CLAIMS

What is claimed is:

1. A process for the membrane-based separation of a mixture of close-boiling hydrocarbon components, said process comprising the steps of:

feeding a feed stream comprising the mixture of close-boiling hydrocarbon components to a first membrane stage at a temperature and a pressure above a critical point of the mixture;

extracting a first permeate stream from the first membrane stage; and

extracting a first non-permeate stream from the first membrane stage.

2. The process of claim 1, the process further comprising the step of cooling the first permeate stream to produce a liquid product.

3. The process of claims 1or 2, wherein the feed stream and the first non-permeate stream each has a density and the ratio of the density of the first non-permeate stream to that of the feed stream is less than 5.

4. The process of any one of claims 1 to 3, the process further comprising the steps of:

feeding the first non-permeate stream to a second membrane stage at a temperature and pressure above the critical point of the first non-permeate stream;

extracting a second non-permeate stream;

extracting a second permeate stream; and

combining the second permeate stream with the feed stream.

5. The process of any one of claims 1 to 4, wherein the feed stream comprises a mixture of propane and propylene.

6. The process of claim 5, wherein the first membrane stage has a selectivity for propylene over propane of at least 5.0.

7. The process of claim 5, wherein the pressure of the feed stream is 700 psi or higher.

8. The process of claim 7, wherein the pressure of the feed stream ranges from about 900 psi to about 1100 psi.

9. The process of claim 5, wherein the temperature of the feed stream is 96°C or higher.

10. The process of claim 5, wherein the second membrane stage has a selectivity for propylene over propane of at least 3.0.

11. The process of claim 10, wherein the second membrane stage has a selectivity for propylene over propane of at least 5.0.

12. The process of claim 11, wherein the second non-permeate stream is collected as a liquid or as a two-phase gas/liquid stream having a purity of at least about 95% propane.

13. A system for the membrane-based separation of a mixture of close boiling hydrocarbon components comprising, in combination:

a feed stream comprising a mixture of close boiling hydrocarbon components;

a pump having an inlet and outlet, the inlet being adapted to receive the feed stream, the pump being adapted and configured to pressurize the feed stream to a pressure above a critical pressure of the mixture;

a first evaporator having an inlet and outlet, the inlet of the first evaporator being in fluid communication with the outlet of the pump, the first evaporator being adapted and configured to raise the feed stream's temperature to a temperature above a critical temperature of the mixture;

a first membrane stage, the first membrane stage having a selectivity for propylene over propane of at least 6.5, a feed port, a non-permeate port, and a permeate port, the first membrane stage feed port being in fluid communication with the outlet of the first evaporator; and,

a second membrane stage, the second membrane stage having a selectivity for propylene over propane of at least 3.0, a feed port, a non-permeate port, and a permeate port, the second membrane stage feed port being in communication with the first membrane stage non-permeate port.

14. The system of claim 13, further comprising a second evaporator having an inlet and outlet, the inlet of the second evaporator being in fluid communication with the non-permeate port of the first membrane stage, the outlet of the second evaporator being in fluid communication with the feed port of the second membrane stage, the second evaporator being adapted and configured to raise a temperature of a non-permeate stream from the first membrane stage to a temperature above a critical temperature of the non-permeate stream.

CLAIMS

What is claimed is:

1. A process for the membrane-based separation of a mixture of close-boiling hydrocarbon components, said process comprising the steps of:

feeding a feed stream comprising the mixture of close-boiling hydrocarbon components to a first membrane stage at a temperature and a pressure above a critical point of the mixture;

extracting a first permeate stream from the first membrane stage;

cooling the first permeate stream to produce a liquid product, the liquid product being chemical-grade propylene product;

extracting a first non-permeate stream from the first membrane stage

feeding the first non-permeate stream to a second membrane stage at a temperature and pressure above the critical point of the first non-permeate stream;

extracting a second non-permeate stream;

extracting a second permeate stream; and

combining the second permeate stream with the feed stream.

2. The process of claim 1, wherein the feed stream and the first non-permeate stream each has a density and the ratio of the density of the first non-permeate stream to that of the feed stream is less than 5.

3. The process of any one of claims 1 to 2, wherein the feed stream comprises a mixture of propane and propylene.

4. The process of claim 3, wherein the first membrane stage has a selectivity for propylene over propane of at least 5.0.

5. The process of claim 3, wherein the pressure of the feed stream is 700 psi or higher.

6. The process of claim 5, wherein the pressure of the feed stream ranges from 900 psi to 1100 psi.

7. The process of claim 3, wherein the temperature of the feed stream is 96°C or higher.

8. The process of claim 3, wherein the second membrane stage has a selectivity for propylene over propane of at least 3.0.

9. The process of claim 8, wherein the second membrane stage has a selectivity for propylene over propane of at least 5.0.

10. The process of claim 9, wherein the second non-permeate stream is collected as a liquid or as a two-phase gas/liquid stream having a purity of at least 95% propane.