[0008] Accordingly, there exists a need for processes for the production of light olefins that may reduce the necessary operating costs and capital costs (e.g., process equipment piece count).

SUMMARY OF THE DISCLOSURE

[0009] ~~In one aspect, e~~Embodiments disclosed herein relate to integration of the reaction and regeneration processes of a series of fixed bed reactor systems, where the catalyst requires regeneration with sufficient frequency.. Multiple reactors are used in a cyclic operation / regeneration cycle. In one aspect~~these embodiments~~, there is provided a process for reacting a feed stream. T~~t~~he process includes: preheating a hydrocarbon feed stream with a regeneration gas via indirect heat exchange; feeding the preheated hydrocarbon feed stream to at least one operating reactor containing a catalyst; feeding the regeneration gas to a second reactor containing a catalyst undergoing regeneration; recovering at least a portion of the regeneration gas from the second reactor; feeding the recovered regeneration gas through a heat recovery system to reheat the recovered regeneration gas; and feeding the reheated recovered regeneration gas to the preheating as the regeneration gas. In some embodiments, the regeneration gas comprises at least one of nitrogen, oxygen, and combinations thereof. In further embodiments, the second reactor regenerates catalyst by combusting the coke that has fouled the catalyst. This process provides for the elimination of separate heating systems for hydrocarbon and regeneration gas and efficiently recovers heat from the circulating regeneration gas.

[0010] In another aspect, there is provided~~embodiments disclosed herein relate to~~ a process for the production of light olefins. The process may include: feeding a hydrocarbon stream comprising C4 to C6 olefins to a cracking reaction zone comprising at least four reactors operated in a staggered reaction / regeneration cycle; contacting at least a portion of the C4 to C6 olefins with a catalyst in one or more of the reactors of the cracking reaction zone operating in a reaction cycle to crack at least a portion of the C4 to C6 olefins to form C2 to C3 olefins; recovering an effluent from the cracking reaction zone comprising the C2 to C3 olefins and unreacted C4 to C6 olefins; separating the effluent from the cracking reaction zone into at least two fractions including one or more fractions comprising at least one of C2 hydrocarbons, C3 hydrocarbons, and a combination thereof, and one or more fractions comprising at least one of C4 hydrocarbons, C5 hydrocarbons, C6 hydrocarbons, and a combination thereof; contacting the hydrocarbon stream with a regeneration gas in

indirect heat exchange to increase a temperature of the hydrocarbon stream prior to the contacting at least a portion of the C4 to C6 olefins with a catalyst in reactors of the cracking reaction zone in a reaction cycle; feeding the regeneration gas and at least one of oxygen and air to one or more of the reactors in the cracking reaction zone operating in a regeneration cycle to regenerate the catalyst contained therein; recovering a regeneration gas effluent comprising combustion products from the reactors in the cracking reaction zone in a regeneration cycle; withdrawing at least a portion of the recovered regeneration gas effluent comprising combustion products as a purge; combining at least a portion of the regeneration gas effluent with make-up nitrogen to form a mixed regeneration gas; heating the compressed mixed regeneration gas to a temperature in the range from about 600°C to about 1000°C; and feeding the heated mixed regeneration gas to the cracking reaction zone as the regeneration gas.

[0011] In another aspects, there is provided ~~embodiments disclosed herein relate to~~ a process for the production of light olefins, including: feeding hydrogen and a C4 to C6 hydrocarbon stream comprising dienes and olefins to a first reaction zone comprising a catalytic distillation reactor system containing a selective hydrogenation catalyst; concurrently in the catalytic distillation reactor system: contacting hydrogen and C4 to C6 dienes with the selective hydrogenation catalyst to selectively hydrogenate C4 to C6 dienes to form additional olefins; recovering an effluent from the catalytic distillation reactor system comprising the C4 to C6 olefins and the additional olefins; feeding at least a portion of the effluent from the catalytic distillation reactor system to a second reaction zone, wherein the second reaction zone comprises at least four reactors operated in a staggered reaction / regeneration cycle; contacting at least a portion of the effluent from the catalytic distillation reactor system with a catalyst in one or more reactors of the second reaction zone operating in a reaction cycle to crack at least a portion of the C4 to C6 olefins to form C2 to C3 olefins; recovering an effluent from the second reaction zone comprising the C2 to C3 olefins and unreacted C4 to C6 olefins; separating the effluent from the second reaction zone into at least two fractions including one or more fractions comprising at least one of C2 hydrocarbons, C3 hydrocarbons, and a combination thereof, and one or more fractions comprising at least one of C4 hydrocarbons, C5 hydrocarbons, C6 hydrocarbons, and a combination thereof; recycling at least a portion of the one

or more fractions comprising C4 hydrocarbons, C5 hydrocarbons, C6 hydrocarbons, and a combination thereof to the first reaction zone; contacting the effluent from the catalytic distillation reaction system with a regeneration gas in indirect heat exchange to increase a temperature of the effluent prior to the contacting of at least a portion of the effluent from the catalytic distillation reactor system with a catalyst in one or more reactors of the second reaction zone operating in a reaction cycle; and feeding the regeneration gas after indirect heat exchange and at least one of oxygen and air to one or more reactors in the second reaction zone operating in a regeneration cycle to regenerate the catalyst contained therein; contacting the effluent from the catalytic distillation reaction system with the effluent from the reactors operating in the reaction cycle in the second reaction zone in indirect heat exchange to increase a temperature of the effluent from the catalytic distillation reaction system prior to the contacting the effluent from the catalytic distillation reaction system indirectly with the regeneration gas; recovering a regeneration gas effluent comprising combustion products from the reactors in the second reaction zone in a regeneration cycle; withdrawing at least a portion of the recovered regeneration gas effluent comprising combustion products as a purge; combining at least a portion of the regeneration gas effluent with make-up nitrogen to form a mixed regeneration gas; compressing the mixed regeneration gas; contacting the regeneration gas effluent in indirect heat exchange with the compressed mixed regeneration gas; heating the compressed mixed regeneration gas to a temperature in the range from about 600°C to about 1000°C; and feeding the heated mixed regeneration gas to the second reaction zone as the regeneration gas.

[0012] In another aspects, there is provided ~~embodiments disclosed herein relate to~~ a process for the production of light olefins, including: feeding hydrogen and a C5 hydrocarbon stream comprising C5 dienes, C5 olefins and cyclopentadiene to a first reaction zone comprising a catalytic distillation reactor system containing a selective hydrogenation catalyst; concurrently in the catalytic distillation reactor system: contacting hydrogen and C5 dienes with the selective hydrogenation catalyst to selectively hydrogenate C5 dienes to form additional olefins and hydrogenate at least a portion of the cyclopentadiene to cyclopentene; recovering an effluent from the catalytic distillation reactor system comprising the C5 olefins and the additional olefins; recovering a bottoms fraction from the catalytic distillation reactor system