

SYSTEMS AND METHODS FOR AMMONIA PURIFICATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application and U.S. Patent Nos. 10,022,650, 10,702,799, 10,850,226, 10,266,418, 10,456,735, 10,843,122, and 10,315,153, which are each incorporated herein by reference, are commonly assigned to Bechtel Energy Technologies and Solutions, Inc.

FIELD OF THE INVENTION

[0002] The present invention generally relates to systems and methods for ammonia purification. More particularly, the present invention relates to ammonia purification using a sour water feed stream with a higher concentration of ammonia (NH₃) than hydrogen sulfide (H₂S) to produce a purified acid gas stream, a purified NH₃ vapor stream and an environmentally safe stripped water stream.

BACKGROUND OF THE INVENTION

[0003] Conventional technology separately recovers H₂S and NH₃ from sour water using an H₂S stripper and an NH₃ stripper, which is sometimes referred to as a two-column sour water stripping process. A two-column sour water stripping process typically includes four main processing stages: 1) degassing and feed preparation; 2) H₂S stripping; 3) NH₃ stripping; and 4) NH₃ purification and liquefaction. This process yields acid gas (predominantly H₂S and CO₂) with less than 50 ppmw NH₃, a purified gaseous and/or liquid NH₃ product and stripped water that may be suitable for reuse or discharged to the environment if the pH of the sour water feed is near neutral. If, however, the pH of the sour water feed is not near neutral (i.e., the sour water feed has a higher concentration of NH₃ than H₂S), then significant amounts of other acids (e.g., hydrochloric, sulfurous, sulfuric, nitric

and potentially other acids) must be added to the sour water stream before the H₂S stripping stage to bind the NH₃ and separate the H₂S and CO₂ from the sour water stream. Likewise, comparable amounts of other bases (e.g., sodium hydroxide, potassium hydroxide and potentially other bases) must be added during the NH₃ stripping stage to bind the other acids added to the sour water stream and release the NH₃. After adding so much acid and base, the resulting stripped water is unsuitable for discharge to the environment because it contains a high concentration of salts.

[0004] Referring now to **FIGS. 1A** and **1B**, a schematic diagram of a conventional two-column sour water stripping system illustrates the four processing stages. The following pressures and temperatures are exemplary and only for purposes of illustration.

Degassing and Feed Preparation:

[0005] Sour water feeds **102** from a single or several sources are combined with a recycle stream **104** from the NH₃ stripper **106**, which are cooled and passed through a degasser **108** where dissolved hydrogen (H₂), methane (CH₄) and other light hydrocarbons are removed as a hydrocarbon vapor stream **105**. The sour water feeds **102** include dissolved NH₃ and H₂S. The recycle stream **104** includes rich NH₃, which helps keep acid gases in solution in the degasser **108**, thereby minimizing the release of acid gas and possible air pollution. The degassed sour water stream **109** is sent to a deoiler **103**, which removes free oil from the degassed sour water stream **109** to produce a degassed/deoiled sour water stream **107**. The degassed/deoiled sour water stream **107** is pumped to a feed preparation tank **110**, which serves to attenuate flow rate and composition changes while also providing the opportunity to remove entrained oil and solids. The feed preparation tank **110** produces a processed sour water stream **111**, which is pumped to a feed coalescer unit **112** that filters solids remaining in the processed sour water stream **111** and further separates entrained oil

to produce a hydrocarbon liquid **113** and a deoiled sour water stream **115**. The deoiled sour water stream **115** is sent to a feed/product exchanger **114**, which acts as a heat exchanger to heat the deoiled sour water stream **115** and cool the NH₃ stripper bottoms stream **132** to produce a heated deoiled sour water stream **116** and the stripped water stream **134**. In this manner, the components comprising the NH₃ stripper bottoms stream **132**, stripped water stream **134** and the components comprising the deoiled sour water stream **115**, heated deoiled sour water stream **116** are, respectively, the same but may have different concentrations and temperatures. The heated deoiled sour water stream **116** is then sent to an H₂S stripper **118**.

H₂S Stripping:

[0006] The H₂S stripper **118** contains trays or packing (not shown) that the heated deoiled sour water stream **116** flows through and around to separate H₂S from the heated deoiled sour water stream **116**. A cooled reflux water stream (e.g. water wash) **136** is used remove heat and suppress evolution of gaseous NH₃ in the H₂S stripper. A reboiler **137** acts as a heat exchanger to provide the energy required to i) heat the heated deoiled sour water stream **116** and the cooled reflux water stream **136** to a preferred temperature; and ii) strip out H₂S from the heated deoiled sour water stream **116**. The resulting H₂S stripper overheads stream **120** is sent to a knock out drum **138** to substantially remove any entrained droplets and produce H₂S stream **126**. The H₂S stream **126** is of high purity and is an excellent feed for a sulfur recovery unit (SRU) or a sulfuric acid plant. It contains a negligible amount of NH₃ (less than 50 ppmw) and very little hydrocarbons since the sour water feeds **102** have been degassed. The H₂S stream **126** is available at about 100-180 psig and 100-120°F. The resulting H₂S stripper bottoms stream **130**, which contains NH₃ and some H₂S, is sent directly to the NH₃ stripper **106**.

NH₃ Stripping:

[0007] The NH₃ stripper **106** is a steam re-boiled, refluxed distillation column. In the NH₃ stripper **106**, essentially all NH₃ and any remaining H₂S are removed from the H₂S stripper bottoms stream **130**, which leaves the NH₃ stripper **106** as an NH₃ stripper bottoms stream **132**. The NH₃ stripper bottoms stream **132** is sent to the feed/product exchanger **114** where heat is exchanged with the deoiled sour water stream **115** and the NH₃ stripper bottoms stream **132** is cooled to form the stripped water stream **134**. The containment levels of H₂S and NH₃ in the stripped water stream **134** may be tailored to individual requirements and is typically 10-50 ppmw NH₃ and 1-25 ppmw H₂S. The stripped water stream **134** is available at about 100-200°F. In the NH₃ stripper **106**, essentially all NH₃ and any remaining H₂S are removed from the H₂S stripper bottoms stream **130**, which leaves the NH₃ stripper **106** as an NH₃ stripper overheads stream **133**. The NH₃ stripper overheads stream **133** is sent to an overhead condenser where it is converted to an NH₃ vapor stream and an NH₃ liquid stream. A knock out drum **139** separates the NH₃ vapor stream **140** and the NH₃ liquid stream **150**. A portion of the NH₃ liquid stream **150** is returned as reflux to the NH₃ stripper **106** and another portion of the NH₃ liquid stream **150** forms the recycle stream **104**. A reboiler **141** acts as a heat exchanger to provide the energy required to remove NH₃ and any remaining H₂S. The NH₃ vapor stream **140** is an NH₃-rich gas, which may be processed in a variety of ways.

NH₃ Purification and Liquefaction:

[0008] Referring now to **FIG. 1B**, the NH₃ vapor stream **140** is sent to a water wash **142** to remove residual amounts of H₂S and some hydrocarbons. This step is also referred to as water scrubbing, which produces a scrubbed NH₃ vapor stream **160**. If NH₃ recovery

is not desired or economic, the scrubbed NH₃ vapor stream **160** may be incinerated. In most cases, however, it is desirable to further purify the scrubbed NH₃ vapor stream **160** to produce either an anhydrous liquid NH₃ stream **170** or an aqueous NH₃ stream **180** suitable for commercial use. In order to further purify the scrubbed NH₃ vapor stream **160**, the scrubbed NH₃ vapor stream **160** is sent to a caustic wash **144** to remove residual contaminants including some hydrocarbons. This step is also referred to as caustic scrubbing, which produces a double scrubbed NH₃ vapor stream **162** and may be necessary when problems are expected with process upsets, carbon dioxide, or complex sulfur compounds (e.g. mercaptans or disulfides). The double scrubbed NH₃ vapor stream **162** may be sent to either a compressor **146** or a refrigeration unit **148** to produce the anhydrous liquid NH₃ stream **170**, which contains a negligible amount of H₂S (less than 5 ppmw). The anhydrous liquid NH₃ stream **170** is available at about 200 psig and 100°F if liquefied by compression and at atmospheric pressure and about -26 F if liquefied by cooling. Cooling water and/or a refrigerant may be used to exchange heat with the double scrubbed NH₃ vapor stream **162**. The double scrubbed NH₃ vapor stream **162** may also be sent to an NH₃ absorber **149**, which is essentially another water wash, to produce the aqueous NH₃ stream **180**, which contains a negligible amount of sulfur (no more than about 2ppmw). The aqueous NH₃ stream **180** is available at about 35 psig and 100°F.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The detailed description is described below with reference to the accompanying drawings in which like elements are referenced with like numerals, and in which:

[0010] **FIGS. 1A-1B** are schematic diagrams illustrating a conventional two-column sour water stripping system.

[0011] **FIG. 2** is a schematic diagram illustrating one embodiment of an NH_3 purification system capable of producing a purified acid gas stream, a purified NH_3 vapor stream and an environmentally safe stripped water stream using a sour water feed stream with a higher concentration of NH_3 than H_2S .

[0012] **FIG. 3** is a schematic diagram illustrating another embodiment of an NH_3 purification system capable of producing a purified acid gas stream, a purified NH_3 vapor stream and an environmentally safe stripped water stream using a sour water feed stream with a higher concentration of NH_3 than H_2S .

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The subject matter of the present disclosure is described with specificity, however, the description itself is not intended to limit the scope of the disclosure. The subject matter thus might also be embodied in other ways, to include different structures, steps and/or combinations similar to and/or fewer than those described herein, in conjunction with other present or future technologies. Although the term “step” may be used herein to describe different elements of methods employed, the term should not be interpreted as implying any particular order among or between various steps herein disclosed unless otherwise expressly limited by the description to a particular order. Other features and advantages of the disclosed embodiments will be or will become apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such additional features and advantages be included within the scope of the disclosed embodiments. Further, the illustrated figures described herein are

only exemplary and are not intended to assert or imply any limitation with regard to the environment, architecture, design, or process in which different embodiments may be implemented. To the extent that temperatures and/or pressures are referred to in the following description, those conditions are merely illustrative and are not meant to limit the disclosure. All streams described herein are carried by physical lines.

[0014] The systems and methods disclosed herein overcome the disadvantages encountered by conventional NH_3 purification processes by using a sour water feed stream with a higher concentration of NH_3 than H_2S to produce a purified acid gas stream, a purified NH_3 vapor stream and an environmentally safe stripped water stream without adding more acid and base.

[0015] In one embodiment, a system is disclosed for ammonia purification, which comprises: i) an ammonia stripper for separating a sour water feed stream comprising ammonia and hydrogen sulfide into an ammonia stripper vapor stream and an ammonia stripper liquid stream; ii) a first heat exchanger positioned upstream of the ammonia stripper and enclosing a portion of the sour water feed stream and a portion of the ammonia stripper liquid stream for heating the sour water feed stream and cooling the ammonia stripper liquid stream to produce a stripped water stream; iii) a second heat exchanger for converting the ammonia stripper vapor stream to a two-phase ammonia stream; iv) a knock-out drum for separating the two-phase ammonia stream into an ammonia vapor stream and an ammonia liquid stream; and v) a water wash for removing hydrogen sulfide and carbon dioxide from the ammonia vapor stream and producing a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

[0016] In another embodiment, a method is disclosed for ammonia purification, which comprises: i) heating a sour water feed stream comprising ammonia and hydrogen sulfide in a heat exchanger using an ammonia stripper liquid stream to produce a heated sour water feed stream; ii) cooling the ammonia stripper liquid stream in the heat exchanger using the sour water feed stream to produce a stripped water stream; iii) separating the heated sour water feed stream into an ammonia stripper vapor stream and an ammonia stripper liquid stream; iv) converting the ammonia stripper vapor stream to a two-phase ammonia stream; v) separating the two-phase ammonia stream into an ammonia vapor stream and an ammonia liquid stream; and vi) removing hydrogen sulfide and carbon dioxide from the ammonia vapor stream to produce a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

[0017] In yet another embodiment, a system is disclosed for ammonia purification, which comprises: i) an ammonia stripper for separating a sour water feed stream comprising ammonia and hydrogen sulfide into an ammonia stripper vapor stream and an ammonia stripper liquid stream; ii) a first heat exchanger positioned upstream of the ammonia stripper and enclosing a portion of the sour water feed stream and a portion of the ammonia stripper liquid stream for heating the sour water feed stream and cooling the ammonia stripper liquid stream to produce a stripped water stream; iii) a cooler for cooling another ammonia stripper liquid stream withdrawn from the ammonia stripper above the ammonia stripper liquid stream; iv) a pump for pumping a portion of the another ammonia stripper liquid stream back to the ammonia stripper; and v) a water wash for removing hydrogen sulfide and carbon dioxide from the ammonia stripper vapor stream and producing a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

[0018] In yet another embodiment, a method is disclosed for ammonia purification, which comprises: i) heating a sour water feed stream comprising ammonia and hydrogen sulfide in a heat exchanger using an ammonia stripper liquid stream to produce a heated sour water feed stream; ii) cooling the ammonia stripper liquid stream in the heat exchanger using the sour water feed stream to produce a stripped water stream; iii) separating the heated sour water feed stream in an ammonia stripper into an ammonia stripper vapor stream and an ammonia stripper liquid stream; iv) withdrawing another ammonia stripper liquid stream from the ammonia stripper; v) cooling the another ammonia stripper liquid stream; and vi) removing hydrogen sulfide and carbon dioxide from the ammonia stripper vapor stream to produce a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

[0019] Referring now to **FIG. 2**, a schematic diagram illustrates one embodiment of an NH₃ purification system **200** capable of producing a purified acid gas stream **274**, a purified NH₃ vapor stream **242** and an environmentally safe stripped water stream **237** using a sour water feed stream **202** with a higher concentration of NH₃ than H₂S.

[0020] A sour water feed stream **202** is mixed with a cooled H₂S stripper liquid stream **278** and, optionally, an NH₃ liquid stream **230**. The mixed stream is then passed through a degasser **208** where dissolved hydrogen (H₂), methane (CH₄), other light hydrocarbons, H₂S and CO₂ may be removed through a hydrocarbon vapor stream **205** to produce a degassed sour water feed stream **209**. The degassed sour water feed stream **209** is sent to a deoiler **203**, which removes free oil from the degassed sour water feed stream **209** to produce a degassed/deoiled sour water feed stream **207**. The degassed/deoiled sour water feed stream **207** is sent by means of a first pump **206** to a feed preparation tank **210**, which serves to attenuate flow rate and composition changes while also providing the

opportunity to remove entrained oil and solids. The feed preparation tank **210** produces a processed sour water feed stream **211**, which is sent to a feed coalescer unit **212** by means of a second pump **213**. The feed coalescer unit **212** filters solids remaining in the processed sour water feed stream **211** and further separates entrained oil to produce a deoiled sour water feed stream **215**. The deoiled sour water feed stream **215** is sent to a feed/product exchanger **214**, which acts as a heat exchanger to heat the deoiled sour water feed stream **215** and cool an NH₃ stripper liquid stream **232** to produce a heated/deoiled sour water feed stream **216** and an environmentally safe stripped water stream **234** that may be further cooled by a first heat exchanger **235** using a coolant to produce a chilled stripped water stream **237**. The chilled stripped water stream **237** may be discharged to the environment and/or reused. In this manner, the components comprising the NH₃ stripper liquid stream **232** and the stripped water stream **234** are effectively the same but may have different pressures and/or temperatures. Likewise, the components comprising the deoiled sour water feed stream **215** and the heated/deoiled sour water feed stream **216** are effectively the same but may also have different pressures and/or temperatures. The heated/deoiled sour water feed stream **216** may be further processed by NH₃ stripping.

[0021] The heated/deoiled sour water feed stream **216** may be sent to an NH₃ stripper **218**, which is a steam re-boiled, refluxed distillation column. Essentially all the NH₃ and any remaining H₂S and CO₂ are separated from the heated/deoiled sour water feed stream **216** in the NH₃ stripper **218**, which produces the NH₃ stripper liquid stream **232** and an NH₃ stripper vapor stream **220**. The NH₃ stripper liquid stream **232** leaves the bottom of the NH₃ stripper **218** and is sent to the feed/product exchanger **214**. The contaminant levels of H₂S, CO₂ and NH₃ in the stripped water stream **234** may be tailored to individual requirements and is typically 10-50 ppmw NH₃, 1-25 ppmw H₂S and

essentially no CO₂. The stripped water stream **234** is available at about 100-200°F. The NH₃ stripper vapor stream **220** leaves the top of the NH₃ stripper **218** and is sent to a second heat exchanger **222** where a coolant is used to convert the NH₃ stripper vapor stream **220** to a two phase NH₃ stream **224** that is sent to a knock-out drum **226**. The knock-out drum **226** separates the two phase NH₃ stream **224** into an NH₃ vapor stream **228** and the NH₃ liquid stream **230**. A portion of the NH₃ liquid stream **230** is returned as reflux to the NH₃ stripper **218** and another portion of the NH₃ liquid stream **230** may be, optionally, recycled back to mix with the sour water feed stream **202** and the cooled H₂S stripper liquid stream **278** using a third pump **236**. A reboiler **238** acts as a heat exchanger to provide the energy required to remove NH₃ and any remaining H₂S. The NH₃ vapor stream **228** is an NH₃-rich gas, which is further processed.

[0022] The NH₃ vapor stream **228** may be sent to a water wash **240** for purification and to preferentially remove residual amounts of H₂S and some hydrocarbons. The water wash **240** produces a purified NH₃ vapor stream **242** and a rich water stream **244** comprising H₂S and CO₂. The rich water stream **244** may be pumped using a fourth pump **246** i) through a third heat exchanger **262** back to the water wash **240** and/or ii) optionally through another feed/product exchanger **264** for further processing. The third heat exchanger **262** uses a coolant to chill the recycled rich water stream **244** pumped back to the water wash **240**. Counterflow of the NH₃ vapor stream **228** and the chilled stripped water stream **237** removes a majority of the H₂S and CO₂. The NH₃ vapor stream **228**, the chilled stripped water stream **237** and the rich water stream **244** entering the water wash **240** may each be divided into two or more streams that enter the water wash **240** at different locations for optimizing the counterflow and removing a majority of the H₂S and CO₂. The feed/product exchanger **264** acts as a heat exchanger to heat the rich water stream **244** and cool an H₂S

stripper liquid stream **276** to produce a heated rich water stream **248** and the cooled H₂S stripper liquid stream **278**.

[0023] The heated rich water stream **248** comprising NH₃, H₂S and CO₂ may be sent to an H₂S stripper **266** to separate the H₂S and CO₂ from the water. The heated rich water stream **248** that enters the H₂S stripper may be divided into two or more streams that enter the H₂S stripper **266** at different locations. The H₂S stripper **266** contains trays or packing that the heated rich water stream **248** flows through and around to separate H₂S and CO₂ from the heated rich water stream **248**. The chilled stripped water stream **237** may be used to remove NH₃ from the exiting vapors. A reboiler **268** acts as a heat exchanger to provide the energy required to i) heat the heated rich water stream **248** and the chilled stripped water stream **237** to preferred temperatures; and ii) strip out H₂S and CO₂ from the heated rich water stream **248**. The H₂S stripper **266** produces an H₂S stripper vapor stream **270**, which is sent to a knock-out drum **272** to substantially remove any entrained droplets and produce a purified acid gas stream **274**. Because the acid gas stream **274** contains negligible NH₃ (less than 50 ppmw) and very little hydrocarbons, it is an excellent feed for a sulfur recovery unit (SRU) or a sulfuric acid plant. The acid gas stream **274** is available at about 50-200 psig and 100-120°F. The H₂S stripper **266** also produces the H₂S stripper liquid stream **276**, which contains NH₃, H₂S and CO₂ from the bottom of an H₂S stripper **266**.

[0024] Referring now to **FIG. 3**, a schematic diagram illustrates another embodiment of an NH₃ purification system **300** capable of producing a purified acid gas stream **274**, a purified NH₃ vapor stream **242** and an environmentally safe stripped water stream **237** using a sour water feed stream **202** with a higher concentration of NH₃ than H₂S.

[0025] The NH₃ purification system **300** is a modification of the NH₃ purification system **200** illustrated in **FIG. 2** and, therefore, includes many of the same components. Alternatively, however, the NH₃ stripper vapor stream **220** may be sent directly to the water wash **240** for purification in the same manner as the NH₃ vapor stream **228** described in reference to **FIG. 2**. Additionally, a pump-around subsystem design may be used with the NH₃ stripper **218** instead of the overhead condensing subsystem design illustrated in **FIG. 2**. The pump-around subsystem uses a third pump **302** to pump another NH₃ stripper liquid stream **304** from the NH₃ stripper **218** through a cooler **306** that produces a cooled NH₃ stripper liquid stream **308**. = The cooled NH₃ stripper liquid stream **308** is recycled back to the NH₃ stripper **218** and, optionally, to the cooled H₂S stripper liquid stream **278** where it is mixed thus, forming a combined liquid stream **310** comprising NH₃ and H₂S. The sour water feed stream **202** may, therefore, be mixed with the cooled H₂S stripper liquid stream **278** or, optionally, the combined liquid stream **310**.

[0026] While the present disclosure has been described in connection with presently preferred embodiments, it will be understood by those skilled in the art that it is not intended to limit the disclosure of those embodiments. It is therefore, contemplated that various alternative embodiments and modifications may be made to the disclosed embodiments without departing from the spirit and scope of the disclosure defined by the appended claims and equivalents thereof.

CLAIMS

1. A system for ammonia purification, which comprises:
 - an ammonia stripper for separating a sour water feed stream comprising ammonia and hydrogen sulfide into an ammonia stripper vapor stream and an ammonia stripper liquid stream;
 - a first heat exchanger positioned upstream of the ammonia stripper and enclosing a portion of the sour water feed stream and a portion of the ammonia stripper liquid stream for heating the sour water feed stream and cooling the ammonia stripper liquid stream to produce a stripped water stream;
 - a second heat exchanger for converting the ammonia stripper vapor stream to a two-phase ammonia stream;
 - a knock-out drum for separating the two-phase ammonia stream into an ammonia vapor stream and an ammonia liquid stream; and
 - a water wash for removing hydrogen sulfide and carbon dioxide from the ammonia vapor stream and producing a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.
2. The system of claim 1, wherein the sour water feed stream includes a higher concentration of the ammonia than the hydrogen sulfide.
3. The system of claim 1, wherein a portion of the rich water stream is fluidly connected to a hydrogen sulfide stripper.
4. The system of claim 3, further comprising a third heat exchanger for chilling another portion of the rich water stream recycled back to the water wash.

5. The system of claim 4, further comprising a fourth heat exchanger for chilling the stripped water stream with a coolant to produce a chilled stripped water stream.
6. The system of claim 5, wherein the chilled stripped water stream is fluidly connected to at least one of the water wash and a hydrogen sulfide stripper.
7. The system of claim 6, wherein the hydrogen sulfide stripper is fluidly connected to the chilled stripped water stream for removing hydrogen sulfide and carbon dioxide from the portion of the rich water stream and producing a vapor stream comprising hydrogen sulfide and carbon dioxide, and a liquid stream comprising ammonia and residual hydrogen sulfide and carbon dioxide.
8. The system of claim 7, further comprising another knock-out drum for removing entrained droplets from the vapor stream and producing a purified acid gas stream.
9. The system of claim 7, wherein the liquid stream is in fluid communication with the sour water feed stream.
10. The system of claim 6, wherein the chilled stripped water stream is fluidly connected to the water wash and the ammonia vapor stream is fluidly connected to the water wash below the chilled stripped water stream and above the rich water stream.
11. The system of claim 1, wherein a portion of the ammonia liquid stream is fluidly connected to the ammonia stripper and another portion of the ammonia liquid stream is in fluid communication with the sour water feed stream.
12. A method for ammonia purification, which comprises:

heating a sour water feed stream comprising ammonia and hydrogen sulfide in a heat exchanger using an ammonia stripper liquid stream to produce a heated sour water feed stream;

cooling the ammonia stripper liquid stream in the heat exchanger using the sour water feed stream to produce a stripped water stream;

separating the heated sour water feed stream in an ammonia stripper into an ammonia stripper vapor stream and the ammonia stripper liquid stream;

converting the ammonia stripper vapor stream to a two-phase ammonia stream;

separating the two-phase ammonia stream into an ammonia vapor stream and an ammonia liquid stream; and

removing hydrogen sulfide and carbon dioxide from the ammonia vapor stream to produce a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

13. The method of claim 12, wherein the sour water feed stream includes a higher concentration of the ammonia than the hydrogen sulfide.

14. The method of claim 12, wherein the rich water stream is fluidly connected to at least one of the water wash and a hydrogen sulfide stripper.

15. The method of claim 14, further comprising chilling the rich water stream fluidly connected to the water wash.

16. The method of claim 15, further comprising chilling the stripped water stream with a coolant to produce a chilled stripped water stream.

17. The method of claim 16, wherein the chilled stripped water stream is fluidly connected to at least one of the water wash and a hydrogen sulfide stripper.

18. The method of claim 17, further comprising removing hydrogen sulfide and carbon dioxide from the rich water stream using the chilled stripped water stream to produce a vapor stream comprising hydrogen sulfide and carbon dioxide and a liquid stream comprising ammonia and residual hydrogen sulfide and carbon dioxide.

19. The method of claim 18, further comprising removing entrained droplets from the vapor stream and producing a purified acid gas stream.

20. The method of claim 18, wherein the liquid stream is in fluid communication with the sour water feed stream.

21. The method of claim 12, wherein the heated sour water feed stream is separated into the ammonia stripper vapor stream and the ammonia stripper liquid stream using the ammonia liquid stream.

22. A system for ammonia purification, which comprises:

an ammonia stripper for separating a sour water feed stream comprising ammonia and hydrogen sulfide into an ammonia stripper vapor stream and an ammonia stripper liquid stream;

a first heat exchanger positioned upstream of the ammonia stripper and enclosing a portion of the sour water feed stream and a portion of the ammonia stripper liquid stream for heating the sour water feed stream and cooling the ammonia stripper liquid stream to produce a stripped water stream;

a cooler for cooling another ammonia stripper liquid stream withdrawn from the ammonia stripper above the ammonia stripper liquid stream;

a pump for pumping a portion of the another ammonia stripper liquid stream back to the ammonia stripper; and

a water wash for removing hydrogen sulfide and carbon dioxide from the ammonia stripper vapor stream and producing a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

23. The system of claim 22, wherein the sour water feed stream includes a higher concentration of the ammonia than the hydrogen sulfide.

24. The system of claim 22, wherein a portion of the rich water stream is fluidly connected to a hydrogen sulfide stripper.

25. The system of claim 24, further comprising a second heat exchanger for chilling another portion of the rich water stream recycled back to the water wash.

26. The system of claim 25, further comprising a third heat exchanger for chilling the stripped water stream with a coolant to produce a chilled stripped water stream.

27. The system of claim 26, wherein the chilled stripped water stream is fluidly connected to at least one of the water wash and a hydrogen sulfide stripper.

28. The system of claim 27, wherein the hydrogen sulfide stripper is fluidly connected to the rich water stream and the chilled stripped water stream for removing hydrogen sulfide and carbon dioxide from the portion of the rich water stream and producing a vapor stream comprising hydrogen sulfide and carbon dioxide, and a liquid stream comprising ammonia and residual hydrogen sulfide and carbon dioxide.

29. The system of claim 28, further comprising another knock-out drum for removing entrained droplets from the vapor stream and producing a purified acid gas stream.

30. The system of claim 28, wherein the liquid stream is in fluid communication with at least one of the sour water feed stream and another portion of the another ammonia stripper liquid stream.

31. The system of claim 27, wherein the chilled stripped water stream is fluidly connected to the water wash, the rich water stream is fluidly connected to the water wash and the ammonia stripper vapor stream is fluidly connected to the water wash below the chilled stripped water stream and above the rich water stream.

32. A method for ammonia purification, which comprises:

heating a sour water feed stream comprising ammonia and hydrogen sulfide in a heat exchanger using an ammonia stripper liquid stream to produce a heated sour water feed stream;

cooling the ammonia stripper liquid stream in the heat exchanger using the sour water feed stream to produce a stripped water stream;

separating the heated sour water feed stream in an ammonia stripper into an ammonia stripper vapor stream and an ammonia stripper liquid stream;

withdrawing another ammonia stripper liquid stream from the ammonia stripper;

cooling the another ammonia stripper liquid stream; and

removing hydrogen sulfide and carbon dioxide from the ammonia stripper vapor stream to produce a purified ammonia vapor stream and a rich water stream comprising hydrogen sulfide and carbon dioxide.

33. The method of claim 32, wherein the sour water feed stream includes a higher concentration of the ammonia than the hydrogen sulfide.

34. The method of claim 32, wherein a portion of the rich water stream is fluidly connected to a hydrogen sulfide stripper.

35. The method of claim 34, further comprising chilling another portion of the rich water stream recycled back to the water wash.

36. The method of claim 35, further comprising chilling the stripped water stream with a coolant to produce a chilled stripped water stream.

37. The method of claim 36, wherein the chilled stripped water stream is fluidly connected to at least one of the water wash and a hydrogen sulfide stripper.

38. The method of claim 37, further comprising removing hydrogen sulfide and carbon dioxide from the portion of the rich water stream using the chilled stripped water stream to produce a vapor stream comprising hydrogen sulfide and carbon dioxide and a liquid stream comprising ammonia and residual hydrogen sulfide and carbon dioxide.

39. The method of claim 38, further comprising removing entrained droplets from the vapor stream and producing a purified acid gas stream.

40. The method of claim 38, wherein the liquid stream is in fluid communication with at least one of the sour water stream and a portion of the another ammonia stripper liquid stream.

41. The method of claim 40, wherein the heated sour water feed stream is separated into the ammonia stripper vapor stream and the ammonia stripper liquid stream using another portion of the another ammonia stripper liquid stream.