Claims

1. A process for producing light olefins, comprising:

contacting an alkane feedstock and a catalyst to conduct a dehydrogenation reaction in one or more dehydrogenation reactors at a dehydrogenation reaction pressure P of 0.6-6 MPa and a volume space velocity H of 100-5000h^{-1};

producing a light olefins-rich hydrocarbon and a spent catalyst from the one or more dehydrogenation reactors;

transporting at least a portion of the spent catalyst to a regeneration reactor to obtain a regenerated catalyst; and

circulating at least a portion of the regenerated catalyst to the one or more dehydrogenation reactors, wherein the dehydrogenation reaction pressure P in the one or more dehydrogenation reactors is at least 0.3 MPa higher than a pressure in the regeneration reactor.

2. The process according to claim 1, wherein during the dehydrogenation reaction, H and P satisfy a mathematical function of H = f(P), which is a strictly increasing function, wherein P varies from 0.6 MPa to 6 MPa and H varies from 100h^{-1} to 1000h^{-1}.

3. The process according to claim 1, wherein each of the one or more dehydrogenation reactors is independently chosen from a fluidized bed reactor, a dense bed reactor, a riser reactor, or an ebullated bed reactor.

4. The process according to claim 1, wherein the alkane feedstock comprises at least one of C2-C12 straight-chain or branched alkanes, or is selected from the group consisting of natural gas condensate, natural gas liquid, catalytic cracking liquefied gas, oil field gas condensate, shale gas condensate, straight-run naphtha, shale oil light constituent, hydrogenated naphtha, coker gasoline, cracking gasoline, and a mixture thereof.

5. The process according to claim 1, wherein the catalyst is a dehydrogenation catalyst, a cracking catalyst, or a dehydrogenation/cracking composite catalyst.

6. The process according to claim 1, wherein the regeneration reactor is maintained at a temperature of 550-750°C, a pressure of 0.1-0.5 MPa, a spent catalyst residence time of 5-60 minutes, and in an oxygen-containing atmosphere.

7. The process according to claim 1, wherein the spent catalyst is separated from the light olefins-rich hydrocarbon using a filter.

8. The process according to claim 1, wherein the transporting and the circulating are respectively performed via one or more lock hoppers.

9. The process according to claim 1, wherein, with the proviso that size and amount of reactors for the dehydrogenation reaction are kept the same, the process enables to increase an output of light olefins by 50% or higher compared to a dehydrogenation reaction conducted at a pressure and a volume space velocity outside of the dehydrogenation reaction pressure and the volume space velocity recited in claim 1.

10. The process according to claim 1, further comprising a step of circulating an unconverted alkane feedstock to the one or more dehydrogenation reactors.

11. The process according to claim 1, comprising:

continuously contacting a preheated alkane feedstock and the catalyst in the one or more dehydrogenation reactors to produce the light olefins-rich hydrocarbon and the spent catalyst;

separating the light olefins-rich hydrocarbon to a product separation-recovery system;

continuously withdrawing the spent catalyst from the one or more dehydrogenation reactors;

transporting the spent catalyst withdrawn from the one or more dehydrogenation reactors to a spent catalyst receiver, then to a spent catalyst feeding tank via a first lock hopper, then to the regeneration reactor from the spent catalyst feeding tank;

regenerating the spent catalyst in an oxygen-containing atmosphere in the regeneration reactor to produce the regenerated catalyst;

continuously withdrawing the regenerated catalyst from the regeneration reactor;

sending the regenerated catalyst to a regenerated catalyst receiver, then to a regenerated catalyst feeding tank via a second lock hopper; and

further sending the regenerated catalyst to the one or more dehydrogenation reactors from the regenerated catalyst feeding tank.

12. The process according to claim 1, wherein the dehydrogenation reaction pressure P is 0.6-2 MPa and the volume space velocity H is 500-1000 h^{-1}.

13. The process according to claim 1, wherein the dehydrogenation reaction pressure P in the one or more dehydrogenation reactors is at least 2.0 MPa higher than the pressure in the regeneration reactor.

14. The process according to claim 3, wherein each of the one or more dehydrogenation reactors is independently chosen from a bubbling fluidized bed reactor or a turbulent fluidized bed reactor.

15. The process according to claim 4, wherein the C2-C12 straight-chain or branched alkanes comprise propane and isobutane.

16. The process according to claim 6, wherein the regeneration reactor is maintained at a temperature of 600-700° C., a pressure of 0.1-0.3 MPa, a spent catalyst residence time of 6-20 minutes, and is maintained in air or oxygen atmosphere.

17. The process according to claim 8, wherein the transporting and the circulating are independently implemented using one or two lock hoppers.

18. The process according to claim 9, wherein the process enables to increase the output of light olefins by 100%, compared to a dehydrogenation reaction conducted at a pressure and a volume space velocity outside of the dehydrogenation reaction pressure and the volume space velocity recited in claim 1.