CLAIMS

1. A system for on-board fuel separation using membrane distillation, the system being mounted in a vehicle, comprising:

a source fuel tank (105) comprising liquid fuel;

a pump (110) configured to deliver the liquid fuel from the source fuel tank (105);

a membrane module (115) comprising a hydrophilic membrane (125), a retentate channel (130), and a permeate channel (135), the retentate and permeate channels being disposed on opposing sides of the hydrophilic membrane (125), wherein the retentate channel (130) and the permeate channel (135) are configured to receive the liquid fuel from the source fuel tank (105) via a feed channel (140, 205, 210), and wherein the membrane module (115) is configured to separate the liquid fuel via membrane distillation in which temperature and partial pressure differences between the retentate and permeate channels create a chemical potential difference between the retentate channel (130) and permeate channel (135) such that a high octane fraction remains in the retentate channel (130) and a low octane fraction diffuses through the hydrophilic membrane (125) to the permeate channel (135);

a low octane fuel tank (180) configured to receive the low octane fraction from the permeate channel (135);

a high octane fuel tank (192) configured to receive the high octane fraction from the retentate channel (130); and

an engine (160) fluidly connected to the permeate channel (135) and the retentate channel (130), and configured to selectively receive at least a portion of the low octane fraction and at least a portion of the high octane fraction.

2. The system of claim 1, further comprising:

a preheater (120) configured to preheat the liquid fuel prior to delivery of the liquid fuel to the retentate (130) and permeate (135) channels of the membrane module (115).

3. The system of claim 1, wherein the hydrophilic membrane (125) is in the form of a flat sheet, a hollow fiber, or a spiral wound.

4. The system of claim 1, further comprising:

a heat exchanger (196) fluidly connected to the retentate channel (130) and configured to maintain the temperature of the retentate channel (130) to enhance separation of the high octane fraction from the low octane fraction in the membrane module (115).

5. The system of claim 1, wherein the liquid fuel is gasoline, naphtha, or diesel fuel.

6. A system for on-board fuel separation using membrane distillation, the system being mounted in a vehicle and comprising:

a source fuel tank (105) comprising liquid fuel;

a pump (110) configured to deliver the liquid fuel from the source fuel tank (105);

a membrane module (115) comprising a hydrophilic membrane (125), a retentate channel (130), and a permeate channel (135), the retentate and permeate channels being disposed on opposing sides of the hydrophilic membrane (125), wherein the retentate channel (130) is configured to receive the liquid fuel from the source fuel tank (105) via a feed channel (140), and wherein the membrane module (115) is configured to separate the liquid fuel via membrane distillation in which temperature and partial pressure differences between the retentate and permeate channels create a chemical potential difference between the retentate channel (130) and permeate channel (135) such that a high octane fraction remains in the retentate channel (130) and a low octane fraction diffuses through the hydrophilic membrane (125) to the permeate channel (135);

a gas channel (145) fluidly connected to the permeate channel (135) and configured to deliver a sweeping gas to the permeate channel (135);

a flash tank (170) fluidly connected to the permeate channel (135) and configured to selectively receive at least a portion of the low octane fraction and the sweeping gas, and to separate the low octane fraction from the sweeping gas;

a low octane fuel tank (180) configured to receive the separated low octane fraction from flash tank (170);

a high octane fuel tank (192) configured to receive the high octane fraction from the retentate channel (130); and

an engine (160) fluidly connected to the permeate channel (135) and configured to selectively receive at least a portion of the low octane fraction and at least a portion of the high octane fraction.

7. The system of claim 6, further comprising:

a preheater (120) configured to preheat the liquid fuel prior to delivery of the liquid fuel to the retentate channel (130) of the membrane module (115).

8. The system of claim 6, further comprising:

a condenser (155) fluidly connected to the permeate channel (135) and the feed channel (140), and configured to condense the low octane fraction prior to delivery of the low octane fraction to the engine (160) or the low octane fuel tank (180).

9. The system of claim 6, wherein the hydrophilic membrane (125) is in the form of a flat sheet, a hollow fiber, or a spiral wound.

10. The system of claim 6, further comprising:

a heat exchanger (196) fluidly connected to the retentate channel (130) and configured to maintain the temperature of the retentate channel (130) to enhance separation of the high octane fraction from the low octane fraction in the membrane module (115).

11. The system of claim 6, wherein the liquid fuel is gasoline, naphtha, or diesel fuel.

12. The system of claim 6, wherein the feed channel (140) is further configured to receive a solvent for enhancing the separation of the low octane and high octane fractions, and wherein a second flash tank is further configured to separate the high octane fraction from the solvent.

13. A method for on-board fuel separation in a vehicle using membrane distillation, the method comprising:

pumping liquid fuel from a source fuel tank (105) to a membrane module (115), wherein the membrane module (115) comprises a hydrophilic membrane (125), a retentate channel (130), and a permeate channel (135), the retentate and permeate channels being disposed on opposing sides of the hydrophilic membrane (125);

supplying a solvent to the liquid fuel upstream of the membrane module (115) before pumping the liquid fuel into the membrane module;

separating, via the membrane module (115), the liquid fuel into a high octane fraction and a low octane fraction via membrane distillation in which temperature and partial pressure differences between the retentate and permeate channels create a chemical potential difference between the retentate channel (130) and permeate channel (135), wherein the high octane fraction collects in the retentate channel (130) and the low octane fraction diffuses through the hydrophilic membrane (125) to the permeate channel (135), and wherein the solvent enhances the separation of the low octane and high octane fractions in the membrane module (115);

separating the high octane fraction from the solvent via flash distillation in a flash tank;

selectively delivering at least a portion of the high octane fraction from the flash tank to a high octane fuel tank (192) or to an engine (160) of the vehicle; and

selectively delivering at least a portion of the low octane fraction from the permeate channel (135) to a low octane fuel tank (180) or to the engine (160) of the vehicle.

14. The method of claim 13, further comprising:

preheating the liquid fuel prior to its delivery to the membrane module (115).

15. The method of claim 13, further comprising:

heating the retentate channel (130) via a heat exchanger to enhance separation of the high octane fraction from the low octane fraction.

16. The method of claim 15, wherein the heat exchanger (196) produces heat using a hot coolant or an exhaust gas.

17. The method of claim 13, further comprising:

passing a sweeping gas stream through the permeate channel (135) to produce a mixture of sweeping gas and the low octane fraction;

condensing the low octane fraction in a condenser (155) prior to delivery of the low octane fraction to the engine (160) or the low octane fuel tank (180); and

separating the low octane fraction from the sweeping gas via another flash tank (170) prior to delivery of the low octane fraction to the low octane fuel tank (180).

18. The method of claim 13, wherein the hydrophilic membrane (125) is in the form of a flat sheet, a hollow fiber, or a spiral wound.

19. The method of claim 13, wherein the liquid fuel is gasoline, naphtha, or diesel fuel.