CLAIMS

What is claimed is:

1. A method of converting undistilled and unfractionated hydrocarbon material into a hydrocarbon product using a direct catalytic cracking system, the method comprising the steps of: introducing a moving bed reactor feed into a moving catalyst bed reactor of the direct catalytic cracking system such that the moving bed reactor feed intermingles with a direct cracking catalyst contained in a catalytic reaction zone within the moving catalyst bed reactor, where the moving bed reactor feed comprises steam and an undistilled and unfractionated hydrocarbon material; introducing the direct cracking catalyst into the catalytic reaction zone of the moving catalyst bed reactor; and operating the direct catalytic cracking system such that an internal temperature profile is maintained along an operative length of the moving catalyst bed reactor, such that a moving catalyst bed comprising the direct cracking catalyst is maintained in the catalytic reaction zone, such that the hydrocarbon material converts in the presence of the direct cracking catalyst into a product hydrocarbon and the direct cracking catalyst converts into a spent direct cracking catalyst in the catalytic reaction zone, such that the spent direct cracking catalyst passes from the catalytic reaction zone to a catalyst regeneration system, and such that the hydrocarbon product is produced from the moving catalyst bed reactor, the hydrocarbon product comprising light olefins and C6-8 aromatics; where the direct catalytic cracking system includes the moving catalyst bed reactor and the catalyst regeneration system, and where the moving catalyst bed reactor has the catalyst reaction zone and is operable to maintain the internal temperature profile for the moving catalyst bed reactor along its operative length.

2. The method of claim 1 where the weight ratio of steam to the hydrocarbon material is in a range of from 0.1 to 2.

3. The method of claim 1 or claim 2 where the moving bed reactor feed further comprises oxygen.

4. The method of any one of claims 1 to 3 where the moving bed reactor feed further comprises hydrogen.

5. The method of any one of claims 1 to 4 where the moving bed reactor feed further comprises recyclable hydrocarbon material, where the weight ratio of recyclable hydrocarbon material to hydrocarbon material is in a range of from 0.1 to 0.75.

6. The method of claim 5 where the recyclable hydrocarbon material comprises product hydrocarbon, and where the weight ratio of product hydrocarbon to hydrocarbon material is in a range of from 0.2 to 0.75.

7. The method of any one of claims 1 to 6 where the weight ratio of light olefins to C6-8 aromatics in the hydrocarbon product is in a range of from 2 to 20.

8. The method of any one of claims 1 to 7 where the light olefins include both ethylene and propylene and where the weight ratio of ethylene to propylene in the hydrocarbon product is in a range of from 1:5 to 5:1.

9. The method of any one of claims 1 to 8 where the internal temperature profile is maintained as a temperature gradient between a position of introduction for the moving bed reactor feed and a position of passing for the hydrocarbon product, where the lowest temperature in the temperature gradient is proximate to the position of introduction and the highest temperature is proximate to the position of passing.

10. The method of claim 9 where the temperature gradient is fixed and constant along the operative length of the moving catalyst bed reactor, where the lowest temperature of the temperature gradient is at the position of introduction for the moving bed reactor feed and the highest temperature of the temperature gradient is at the position of passing for the hydrocarbon product.

11. The method of any one of claims 1 to 8 where the internal temperature profile is maintained as more than one fixed temperature zone between a position of introduction for the moving bed reactor feed and a position of passing for the hydrocarbon product, where a first fixed temperature zone having a first temperature is positioned proximate to the position of introduction and a second fixed temperature zone having a second temperature is positioned proximate to the position of passing, and where the second temperature is greater than the first temperature.

12. The method of claim 11 where the second temperature is the highest temperature and the first temperature is the lowest temperature along the operating length of the reactor.

13. A direct catalytic cracking system that is operable to convert an undistilled and unfractionated hydrocarbon material into a hydrocarbon product comprising a mixture of light olefins and C6-8 aromatics using a direct cracking catalyst, the direct catalytic cracking system comprising: a moving catalyst bed reactor that is operable to receive a moving bed reactor feed comprising the undistilled and unfractioned hydrocarbon material and to pass a

hydrocarbon product comprising a mixture of light olefins and C6-8 aromatics, that has a catalytic reaction zone, where the catalytic reaction zone is operable to receive the direct cracking catalyst, to contain an amount of the direct cracking catalyst in the form of a moving catalyst bed and to pass a spent direct cracking catalyst such that it egresses from the moving catalyst bed reactor, that is operable to permit the intermingling of hydrocarbons with the direct cracking catalyst in the moving catalyst bed along at least a portion of the operative length of the moving catalyst bed reactor, and that is operable to maintain an internal temperature profile for the moving catalyst bed reactor along its operative length; and a catalyst regeneration system that couples to the moving catalyst bed reactor such that the direct catalytic cracking system is operable to introduce the direct cracking catalyst from the catalyst regeneration system to the catalytic reaction zone and is operable to introduce the spent direct cracking catalyst from the catalytic reaction zone to the catalyst regeneration system, and that is operable to convert introduced the spent direct cracking catalyst into the direct cracking catalyst using a source of oxygen.

14. The direct catalytic cracking system of claim 13 where the internal temperature profile is a temperature gradient along the operating length of the moving catalyst bed reactor.

15. The direct catalyst cracking system of claim 14 where the temperature gradient is a fixed temperature gradient.

16. The direct catalytic cracking system of claim 13 where the internal temperature profile has more than one fixed temperature zones along the operating length of the moving catalyst bed reactor.

17. The direct catalytic cracking system of any one of claims 13 to 15 where each catalytic reaction zone within the moving catalyst bed reactor is associated with a fixed temperature zone.

18. The direct catalytic cracking system any one of claims 13 to 16 where the moving catalyst bed reactor is further operable to pass hydrocarbons from a first portion of the moving catalyst bed reactor to a second portion of the moving catalyst bed reactor, where the second portion is more proximate to the position where the moving bed reactor feed is introduced than the first position.

19. The direct catalytic cracking system of claim 18 where the first portion has a first temperature and the second portion has a second temperature, and where the first temperature is maintained at a greater temperature than the second temperature.

20. The direct catalytic cracking system any one of claims 13 to 19 where the system is operable to introduce a portion of the hydrocarbon product to the moving bed reactor as part of the moving bed reactor feed.

CLAIMS

1. A method of converting undistilled and unfractionated crude oil into a hydrocarbon product using a system comprising a moving catalyst bed and a catalyst regeneration system, the method comprising the steps of:

introducing a moving bed reactor feed into a moving catalyst bed reactor of the system such that the moving bed reactor feed intermingles with a cracking catalyst contained in a catalytic reaction zone within the moving catalyst bed reactor, where the moving bed reactor feed comprises steam and an undistilled and unfractionated hydrocarbon material;

introducing the cracking catalyst into the catalytic reaction zone of the moving catalyst bed reactor; and

operating the system such that an internal temperature profile is maintained along an operative length of the moving catalyst bed reactor, such that a moving catalyst bed comprising the cracking catalyst is maintained in the catalytic reaction zone, such that the hydrocarbon material converts in the presence of the cracking catalyst into the hydrocarbon product and the cracking catalyst converts into a spent cracking catalyst in the catalytic reaction zone, such that the spent cracking catalyst passes from the catalytic reaction zone to a catalyst regeneration system, and such that the hydrocarbon product is produced from the moving catalyst bed reactor, the hydrocarbon product comprising light olefins and C6-C8 aromatics;

where the system includes the moving catalyst bed reactor and the catalyst regeneration system, and

where the moving catalyst bed reactor comprises several internal perforated collection funnels and the catalyst reaction zone and is operable to maintain the internal temperature profile for the moving catalyst bed reactor along its operative length.

2. The method of claim 1 where the weight ratio of steam to the hydrocarbon material is in a range of from 0.1 to 2.

3. The method of claim 1 or claim 2 where the moving bed reactor feed further comprises oxygen.

4. The method of any one of claims 1 to 3 where the moving bed reactor feed further comprises hydrogen.

5. The method of any one of claims 1 to 4 where the moving bed reactor feed further comprises recyclable hydrocarbon material, where the weight ratio of recyclable hydrocarbon material to hydrocarbon material is in a range of from 0.1 to 0.75.

6. The method of claim 5 where the recyclable hydrocarbon material comprises product hydrocarbon, and where the weight ratio of product hydrocarbon to hydrocarbon material is in a range of from 0.2 to 0.75.

7. The method of any one of claims 1 to 6 where the weight ratio of light olefins to C6-C8 aromatics in the hydrocarbon product is in a range of from 2 to 20.

8. The method of any one of claims 1 to 7 where the light olefins include both ethylene and propylene and where the weight ratio of ethylene to propylene in the hydrocarbon product is in a range of from 1:5 to 5:1.

9. The method of any one of claims 1 to 8 where the internal temperature profile is maintained as a temperature gradient between a position of introduction for the moving bed reactor feed and a position proximate to the highest temperature in the temperature gradient, where the lowest temperature in the temperature gradient is proximate to the position of introduction.

10. The method of claim 9 where the temperature gradient is fixed and constant along the operative length of the moving catalyst bed reactor, where the lowest temperature of the temperature gradient is at the position of introduction for the moving bed reactor feed and the highest temperature of the temperature gradient is at the position of passing for the hydrocarbon product.

11. The method of any one of claims 1 to 8 where the internal temperature profile is maintained as more than one fixed temperature zone between a position of introduction for the moving bed reactor feed and a position of passing for the hydrocarbon product, where a first fixed temperature zone having a first temperature is positioned proximate to the position of introduction and a second fixed temperature zone having a second temperature is positioned proximate to the position of passing, and where the second temperature is greater than the first temperature.

12. The method of claim 11 where the second temperature is the highest temperature and the first temperature is the lowest temperature along the operating length of the reactor.

13. A system that is operable to convert an undistilled and unfractionated crude oil into a hydrocarbon product comprising a mixture of light olefins and C6-C8 aromatics using a cracking catalyst, the catalytic cracking system comprising:

a moving catalyst bed reactor that is operable to receive a moving bed reactor feed comprising the undistilled and unfractioned crude oil and to pass the hydrocarbon product comprising the mixture of light olefins and C6-C8 aromatics, that has a catalytic reaction zone, where the catalytic reaction zone is operable to receive the cracking catalyst, to contain an amount of the cracking catalyst in the form of a moving catalyst bed and to pass a spent cracking catalyst such that it egresses from the moving catalyst bed reactor, that is operable to permit the intermingling of hydrocarbons with the cracking catalyst in the moving catalyst bed along at least a portion of the operative length of the moving catalyst bed reactor, and that is operable to maintain an internal temperature profile for the moving catalyst bed reactor along its operative length; and a catalyst regeneration system that couples to the moving catalyst bed reactor such that the system is operable to introduce the cracking catalyst from the catalyst regeneration system to the catalytic reaction zone and is operable to introduce the spent cracking catalyst from the catalytic reaction zone to the catalyst regeneration system, and that is operable to convert introduced the spent cracking catalyst into the cracking catalyst using a source of oxygen, wherein the moving catalyst bed reactor comprises several internal perforated collection funnels.

14. The system of claim 13 where the internal temperature profile is a temperature gradient along the operating length of the moving catalyst bed reactor.

15. The system of claim 14 where the temperature gradient is a fixed temperature gradient.

16. The system of claim 13 where the internal temperature profile has more than one fixed temperature zones along the operating length of the moving catalyst bed reactor.

17. The system of any one of claims 13 to 15 where each catalytic reaction zone within the moving catalyst bed reactor is associated with a fixed temperature zone.

18. The system any one of claims 13 to 16 where the moving catalyst bed reactor is further operable to pass hydrocarbons from a first portion of the moving catalyst bed reactor to a second portion of the moving catalyst bed reactor, where the second portion is more proximate to the position where the moving bed reactor feed is introduced than the first position.

19. The system of claim 18 where the first portion has a first temperature and the second portion has a second temperature, and where the first temperature is maintained at a greater temperature than the second temperature.

20. The system any one of claims 13 to 19 where the system is operable to introduce a portion of the hydrocarbon product to the moving bed reactor as part of the moving bed reactor feed.