CLAIMS

1. An integrated upgrading process for upgrading a heavy oil, the process comprising the steps of:

introducing the heavy oil to a visbreaker unit;

processing the heavy oil in the visbreaker unit to produce a visbreaker product stream;

feeding the visbreaker product stream to a fractionator;

separating the visbreaker product stream in the fractionator to produce a bottoms stream, a gas oil stream, a naphtha stream, and a gas product stream;

feeding the entirety of the bottoms stream to a supercritical water unit; and

feeding a water feed to the supercritical water unit, wherein a ratio of the volumetric flow rate of bottoms stream to water feed is in the range between 1:4 and 1:2 at standard ambient temperature and ambient pressure (SATP), and

processing the bottoms stream and the water feed in the supercritical water unit to produce an upgraded bottoms stream, wherein conversion reactions occur in a supercritical water reactor such that upgraded bottoms stream is upgraded relative to the bottoms stream.

2. The integrated upgrading process of claim 1, wherein the heavy oil is selected from the group consisting of a vacuum residue, an atmospheric residue, a fluid catalytic cracking clarified slurry oil having a T5% cut point of greater than 600 deg F, a naphtha steam cracker pyrolysis fuel oil, and residue streams.

3. The integrated process of claim 1, wherein the fractionator comprises a separator that separates based on boiling point.

4. The integrated process of claim 1, wherein the gas oil stream comprises hydrocarbons with a T95% cut point of 600 deg F.

5. The integrated process of claim 1, wherein the naphtha stream comprises hydrocarbons with a T95% cut point of 350 deg F.

6. The integrated process of claim 1, wherein the visbreaker unit comprises a furnace, wherein the furnace operates at a temperature in a range between 400 deg C and 500 deg C.

7. The integrated process of claim 1, wherein the supercritical water unit comprises a supercritical water reactor, wherein the supercritical water reactor can operate a temperature in a range between 380 deg C and 600 deg C.

8. The integrated process of claim 1, further comprising the steps of:

introducing the upgraded bottoms stream to a bottoms separator; and

separating the upgraded bottoms stream in the bottoms separator to produce a resid fraction.

9. The integrated process of claim 8, wherein the resid fraction comprises hydrocarbons having a T5% cut point in a range between 600 deg F and 1050 deg F.

10. The integrated process of claim 8, further comprising the steps of:

mixing the resid fraction and the heavy oil to produce a mixed feed stream; and

introducing the mixed feed stream to the visbreaker unit.

11. The integrated process of claim 8, further comprising the steps of:

mixing the resid fraction and a hydrogen donor stream to produce a mixed resid fraction;

mixing the mixed resid fraction and the heavy oil to a produce hydrogen mixed feed stream; and

introducing the hydrogen mixed feed stream to the visbreaker unit.

12. The integrated process of claim 11, wherein the hydrogen donor stream is selected from the group consisting of an FCC clarified slurry oil, a hydrocracker bottom, and a steam cracker bottom.

13. The integrated process of claim 1, further comprising the steps of:

mixing a cutterstock stream and the bottoms stream to produce a mixed bottom fraction; and

introducing the mixed bottom fraction to the supercritical water unit.

14. The integrated process of claim 13, wherein the cutterstock stream is selected from the group consisting of straight run gas oil, FCC light cycle oil having an aromatic content of greater than 40 wt%, a naphtha-containing stream, and a gas oil-containing stream.

15. The integrated process of claim 13, wherein the mixed bottom fraction has a viscosity of less than 800 cSt at 122 deg F.

16. An integrated method for upgrading a heavy oil, the method comprising the steps of:

introducing the heavy oil to a supercritical water unit, wherein the supercritical water unit comprises a supercritical water reactor;

processing the heavy oil in the supercritical water unit to produce an upgraded heavy oil, wherein the supercritical water reactor operates at a temperature in the range between 390 deg C. and 450 deg C. and a pressure of greater than the critical pressure of water;

introducing the entirety of the upgraded heavy oil to a visbreaker unit;

processing the upgraded heavy oil in the visbreaker unit to produce a visbreaker effluent stream;

introducing the visbreaker effluent stream to a fractionator; and

separating the visbreaker effluent stream in the fractionator to produce a bottoms stream.

17. The integrated method of claim 16, wherein the heavy oil is selected from the group consisting of a vacuum residue, an atmospheric residue, a fluid catalytic cracking clarified slurry oil having a T5% cut point of greater than 600 deg F, a naphtha steam cracker pyrolysis fuel oil, and residue streams.

18. A method for upgrading a heavy oil, the method comprising the steps of:

introducing the heavy oil to a supercritical water unit, wherein the supercritical water unit comprises a supercritical water reactor;

processing the heavy oil in the supercritical water unit to produce an upgraded heavy oil, wherein the supercritical water reactor operates a temperature in the range between 390 deg C. and 450 deg C. and a pressure of greater than the critical pressure of water;

mixing the entirety of the upgraded heavy oil with the entirety of a visbreaker product to produce a mixed product stream;

introducing the mixed product stream to a fractionator;

separating the mixed product stream in the fractionator to produce a bottom fraction;

separating a bottom split stream from the bottom fraction;

introducing a bottom fraction to a visbreaker unit; and

processing the bottom fraction in the visbreaker unit to produce the visbreaker product.

19. The method of claim 18, wherein the heavy oil is selected from the group consisting of a vacuum residue, an atmospheric residue, a fluid catalytic cracking clarified slurry oil having a T5% cut point of greater than 600 deg F, a naphtha steam cracker pyrolysis fuel oil, and residue streams.