**Claims:**

1. A system, comprising:

an ammonia-decomposition photocatalytic reactor; and

a coolant circulation system configured to utilize liquid ammonia as a coolant for cooling LEDs in the photocatalytic reactor, wherein the liquid ammonia is recovered from a product stream from the photocatalytic reactor.

2. A system comprising:

an ammonia-decomposition photocatalytic reactor; and

a coolant circulation system configured to utilize water as a coolant to cool LEDs in the photocatalytic reactor, wherein heat energy is removed from the coolant via chilled liquid ammonia, and wherein the liquid ammonia is recovered from a product stream from the photocatalytic reactor.

3. The system of claim 1 or 2, comprising only a single compressor positioned in a feed stream prior to an inlet of the photocatalytic reactor, the compressor configured to compress ammonia gas to a pressure ranging approximately from 1 Bar to a critical pressure of 113.4 Bar at a temperature ranging approximately from 20 C to a critical temperature of 132.4 C.

4. The system of claim 1 or 2, further comprising a single-walled tank configured to store feed ammonia at an elevated temperature and an elevated pressure, the elevated temperature being in a range that includes ambient temperature at its upper end, the elevated pressure being up to a critical pressure of 113.4 bar, the elevated temperature and elevated pressure thereby eliminating a need for chilling of the circulating coolant used to cool LEDs in the photoreactor, the elevated temperature and elevated pressure also thereby eliminating a need for the tank to be double-walled, the elevated temperature and elevated pressure causing a

decreased amount of ammonia vapor to be generated in the tank to thereby reduce a compressor duty.

5. The system of claim 4, wherein the system does not comprise an overhead compression system.

6. The system of claim 5, further comprising a multi-stage compressor with inter-stage cooling configured to be positioned in the product stream after the photoreactor.

7. The system of claim 1 or 2, further comprising a tank configured to store feed ammonia at a temperature range of approximately -33C to 20C and at a pressure ranging approximately from atmospheric pressure to a critical pressure of 113.4 bar, wherein the system does not comprise one or more downstream compressors, wherein the tank is configured to feed the feed ammonia to the photocatalytic reactor.

8. The system of claim 1 or 2, wherein the product stream from the photocatalytic reactor is provided directly to an ammonia scrubber, without being acted on by a compressor, a condenser, or a two-phase separator, to thereby produce ammonium hydroxide as a by-product to ammonia-decomposition.

9. The system of claim 1 or 2, further comprising an ammonia scrubber configured to directly receive the product stream from the photocatalytic reactor, without applying any compressor, condenser, or scrubber, to thereby produce ammonium hydroxide as a by-product.

10. The system of claim 1 or 2, further comprising a Pressure Swing Adsorber (PSA) system at an output of the system.

11. The system of claim 1 or 2, further comprising a membrane H2 and N2 separator at an output of the system.

12. The system of claim 1 or 2, further comprising:

a first Pressure Swing Adsorber (PSA) system configured to separate ammonia as backflush; and

a second PSA system to separate H2 and N2.

13. The system of claim 12, wherein the first and second PSA systems are instead of a compressor, a condenser, a two-phase separator, and an ammonia scrubber.

14. The system of claim 12, further comprising a compressor between the first PSA system and the second PSA system.

15. A method for cooling a plurality of LEDs in an ammonia-decomposition photocatalytic reactor system, the method comprising circulating liquid ammonia proximate the plurality of LEDs to remove heat generated by the plurality of LEDs, wherein the liquid ammonia is recovered from a product stream from the photocatalytic reactor.

16. A method for cooling a plurality of LEDs in an ammonia-decomposition photocatalytic reactor system, the method comprising circulating water in proximity to the plurality of LEDs to remove heat generated by the plurality of LEDs.

17. The method of claim 15 or 16, further comprising storing feed ammonia at a temperature range of approximately -33C to 20C and at a pressure ranging approximately from atmospheric pressure to a critical pressure of 113.4 bar, to thereby eliminate a need for

one or both downstream compressors, wherein the feed ammonia is fed to the photocatalytic reactor.

18. The method of claim 15 or 16, further comprising separating a product stream from the photocatalytic reactor via a membrane H2 and N2 separator to thereby produce separate H2 and N2 product streams.

19. A photocatalytic ammonia-decomposition reactor system comprising:

a membrane separator at a product stream outlet of the reactor system;

a product stream gas cooler; and

a Pressure Swing Adsorber (PSA) system configured to separate ammonia and nitrogen.

20. A photocatalytic reactor system comprising:

A photocatalytic ammonia-decomposition (P-DA) reactor having a plurality of LEDs configured to catalyze an ammonia decomposition reaction in which a feed ammonia stream is converted into a product gas comprising hydrogen, nitrogen, and unconverted ammonia, the plurality of LEDs being cooled by a cooling block heat exchanger through which a coolant is circulated;

an ammonia tank configured to store liquid ammonia at atmospheric pressure, the tank supplying the feed ammonia stream to the P-DA reactor, wherein the feed ammonia stream supplied by the tank is vaporized using the heat energy from the coolant so that the feed ammonia stream is supplied to the P-DA reactor in a gaseous state;

a turboexpander configured to cool the product gas from the P-DA reactor after the product gas has been compressed and cooled via an ammonia recycle loop that

includes the ammonia tank, an ammonia cooler, a first ammonia condenser, and a recycle compressor;

a second ammonia condenser configured to reduce the product gas cooled by the turboexpander;

a preheater configured to heat the reduced product gas by removing heat energy from the coolant circulating through the cooling block heat exchanger; and

a Pressure Swing Adsorber (PSA) system configured to receive the heated product gas from the preheater and outputs hydrogen and a tail gas comprising a mixture of unrecovered hydrogen and nitrogen.

21. The photocatalytic reactor system of claim 20, wherein the coolant is water.

22. The photocatalytic reactor system of claims 20 or 21, further comprising a plurality of knockout separators configured to remove liquid ammonia from the product gas, wherein the liquid ammonia is returned to the ammonia recycle loop.