

CLAIMS

1. A process for upgrading heavy oil, the process comprising:
 - removing at least a portion of metals from the heavy oil in a hydrodemetalization reaction zone to form a hydrodemetalization reaction effluent;
 - removing at least a portion of metals and at least a portion of nitrogen from the hydrodemetalization reaction effluent in a transition reaction zone to form a transition reaction effluent, where the transition reaction zone is positioned downstream of the hydrodemetalization reaction zone;
 - removing at least a portion of nitrogen from the transition reaction effluent in a hydrodenitrogenation reaction zone to form a hydrodenitrogenation reaction effluent, where the hydrodenitrogenation reaction zone is positioned downstream of the transition reaction zone;
 - reducing aromatics content in the hydrodenitrogenation reaction effluent in a hydrocracking reaction zone to form an upgraded fuel, where:
 - the hydrocracking reaction zone is positioned downstream of the hydroprocessing reaction zone;
 - the hydrocracking reaction zone comprises a hydrocracking catalyst comprising a mesoporous zeolite and one or more metals, where the mesoporous zeolite has an average pore size of from 2 nm to 50 nm; and
 - the aromatics content is reduced in the hydrodenitrogenation reaction effluent in the hydrocracking reaction zone by contacting the hydrodenitrogenation reaction effluent with the hydrocracking catalyst.
2. The process of claim 1, where the hydrocracking catalyst comprises tungsten and nickel.
3. The process of claim 1, where the hydrocracking catalyst comprises molybdenum and nickel.

4. The process of claim 1, where the heavy oil comprises crude oil, where the crude oil has an American Petroleum Institute (API) gravity of from 25 degrees to 50 degrees.
5. The process of claim 1, further comprising processing the upgraded fuel to form one or more petrochemical fractions.
6. A process for upgrading heavy oil, the process comprising:
introducing a stream comprising the heavy oil to a hydrodemetalization reaction zone comprising hydrodemetalization catalyst;
10 removing at least a portion of metals from the heavy oil in a hydrodemetalization reaction zone to form a hydrodemetalization reaction effluent;
passing the hydrodemetalization reaction effluent from the hydrodemetalization reaction zone to a transition reaction zone comprising a transition catalyst;
removing at least a portion of metals and a portion of nitrogen from the hydrodemetalization reaction effluent in the transition reaction zone to form a transition
15 reaction effluent;
passing the transition reaction effluent from the transition reaction zone to a hydrodenitrogenation reaction zone comprising a hydrodenitrogenation catalyst;
removing at least a portion of nitrogen from the transition reaction effluent in the
20 hydrodenitrogenation reaction zone to form a hydrodenitrogenation reaction effluent;
passing the hydrodenitrogenation reaction effluent to a hydrocracking reaction zone comprising a hydrocracking catalyst, where the hydrocracking catalyst comprises a mesoporous zeolite and one or more metals, where the mesoporous zeolite has an average pore size of from 2 nm to 50 nm; and
25 reducing aromatics content in the hydrodenitrogenation reaction effluent in the hydrocracking reaction zone to form an upgraded fuel.
7. The process of claim 6, where the hydrocracking catalyst comprises tungsten and nickel.

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8. The process of claim 6, where the hydrocracking catalyst comprises molybdenum and nickel.

9. The process of claim 6, where the heavy oil comprises crude oil, where the crude
5 oil has an American Petroleum Institute (API) gravity of from 25 degrees to 50 degrees.

10. The process of claim 6, further comprising processing the upgraded fuel to form one or more petrochemical fractions, where the processing of the upgraded fuel comprises a hydrocracking process, fluid catalytic cracking, or both.

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11. A process for upgrading heavy oil, the process comprising:

removing at least a portion of metals from the heavy oil in a hydrodemetalization reaction zone to form a hydrodemetalization reaction effluent;

removing at least a portion of metals and at least a portion of nitrogen from the
15 hydrodemetalization reaction effluent in a transition reaction zone to form a transition reaction effluent, where the transition reaction zone is positioned downstream of the hydrodemetalization reaction zone;

removing at least a portion of nitrogen from the transition reaction effluent in a hydrodenitrogenation reaction zone to form a hydrodenitrogenation reaction effluent,

20 where:

the hydrodenitrogenation reaction zone is positioned downstream of the transition reaction zone; and

the hydrodenitrogenation reaction zone comprises a hydrodenitrogenation catalyst comprising one or more metals on an alumina support, the alumina support having an averages pore size of from 25 nm to 50
25 nm; and

and the nitrogen is removed from the transition reaction effluent in the hydrodenitrogenation reaction zone by contacting the transition reaction effluent with the hydrodenitrogenation catalyst; and

reducing aromatics content in the hydrodenitrogenation reaction effluent in a hydrocracking reaction zone by to form an upgraded fuel, where the hydrocracking reaction zone is positioned downstream of the hydrodenitrogenation reaction zone.

5 12. The process of claim 11, where aromatic content is reduced in the transition reaction effluent in the hydrodenitrogenation reaction zone.

13. The process of claim 11, where the hydrodenitrogenation catalyst comprises molybdenum, nickel, or both.

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14. The process of claim 11, where the hydrodenitrogenation catalyst comprises molybdenum and nickel.

15. The process of claim 11, where the heavy oil comprises crude oil, where the
15 crude oil has an American Petroleum Institute (API) gravity of from 25 degrees to 50 degrees.

16. The process of claim 11, further comprising processing the upgraded fuel to form one or more petrochemical fractions.

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17. The process of claim 11, where the hydrocracking catalyst comprises a mesoporous zeolite and one or more metals, where the mesoporous zeolite has an average pore size of from 2 nm to 50 nm.

25 18. A process for upgrading heavy oil, the process comprising:
 introducing a stream comprising the heavy oil to a hydrodemetalization reaction zone comprising hydrodemetalization catalyst;
 removing at least a portion of metals from the heavy oil in a hydrodemetalization reaction zone to form a hydrodemetalization reaction effluent;

passing the hydrodemetalization reaction effluent from the hydrodemetalization reaction zone to a transition reaction zone comprising a transition catalyst;

removing at least a portion of metals and a portion of nitrogen from the hydrodemetalization reaction effluent in the transition reaction zone to form a transition
5 reaction effluent;

passing the transition reaction effluent from the transition reaction zone to a hydrodenitrogenation reaction zone comprising a hydrodenitrogenation catalyst, where the hydrodenitrogenation catalyst comprises one or more metals on an alumina support, the alumina support having an average pore size of from 25 nm to 50 nm;

10 removing at least a portion of nitrogen from the transition reaction effluent in the hydrodenitrogenation reaction zone to form a hydrodenitrogenation reaction effluent;

passing the hydrodenitrogenation reaction effluent to a hydrocracking reaction zone comprising a hydrocracking catalyst; and

reducing aromatics content in the hydrodenitrogenation reaction effluent in the
15 hydrocracking reaction zone to form an upgraded fuel, where the hydrocracking reaction zone comprises a hydrocracking catalyst.

19. The process of claim 18, where the hydrodenitrogenation catalyst comprises molybdenum and nickel.

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20. The process of claim 18, wherein the hydrocracking catalyst comprises a zeolite and one or more metals.

21. The process of claim 18, where the hydrocracking catalyst comprising a
25 mesoporous zeolite and one or more metals, where the mesoporous zeolite has an average pore size of from 2 nm to 50 nm.

22. The process of claim 18, where the heavy oil comprises crude oil, where the crude oil has an American Petroleum Institute (API) gravity of from 25 degrees to 50
30 degrees.