydrocarbon feed in a first riser using first FCC conditions to form a first effluent enriched in medium and/or light hydrocarbons, and cracking one or more light and/or medium hydrocarbon feeds in one or more risers different than the first riser under FCC conditions different than the first FCC

conditions to form one or more effluents enriched in light olefins. According to some embodiments, the heavy feed comprises one or more hydrocarbons having an average carbon number of 18 or more. According to some embodiments, the heavy feed comprises one or more components selected from the group consisting of vacuum gas oil (VGO), reduced crudes, atmospheric tower bottoms, vacuum tower bottoms, resid, and de-asphalted oil (DAO). According to some examples, the first effluent is enriched in hydrocarbons having a carbon number of 3 to 18. According to some examples, the one or more light and/or medium hydrocarbon feeds comprise distillates. According to some examples, the one or more light and/or medium hydrocarbon feeds comprises one or more hydrocarbons having an average carbon number of 1 to 18. According to some examples, the one or more light and/or medium hydrocarbon feeds comprises one or more components selected from the group consisting of jet fuel, diesel, naphtha, kerosene, C4s, and oxygenates. According to some examples, the first FCC conditions comprise maintaining an outlet temperature of the first riser at 510 ºC to 575 ºC. According to some examples, the first FCC conditions comprise mixing steam and the heavy hydrocarbon feed in the first riser a concentration of 1 wt. % to 6 wt %. According to some examples, the FCC conditions different than the first FCC conditions comprise maintaining an outlet temperature of the one or more risers different than the first riser at 550 ºC to 675 ºC. According to some examples, the FCC conditions different than the first FCC conditions comprise mixing steam with the one or more light and/or medium hydrocarbon feeds at a concentration of 5 wt. % to 20 wt %. According to some examples, the process further comprises providing at least a portion of the first effluent to the one or more risers different than the first riser. According to some examples, providing at least a portion of the first effluent to the one or more risers different than the first riser comprises: using a fractionation system to fractionate the first effluent to yield a fractionated stream enriched in one or more of the components of the first effluent, and recycling the fractionated stream from the fractionation system to the one or more risers different than the first riser. According to some examples, the fractionated stream is enriched in one or more of naphtha and C4s. According to some examples, cracking one or more light and/or medium hydrocarbon feeds in one or more risers different than the first riser comprises: cracking a medium feed in a second riser under second FCC conditions, and cracking a light feed in a third riser under third FCC conditions different than the second FCC conditions.

According to some examples, the medium feed comprises one or more of gasoline, kerosene, jet fuel, and diesel fuel. According to some examples, the second FCC conditions comprise maintaining an outlet temperature of the first riser at 550 ºC to 675 ºC. According to some examples, the light feed comprises one or more of naphtha, C4s, and oxygenates. According to some examples, the FCC reactions in each of the risers comprise cracking using a catalyst mixture comprising a Y zeolite and a shape selective zeolite. According to some examples, the shape selective zeolite is ZSM-5.

[008] Also disclosed herein is a fluid catalytic cracking (FCC) reactor, comprising: a first riser configured to crack a heavy hydrocarbon feed and using first FCC conditions to form a first effluent enriched in medium and/or light hydrocarbons, and one or more additional risers configured to crack one or more light and/or medium hydrocarbon feeds under FCC conditions different than the first FCC conditions to form one or more effluents enriched in light olefins. According to some examples, heavy feed comprises one or more hydrocarbons having an average carbon number of 18 or more. According to some examples, the heavy feed comprises one or more components selected from the group consisting of vacuum gas oil (VGO), reduced crudes, atmospheric tower bottoms, vacuum tower bottoms, resid, and de-asphalted oil (DAO). According to some examples, the first effluent is enriched in hydrocarbons having a carbon number of 3 to 18. According to some examples, the one or more light and/or medium hydrocarbon feeds comprise distillates. According to some examples, the one or more light and/or medium hydrocarbon feeds comprises one or more hydrocarbons having an average carbon number of 1 to 18. According to some examples, the one or more light and/or medium hydrocarbon feeds comprises one or more components selected from the group consisting of jet fuel, diesel, naphtha, kerosene, C4s, and oxygenates. According to some examples, the first FCC conditions comprise maintaining an outlet temperature of the first riser at 510 ºC to 575 ºC. According to some examples, the first FCC conditions comprise mixing steam and the heavy hydrocarbon feed in the first riser a concentration of 1 wt. % to 6 wt %. According to some examples, the FCC conditions different than the first FCC conditions comprise maintaining an outlet temperature of the one or more risers different than the first riser at 550 ºC to 675 ºC. According to some examples, the FCC conditions different than the first FCC conditions comprise mixing steam and the one or more light and/or medium hydrocarbon feeds at a concentration of 5 wt.

% to 20 wt %. According to some examples, the reactor is configured to provide at least a portion of the first effluent to the one or more risers different than the first riser. According to some examples, providing at least a portion of the first effluent to the one or more risers different than the first riser comprises: using a fractionation system to fractionate the first effluent to yield a fractionated stream enriched in one or more of the components of the first effluent, and recycling the fractionated stream from the fractionation system to the one or more risers different than the first riser. According to some examples, the fractionated stream is enriched in one or more of naphtha and C4s. According to some examples, cracking one or more light and/or medium hydrocarbon feeds in one or more risers different than the first riser comprises: cracking a medium feed in a second riser under second FCC conditions, and cracking a light feed in a third riser under third FCC conditions different than the second FCC conditions. According to some examples, the medium feed comprises one or more of gasoline, kerosene, jet fuel, and diesel fuel. According to some examples, the second FCC conditions comprise maintaining an outlet temperature of the first riser at 550 ºC to 675 ºC. According to some examples, the light feed comprises one or more of naphtha, C4s, and oxygenates. According to some examples, the FCC reactions in each of the risers comprise cracking using a catalyst mixture comprising a Y zeolite and a shape selective zeolite. According to some examples, the shape selective zeolite is ZSM-5.

BRIEF DESCRIPTION OF THE DRAWINGS

[009] Figure 1 shows a multiple riser FCC reactor.

[0010] Figure 2 shows a process using a multiple riser FCC reactor.

DETAILED DESCRIPTION

[0011] Figure 1 illustrates one embodiment of a multiple-riser FCC reactor 100, as disclosed herein. The general functionality of FCC reactors are known in the art and is discussed here only briefly. Reactor 100 has three risers, 102, 104, and 106. However, other embodiments may have more or fewer risers, for example, two, four, five risers, etc. As described in more detail below, each of the risers may be configured for a different feedstock. Feedstock is provided to the first riser 102 at a first feed nozzle 114. According to some embodiments, any of the risers may comprise more than one nozzle. Catalyst is provided to the first riser at a first