



Control Valve Sourcebook — Chemical Process Overview

Ammonia Production

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Ammonia Production

Ammonia production can be broken down into the following processes: purification of feedstock, reforming, shift conversion, carbon dioxide conversion/removal, methanation, and ammonia synthesis. Several companies own licenses to an ammonia production process; however, they share many common steps.

I. Purification of Feedstock

Natural gas is initially directed to a feed gas knockout drum, where entrained liquids and solids are removed. A single case centrifugal compressor may be utilized depending on the transmission line pressure.

The compressor feed gas is heated to 371°C in the convection section of the primary reformer, prior to desulfurization. The nickel-containing catalysts are sensitive to poisons, any sulfur compounds present in the hydrocarbon feedstock have to be removed. The heated gas then enters the desulfurization vessel where any small quantities of organic sulfur compounds are hydrogenated to create hydrogen sulfide, H₂S, over a series of catalyst beds.

The two desulfurization vessels are arranged in a “lead lag” configuration such that either vessel can be taken off-line for catalyst replacement while the other remains in service. Each vessel contains enough catalyst for at least one year of service.

The desulfurized feed is mixed with medium pressure steam prior to reforming. The mixed feed is then preheated in the convection section of the primary reformer. The temperature used is higher to reduce the furnace firing requirements and improve overall efficiency.

II. Reforming

Steam Reforming

The objective of the primary reformer is to produce a hydrogen rich synthesis gas. The primary reformer consists of a multitude of reformer tubes loaded with the catalyst in a furnace box where the heat needed for the synthesis gas reaction is transferred to the tubes by radiation.

The preheated feed is distributed to the reformer tubes which are suspended in the radiant section of the furnace. The feed flows down through the reforming catalyst and is reacted to form hydrogen, carbon monoxide, and carbon dioxide. The reforming process is endothermic. The furnace burners utilize down firing and develop a reformed gas at the outlet of the catalyst tubes.

The reforming furnace is designed to attain maximum thermal efficiency (approximately 95%) by recovering heat in the convection section.

After the reaction the synthesis gas leaves the primary reformer and continues to the secondary reformer for further conversion. The synthesis gas leaving the primary reformer contains about 65% hydrogen and 14% methane with the balance containing carbon dioxide and carbon monoxide.

Secondary Reforming

During secondary reforming, the synthesis gas is mixed with the necessary quantity of preheated process air to provide the nitrogen content required for the ammonia synthesis reaction.

Oxygen in the air combusts part of the methane gas from the primary reformer. This leads to mixing of the process in a high temperature combustion chamber above the catalyst bed. The combusted gas from this process passes through a bed of reforming catalyst where it reacts to further produce hydrogen, but with heat provided by methane combustion. Due to the overall endothermic nature of the reforming reaction, the gas temperature leaving the secondary reformer is approximately 1010°C (1,850°F).

The synthesis gas leaving the secondary reformer passes directly to the secondary reformer waste heat boiler where high pressure steam is generated. The partially cooled gas then proceeds to the high temperature shift reactor.

III. Shift Conversion

During shift conversion, the intent is to drive carbon dioxide and hydrogen formation. This is accomplished when carbon monoxide is reacted with steam.

There are two shift reactors, the high temperature shift converter (HTS), and the low temperature shift converter

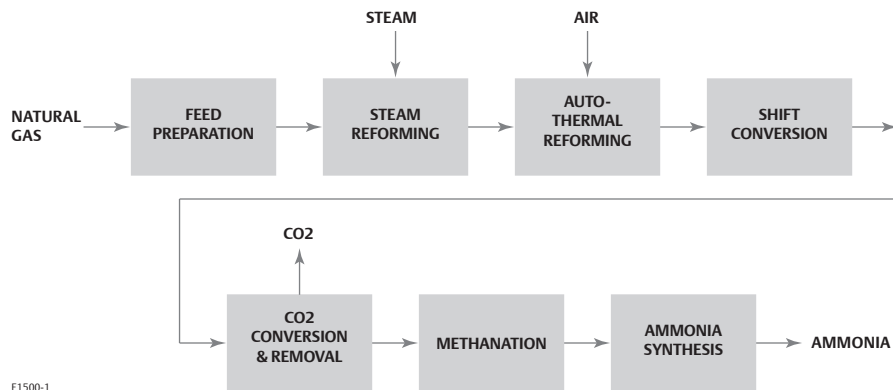


Figure 1. Block Diagram of Typical Ammonia Production Process

(LTS). Each shift uses a different kind of catalyst. The shift reaction is a reversible exothermic reaction. The carbon monoxide shift reaction is favored by high temperatures, while the conversion of carbon monoxide to carbon dioxide is found at low temperatures.

High pressure steam is generated utilizing the LTS effluent (carbon dioxide and hydrogen) in a boiler feed water preheater to moderate gas temperature between the high and low temperature shift. The carbon dioxide removal section utilizes LTS effluent waste heat for steam generation. The remaining synthesis gas waste heat is utilized to preheat a major portion of the demineralized water supply to the de-aerator.

IV. Carbon Dioxide Conversion & Removal

The synthesis gas leaving the shift converters primarily contains carbon dioxide, hydrogen, and nitrogen with residual carbon monoxide, methane, and water. The synthesis gas is further treated to remove carbon dioxide yielding a highly pure hydrogen-nitrogen rich synthesis gas.

This is accomplished by use of a potassium carbonate solution. The carbonate solution chemically combines with the carbon dioxide in the synthesis gas, but not with the other elements.

The removal of carbon dioxide from the synthesis gas is done by counter—currently contacting the gas with the potassium carbonate solution in the carbon dioxide absorber. Synthesis gas enters the lower section of the pack absorber where a major portion of the carbon dioxide gas is removed by contact with the carbonate solution. The synthesis gas leaving the lower section is again contacted by a portion of the regenerated carbonate solution in the upper section of the absorber.

The “rich” potassium carbonate solution, containing high concentrations of carbon dioxide, flows from the bottom of the absorber to a hydraulic turbine.

Regeneration of the potassium carbonate solution is accomplished by steam stripping in the carbon dioxide stripper. Heat required for stripping, available from the LTS effluent, is obtained by reboiling stripper condensate and from the lean solution flash system.

Final removal of residual carbon dioxide and carbon monoxide is accomplished by methanating the carbon oxides to methane and water by using hydrogen.

V. Methanation

Methanation is the simplest method to reduce concentrations of carbon oxides and is widely used in steam reforming plants. Disadvantages include hydrogen consumption and production of additional inert gases in the make-up gas of the synthesis loop.

The advantages of simplicity and low cost outweigh the disadvantages. The hydrogen and nitrogen rich synthesis gas from the carbon dioxide absorber overhead knock out drum is heated in the methanator exchanger. A gas bypass is used

to control the feed temperature when the oxide content in the synthesis gas is high.

The methanator contains a bed of catalyst that promotes the reaction of carbon dioxide and carbon monoxide with hydrogen to form methane and water.

After the heat exchange, the purified synthesis gas is cooled in the synthesis gas suction chiller, before going to the synthesis gas compressor suction drum. A small portion of the synthesis gas is recycled back to the natural gas compressor to provide a hydrogen source for desulfurization. This is done to promote contaminant removal in the reformer catalyst.

VI. Ammonia Synthesis

Only partial conversion 25% of the synthesis gas can be obtained from passage through the ammonia converter. This is due to the unfavorable reaction of nitrogen and hydrogen to ammonia. The ammonia created is separated from the unreacted synthesis gas by condensation. This requires relatively low temperatures for reasonable efficiency.

With increasing pressure, ammonia formation increases. Today, plants are built mainly for synthesis pressures of 150 to 250 bar (2175 psi to 3625 psi).

The unreacted synthesis gas is supplemented with fresh synthesis gas and recycled to the synthesis gas compressor. These gases are mixed in a single case centrifugal compressor. Synthesis gas compressor kickbacks and coolers are used to cool the recycle gas which protects the compressor. Synthesis gas is then preheated before entering the ammonia converter.

The gas leaving the ammonia converter is cooled and condensed in the ammonia chiller. Liquid ammonia is removed from the synthesis gas in the separator.

VII. Unconverted Gas Treatment

Gas leaving the separator is purged to remove methane and inert gases so they do not enter the ammonia synthesis loop. The purge gas stream from the separator is directed to the high pressure ammonia scrubber for removal of any ammonia that may be present. The ammonia vapor removed from the high pressure scrubber is then sent to a cryogenic purge gas recovery unit where a major portion of the hydrogen and nitrogen are recovered and sent to the synthesis compressor.

Liquid ammonia from the separator is then depressurized and flashed into the ammonia letdown drum. The flashed vapor is mixed with the refrigeration system purge gas and sent to the low pressure ammonia scrubber. The liquid ammonia produced from the low pressure scrubber is then sent to the refrigeration system.

In both the low and high pressure scrubbers, ammonia is absorbed by a water wash and the ammonia is recovered in an ammonia distillation column.

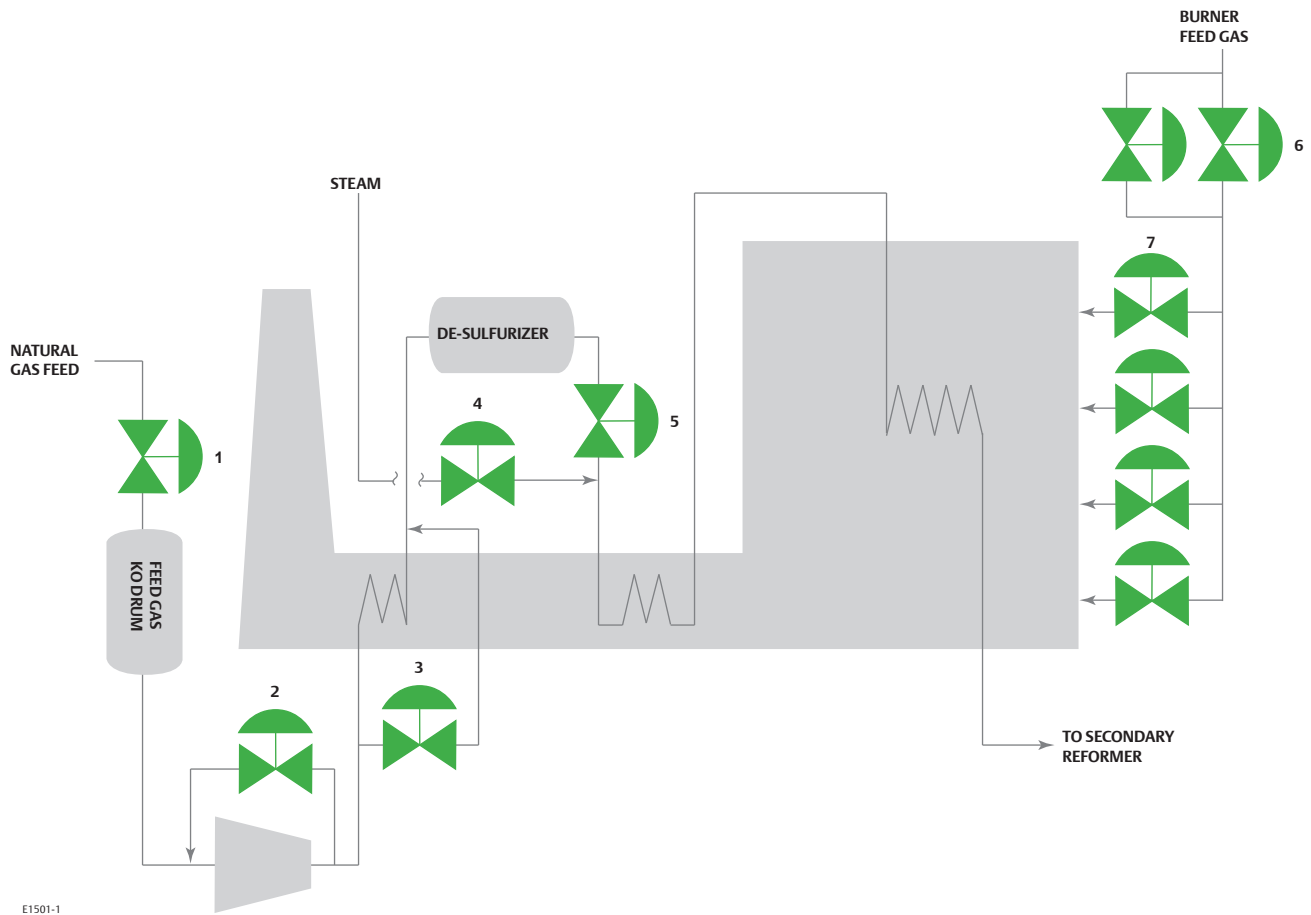


Figure 2. Process Diagram of the Primary Reformer Unit

VIII. Application Review

The KBR KAAP process and the Uhde dual pressure process are two commonly utilized technologies for ammonia processing. Primary differences between the two processes are found in the synthesis loop. The application review section will cover valve applications that are common within an ammonia plant. Each section will describe what is happening, some typical process conditions, and an example valve solution.

Reformer

A typical primary reformer flow is featured in Figure 2. Natural gas coming into the plant has impurities such as sulfur that must be removed before steam is added. This takes place in the knockout drum and desulfurizer. Natural gas is also compressed prior to entering the reformer. Steam is added after impurity removal to promote the reaction of hydrogen formation. Heat is gained as the feed gas passes through the reformer before entering the reformer tubes where the reaction takes place. The reformer is heated by a set of burners that are fueled by natural gas.

1. Natural Gas Feed Control Valve:

Natural gas is first fed to the knock out drum for impurity removal. This valve controls the flow into the plant. Poor control can reduce efficiency through the desulfurizer and poison catalyst. This valve typically takes a minimal pressure drop and may require tight shutoff depending upon block valve availability.

Typical valve selection:

- NPS 8 - 12 Fisher™ ED, EWD valve ANSI 300
- ANSI Class II shutoff
- WCC body
- 416 SST trim

2. Feed Gas Compressor Anti-surge Control Valve:

After impurities have been removed from the natural gas feed, it is mixed with a recycle stream of hydrogen rich synthesis gas and compressed in a centrifugal feed gas compressor. This valve is for anti-surge control and allows a portion of the compressor discharge to recycle to maintain a consistent downstream pressure. Whisper Trim™ is commonly used depending upon the pressure drop.

Typical valve selection:

- NPS 3 Fisher ED, ET valve ANSI 600
- ANSI Class V shutoff
- WCC or CF8M body
- 416 SST or 316 SST trim
- Fisher Whisper Trim™ I cage

3. Desulfurized Feed Temperature Control Valve:

Feed to the primary reformer is maintained at a constant temperature to support a consistent reaction rate through the reformer. Either a carbon or stainless steel butterfly valve could be specified. A metal seal is needed due to potential exposure to high temperatures.

Typical valve selection:

- NPS 3 - 4 Fisher A11 valve ANSI 600
- ANSI Class IV shutoff
- WCC or CF8M body
- 316 SST chrome plate disk
- 17-4 SST metal seal

4. Primary Reformer Steam Feed Control Valve:

Steam is added to the natural gas stream to increase hydrogen yield. A specific steam to carbon molar ratio is required to achieve high yields. Excess steam results in wasted energy and reduced yields. A globe valve with stainless body and trim is the most common selection.

Typical valve selection:

- NPS 4 - 6 Fisher ED valve ANSI 600
- ANSI Class IV shutoff
- CF8M body and trim

5. Primary Reformer Feed Gas Control Valve:

The desulfurized natural gas feed is controlled to maximize hydrogen yield by maintaining a consistent feed to the reformer. Noise attenuating trim may be needed depending on pressure drops.

Typical valve selection:

- NPS 4 - 6 Fisher ED, ET valve ANSI 600
- Class IV shutoff
- WCC body
- 416 SST trim
- Fisher Whisper Trim cage

6. Primary Reformer Burner Feed Control Valve:

Natural gas fed to reformer burners is controlled to a consistent pressure. Burner control is essential for maintaining reformer temperature, and an efficient reformer reaction. In addition to the main feed control valve, a trim valve can be utilized to provide more precise control.

Typical valve selection:

- NPS 6 - 8 Fisher ED, ET valve ANSI 300
- Class IV shutoff
- WCC body
- 416 SST or 17-4 SST trim
- Fisher Whisper Trim cage

7. Primary Reformer Burner Inlet Control Valve:

Natural gas fed to the reformer is distributed to multiple burners throughout the reformer. Maintaining consistent pressure to each burner assists to maintain temperature control throughout the whole reformer.

Typical valve selection:

- NPS 2 - 3 Fisher GX, ET valve ANSI 300
- Class IV shutoff
- WCC body, 416 SST trim

Secondary Reformer

During secondary reforming, the process gas leaving the primary reformer is mixed with the necessary quantity of preheated process air to provide the nitrogen requirements of the ammonia synthesis reaction. The secondary reformer is filled with catalyst that further promotes hydrogen formation. Figure 3 illustrates the secondary reformer flow path.

1. Secondary Reformer Temperature Control Valve:

The oxygen in the air combusts part of the process gas from the primary reformer. The air is preheated to aid reaction efficiency.

Typical valve selection:

- NPS 2 - 4 Fisher ED ANSI 600
- Class II shutoff
- WCC or WC9 body
- 316 SST / CoCr-A trim

2. Process Air Anti-surge Control Valve:

The air is compressed before being heated in the primary reformer. All plant air is sent through the same compressor system and this valve is in place to protect equipment against any process upsets.

Typical valve selection:

- NPS 4 - 6 Fisher ET valve ANSI 600
- Class IV shutoff
- WCC body
- 416 SST trim
- Fisher Whisper Trim cage

Shift Conversion

In the shift conversion step, carbon dioxide and hydrogen are formed when carbon monoxide is reacted with steam. The carbon monoxide shift reaction rate is favored by high

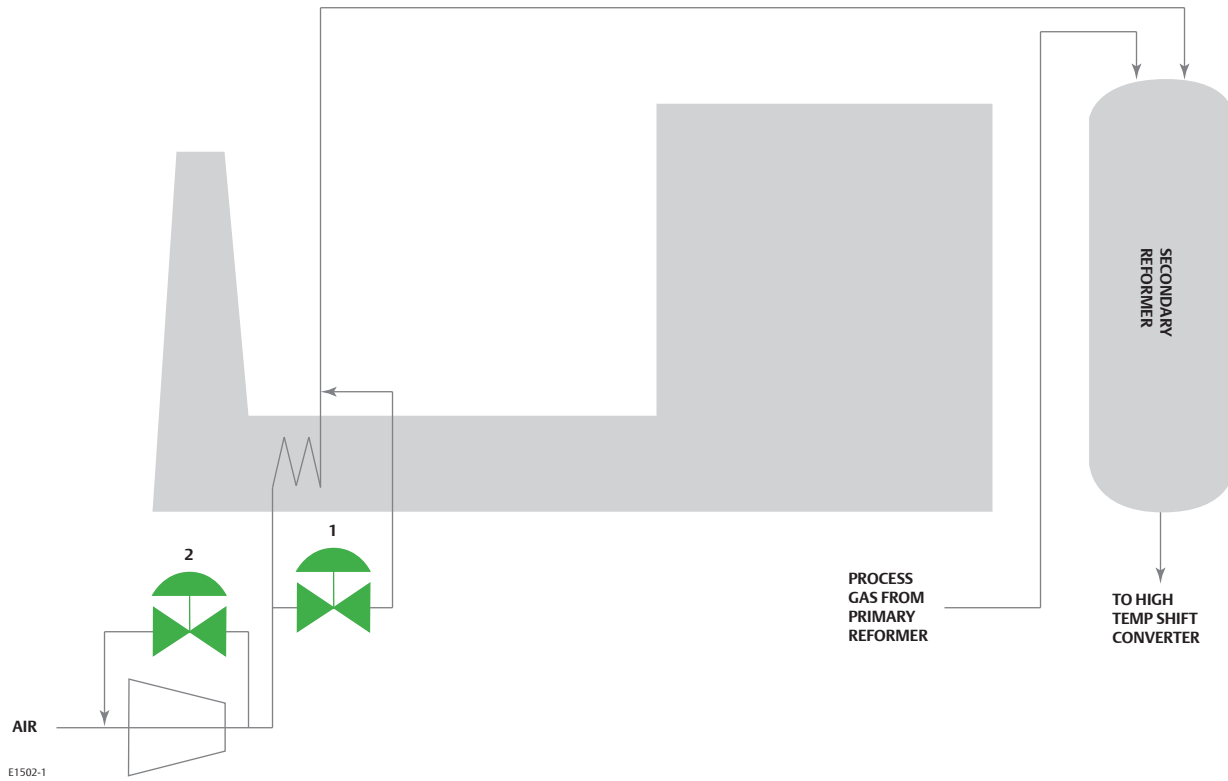


Figure 3. Process Diagram of the Primary and Secondary Reformer Unit

temperatures, but the conversion of carbon monoxide to carbon dioxide is favored by low temperatures. Therefore, there are two shift converters to aid this process as shown in Figure 4.

1. - 2. Low Temperature Shift Converter Temperature Control Valve:

High pressure steam is generated in the effluent boiler feed water preheaters. The exchange of heat allows the synthesis gas temperature to be moderated between the shift converters. There are two control valves utilized for temperature regulation.

Typical valve selection:

- NPS 3 - 4 Fisher HPD valve ANSI 1500
- Class II shutoff
- WCC body
- 416 SST trim

3. - 4. Converter Vent Valves:

Unconverted gas is flared during startup and emergency situations. This is done to protect equipment and prevent catalyst poisoning downstream.

Typical valve selection:

- NPS 12 x 8 Fisher EWT valve ANSI 600
- Class IV shutoff
- WCC body
- 416 SST trim
- Whisper Trim cage

Typical valve selection:

- NPS 10 x 8 Fisher EWT valve ANSI 600
- Class IV shutoff
- WCC body
- 416 SST trim

Synthesis Gas Separation

After the synthesis gas leaves the shift converters it primarily contains: carbon monoxide, carbon dioxide, and water. The synthesis gas is cooled and sent to the raw gas separator to remove as much condensate as possible before carbon monoxide / carbon dioxide removal, as shown in Figure 5.

1. Steam Generator Level Control Valve:

The carbon dioxide removal system utilizes LTS effluent waste heat for steam generation in the carbon dioxide removal process. The level is maintained in the generator to provide consistent steam generation.

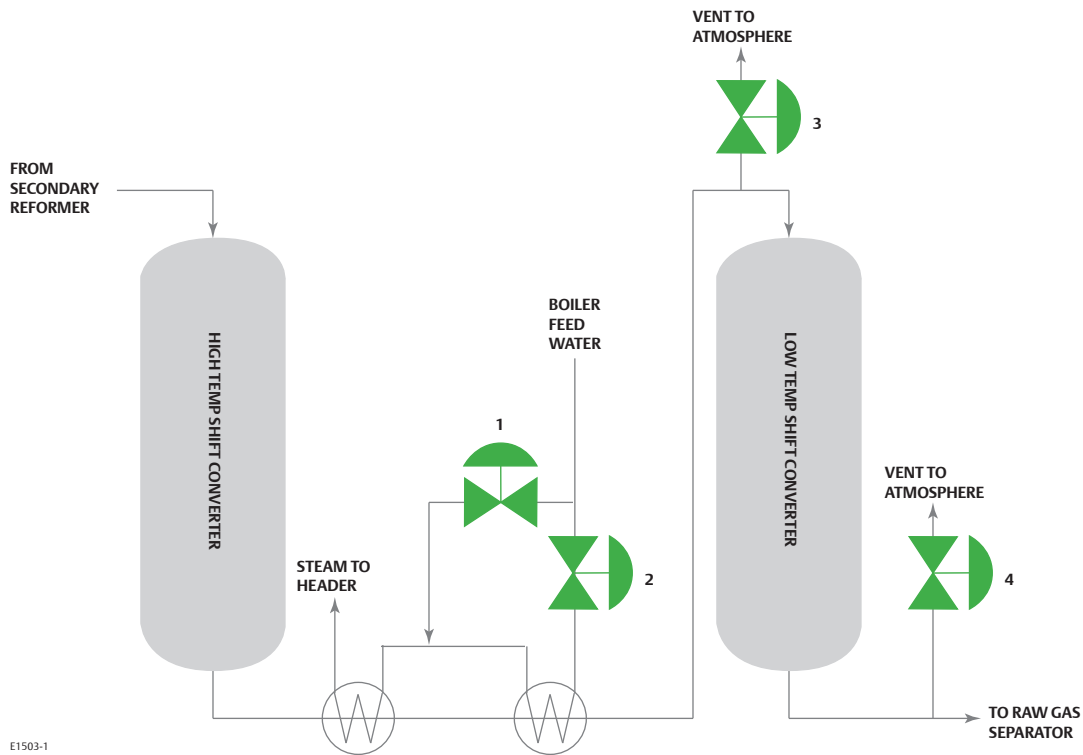


Figure 4. Process Diagram of the Shift Converters

Typical valve selection:

- NPS 2 Fisher GX, EZ valve
- Class IV shutoff
- WCC body
- 316 SST / CoCr-A trim

2. Steam Generator Pressure Control Valve:

Steam generated from the LTS effluent is allowed to build pressure in the generator. The steam pressure released is controlled to provide a consistent quality.

Typical valve selection:

- NPS 16 Fisher FBT valve
- Class IV shutoff
- CF8M body
- 316 SST / CoCr-A trim
- Whisper Trim cage

3. Raw Gas Separator Vent Valve:

Before the synthesis gas stream is sent to the carbon dioxide absorber it enters a raw gas separator. A critical startup vent valve is located on the effluent line to the absorber.

Typical valve selection:

- NPS 12 Fisher EWT valve
- Class V shutoff
- CF8M body
- 316 SST trim
- Whisper Trim

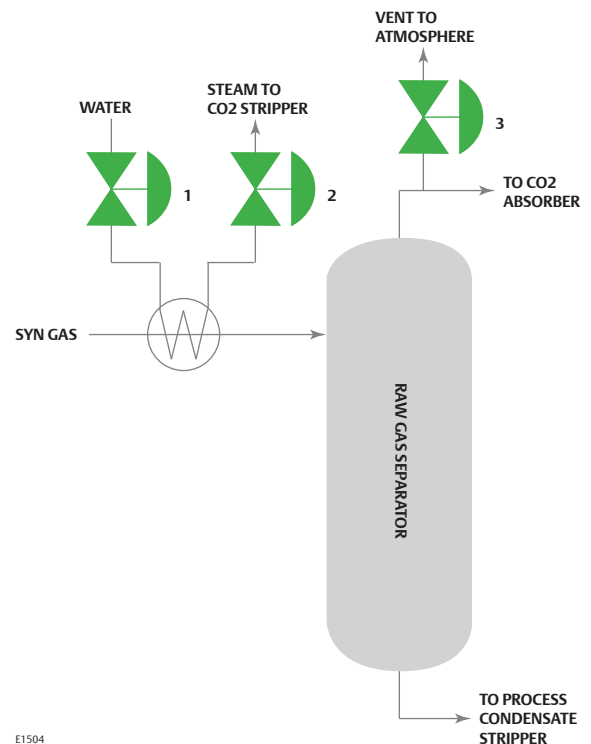


Figure 5. Process Diagram of Synthesis Gas Separation

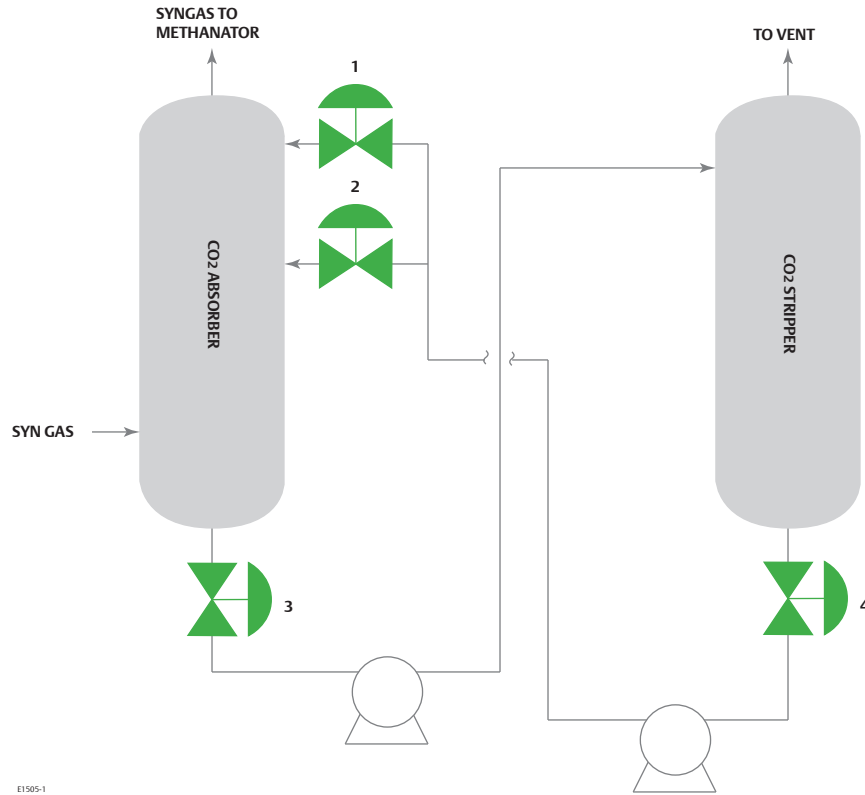


Figure 6. Process Diagram of Synthesis Gas Purification

Synthesis Gas Purification

Synthesis gas is further processed to remove carbon dioxide to yield a high purity hydrogen and nitrogen synthesis gas. This is accomplished by sending the synthesis gas through an absorber that counter currently flows an aqueous potassium carbonate solution. Figure 6 illustrates this process and includes the carbon dioxide rich solution sent to the stripper for regeneration. The “rich” potassium carbonate solution will partially flash at the stripper operating pressure as it enters the column. The steam entering the bottom of the stripper will regenerate the potassium carbonate solution before it is returned to the absorber. The regenerated solution is withdrawn and directed to the solution flash tank for heat recovery.

1.-2. Regenerated Amine Feed Control Valve:

The carbon dioxide removal process commonly uses a potassium carbonate solution for absorption. The solution fed to the absorber is flow controlled in the upper and lower section by a similar valve selection for each location.

Typical valve selection:

- NPS 10 - 12 Fisher EWT valve
- Class II shutoff
- WCC body
- 316 SST / CoCr-A trim
- Alloy 6 seat ring

3. Absorber Level Control Valve:

The level in the absorber is controlled by a one- or two-valve configuration. The large pressure drop across these valves causes carbon dioxide to be released from the solution resulting in out-gassing and requires special attention. Depending upon the pressure drop different considerations should be taken. Hard faced trim could be sufficient without a Whisper Trim cage. An oversized stem in alternative materials would also provide a more robust construction when high vibration is likely.

Typical valve selection:

- NPS 8 - 12 Fisher EWT valve
- Class IV shutoff
- CF8M body
- Solid Alloy 6 seat ring and cage
- Oversized Inconel 718 shaft
- Double-nut, tack welded plug/stem assembly

4. Flash Tank Level Control Valve:

In the flash tank vessel the solution is successively flashed in multiple stages thereby cooling the solution and generating low pressure flash steam. This flash steam is then recompressed and directed back into the stripper column. The solution entering the tank is controlled to keep a steady level to achieve the desired cooling.

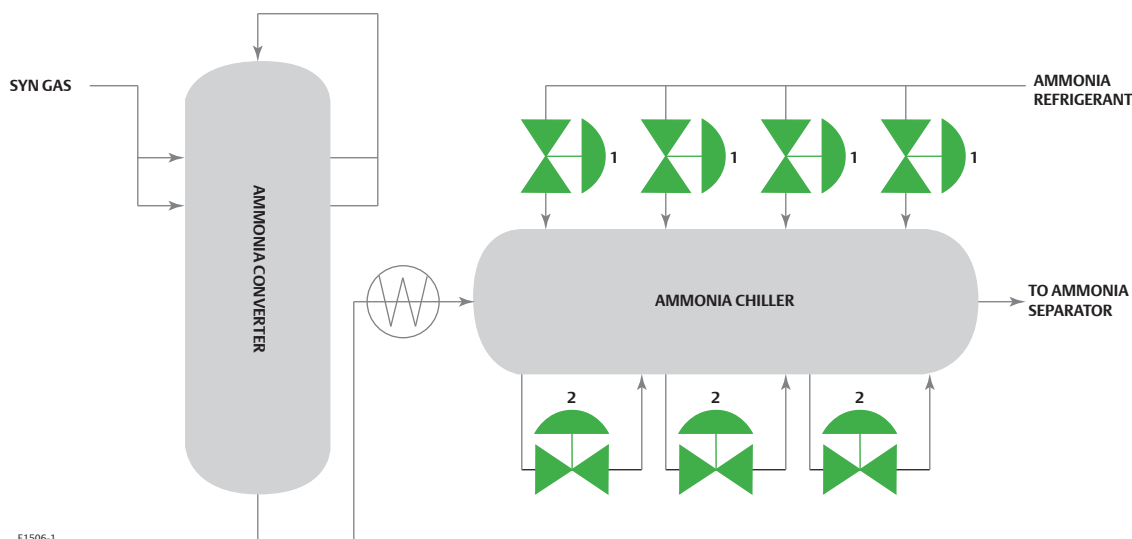


Figure 7. Process Diagram of Ammonia Synthesis and Cooling

Typical valve selection:

- NPS 24 Fisher HPBV valve
- Class IV shutoff
- CF8M body
- 316 SST trim and Novex seal

Ammonia Synthesis

After the carbon oxides have been removed in the absorber and methanator, the synthesis gas is sent to the ammonia converter. The synthesis reactor utilizes the converted gas as a heat source for the incoming synthesis gas as shown in Figure 7. The gas is then cooled in the ammonia chiller.

1. Refrigerant Flow Control Valve:

The synthesis gas leaving the converter is cooled and condensed in the ammonia chiller. There are multiple flash drums located in the chiller unit. Each compartment has a flow control valve to provide a consistent supply of ammonia refrigerant.

Typical valve selection:

- NPS 6 - 8 Fisher ED, EWD valve
- Class II shutoff
- WCC body and 416 SST trim
- Whisper Trim III cages A3-D3

2. Chiller Level Control Valve:

The synthesis gas leaving the converter is cooled and condensed in the ammonia chiller. There are multiple flash drums located in the chiller unit. These valves assist to maintain a consistent level in each compartment.

Typical valve selection:

- NPS 4 Fisher ED, ET valve
- Class II shutoff
- WCC or LCC body
- 316 SST / CoCr-A hard faced trim
- Extended bonnet

Ammonia Separation

Liquid ammonia is removed from unconverted synthesis gas in the ammonia separator as shown in Figure 8. Liquid ammonia from the separator is then depressurized and flashed into the ammonia letdown drum. The liquid is further cooled in the ammonia chiller and sent to storage. Flashed vapor is sent to the low pressure (LP) scrubber.

1. Ammonia Separator Level Control Valve:

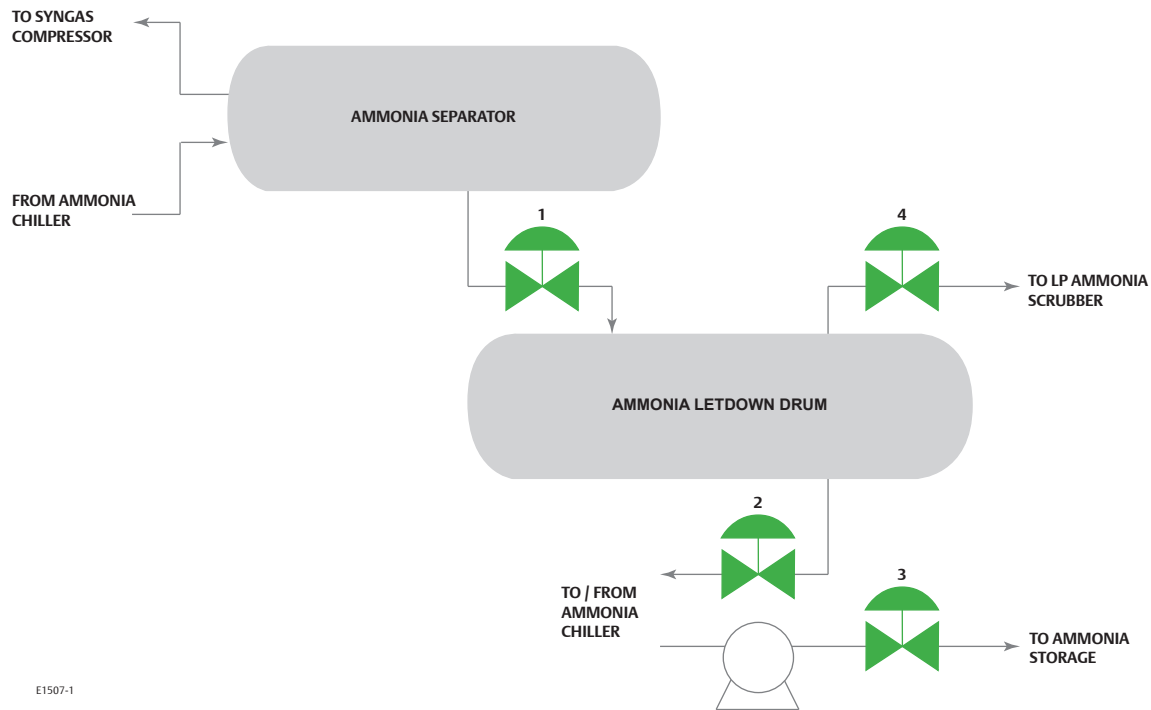
The level in the separator is maintained to provide a consistent separation of liquid ammonia from synthesis gas. The pressure drop can commonly result in flashing, therefore the trim is hard faced. Due to the cold temperatures, an extension bonnet can be utilized to move the actuator and positioner away from the process.

Typical valve selection:

- NPS 2 - 3 Fisher HPS valve ANSI 1500
- Class IV shutoff
- WCC body
- 316 SST / CoCr-A trim
- Bonnet extension

2. Ammonia Letdown Drum Level Control Valve:

The level in the letdown drum is maintained to allow the pressure of the ammonia liquid to be reduced and allow any inert gases to flash off. The pressure drop can commonly result in flashing, therefore the trim is hard faced. Due to the



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Figure 8. Process Diagram of Ammonia Separation

cold temperatures, an extension bonnet can be utilized to move the actuator and positioner away from the process.

Typical valve selection:

- NPS 6 Fisher ET, EWT valve ANSI 300
- Class IV shutoff
- WCC body
- 316 SST / CoCr-A trim, Alloy 6 seat
- Fisher ENVIRO-SEAL™ packing
- Bonnet extension

3. Ammonia Chiller Level Control Valve:

The level in the chiller is maintained to allow the liquid ammonia to cool as much as possible before heading to storage. Due to the cold temperatures, an extension bonnet can be utilized to move the actuator and positioner away from the process.

Typical valve selection:

- NPS 3 - 4 Fisher ET valve ANSI 300
- Class IV shutoff
- LCC body
- 316 SST trim
- Fisher ENVIRO-SEAL packing
- Bonnet extension

4. Ammonia Let Down Drum Pressure Control Valve:

This valve aids in maintaining a consistent pressure in the let down drum. This allows for separation of ammonia and provides a consistent feed to the LP scrubber.

Typical valve selection:

- NPS 1 Fisher EZ, GX valve ANSI 300
- Class IV shutoff
- WCC body
- 416 SST Fisher Micro-Form trim
- Fisher ENVIRO-SEAL packing

LP Ammonia Scrubber

Flash and inert gases are sent to the low pressure ammonia scrubber, illustrated in Figure 9 . Ammonia is absorbed by a water wash and the ammonia is recovered in the ammonia distillation column.

1. LP Scrubber Pressure Control Valve:

A consistent pressure in the scrubber aids water absorption of ammonia. It also serves the purpose of maintaining a safe operating pressure inside the scrubber.

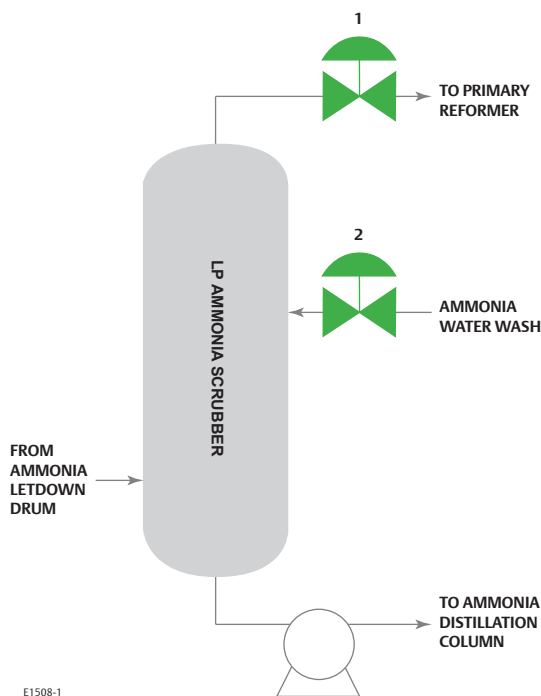


Figure 9. Process Diagram of the Low Pressure Ammonia Scrubber

Typical valve selection:

- NPS 1 Fisher EZ, GX valve ANSI 300
- Class IV shutoff
- WCC body
- 416 SST Fisher Micro-Form trim
- Fisher ENVIRO-SEAL packing

2. LP Scrubber Flow Control Valve:

This valve aids in providing a consistent flow of water wash to the scrubber. Accurate control is needed to provide sufficient flow to absorb any ammonia.

Typical valve selection:

- NPS 1 Fisher EZ, GX valve ANSI 300
- Class IV shutoff
- WCC body
- 416 SST Fisher low-flow trim
- Fisher ENVIRO-SEAL packing

High Pressure (HP) Ammonia Scrubber

Purge gas from the ammonia separator in the synthesis loop is sent to the HP scrubber to remove any residual ammonia that is present. Ammonia is absorbed by the water wash solution entering the top of the column coming into contact with the purge gas entering the bottom as shown in Figure 10.

1. HP Scrubber Level Control Valve:

This valve maintains a consistent level in the scrubber allowing for sufficient contact time between the water and purge gas.

Typical valve selection:

- NPS 1 Fisher HPS valve ANSI 900
- Class IV shutoff
- WCC body
- 416 SST Fisher low-flow trim
- Fisher ENVIRO-SEAL packing

Ammonia Distillation Column

The water/ammonia solutions leaving the low and high pressure ammonia scrubbers are sent to the ammonia distillation column for separation. Ammonia from the refrigerant condenser is fed to the column to regulate the column temperature as shown in Figure 11.

1. Ammonia Distillation Column Temperature Control Valve:

A portion of the ammonia collected in the refrigerant condenser is sent to the column to help regulate the temperature and acts as the column reflux. Proper temperature control is essential to column efficiency. Micro trim is commonly used to control the lower flow needs.

Typical valve selection:

- NPS 1 Fisher EZ, GX valve ANSI 300
- Class IV shutoff
- WCC body
- 416 SST Fisher low-flow trim
- Fisher ENVIRO-SEAL packing

2. Ammonia Distillation Column Pressure Control Valve:

This valve controls the amount of back pressure on the column. A careful balance of temperature and pressure is important to the overall efficiency of the column and resulting ammonia purity.

Typical valve selection:

- NPS 2 Fisher ED, GX valve ANSI 300
- Class II shutoff
- WCC body
- 416 SST trim
- Fisher ENVIRO-SEAL packing

3. Ammonia Distillation Column Reboiler Control Valve:

This valve controls the amount of steam flow through the reboiler and therefore the temperature of the column. This valve must maintain a balance between ammonia purity and energy usage.

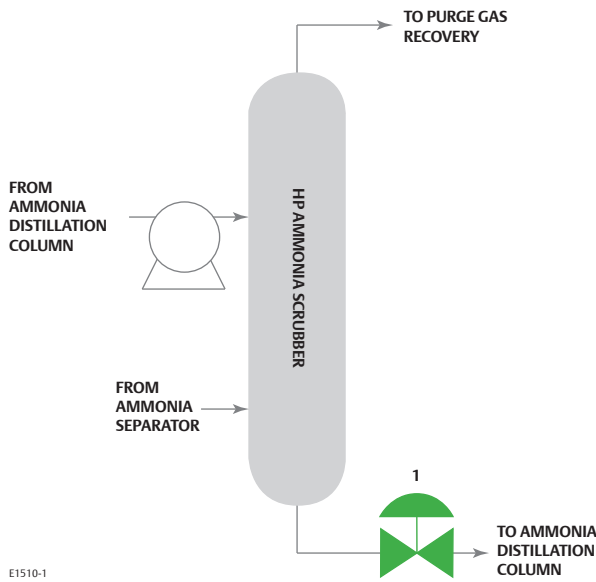


Figure 10. Process Diagram of Ammonia Distillation Column

Typical valve selection:

- NPS 2 Fisher EZ valve ANSI 600
- Class IV shutoff
- WCC body
- 316 SST / CoCr-A Fisher low-flow trim

4. Ammonia Distillation Column Level Control Valve:

The level in the bottom of the column must be maintained to ensure column performance. A small amount of condensate is added to maintain a balance in the column.

Typical valve selection:

- NPS 3/4 - 1 Fisher EZ valve ANSI 600
- Class IV shutoff
- WCC body
- 316 SST / CoCr-A

Steam Distribution

There is commonly a low pressure, medium pressure, and high pressure steam header in ammonia plants. Therefore, there are two desuperheaters that are utilized between the pressure headers. Pressure control valves are also utilized on each header.

1. HP Steam Valve:

High pressure steam is utilized to drive the turbines and corresponding compressors.

Typical valve selection:

- NPS 8 Fisher EHD valve ANSI 1500
- Class V shutoff
- WCC or WC9 body material
- 316 SST trim

2. MP Steam Valve:

Medium pressure steam is used in process and heat exchangers.

Typical valve selection:

- NPS 6 - 8 Fisher ED valve ANSI 600
- Class V shutoff
- WCC
- 416 SST trim

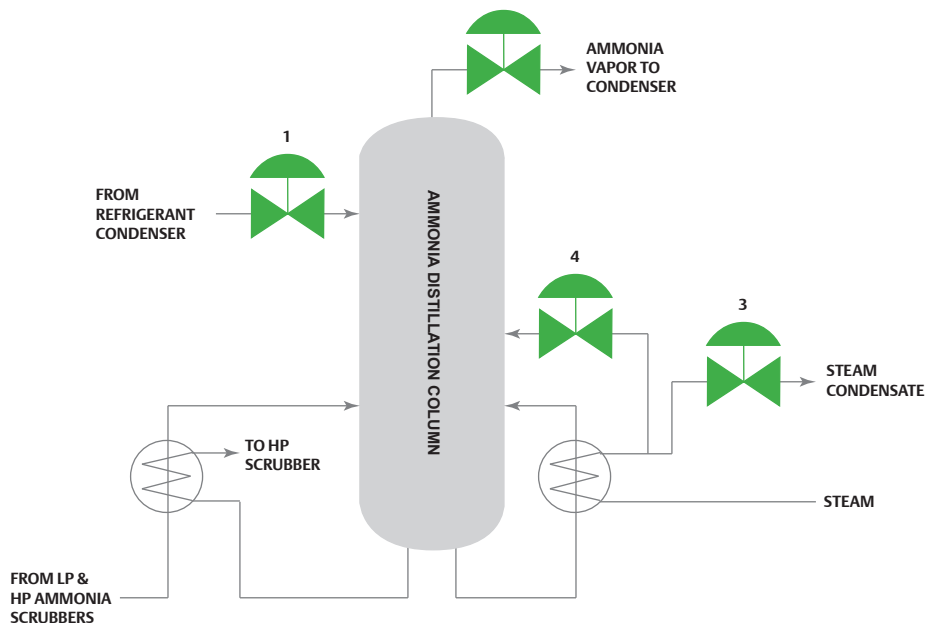


Figure 11. Process Diagram of High Pressure Ammonia Scrubber

Typical valve selection:

- NPS 4 - 6 Fisher ED valve ANSI 150
- Class V shutoff
- WCC
- 416 SST trim

Table 1. Key Applications

Application	Common Issues	Impact to Plant	Fisher Solution & Performance Impact
Primary Reformer Feed Gas Control Valve	<ul style="list-style-type: none"> ■ Valve noise issues due to large pressure drop across the valve ■ Inability of valve to accurately maintain steam to carbon ratio 	<ul style="list-style-type: none"> ■ Excessive noise can be damaging to downstream reformer equipment. Regulatory requirements typically limit noise to 85 dBa. ■ Poor controllability can negatively impact hydrogen yield and resulting ammonia yield 	<ul style="list-style-type: none"> ■ Fisher GX, ED, or ET globe valves with FIELDVUE™ instrument provides unmatched accuracy to ensure proper steam to carbon ratio ■ Improved controllability maximizes hydrogen yield and downstream ammonia yield
Primary Reformer Steam Feed Control Valve	<ul style="list-style-type: none"> ■ Inability of valve to accurately maintain steam to carbon ratio ■ Exposure to high process and ambient temperature 	<ul style="list-style-type: none"> ■ Poor controllability can negatively impact hydrogen yield and resulting ammonia yield ■ Unstable flow control caused by poor performance can lead to excessive steam use ■ Potential for reduced reliability due to long-term exposure to high temperatures 	<ul style="list-style-type: none"> ■ Fisher GX or ED can accurately control flow to ensure proper steam to carbon ratio ■ Extension bonnets and remote-mounted FIELDVUE DVC instruments mitigate the effects of high temperature service and ensure long-term reliability
Feed Gas Anti-surge Control Valve	<ul style="list-style-type: none"> ■ Valve can be oversized as a result of overestimating surge protection needs ■ High noise and vibration due to high pressure drops and flow rates during surge events ■ Sluggish performance caused by inadequate actuation system 	<ul style="list-style-type: none"> ■ Unstable flow causing large-scale flow oscillation to the reformer impacting efficiency ■ Noise can cause control valve or piping damage ■ Poor control can cause pressure fluctuations and potential damage to the compressor 	<ul style="list-style-type: none"> ■ Fisher easy-e™ with Whisper Trim III or WhisperFlo™ Trim significantly reduces noise levels ■ Fisher Optimized Antisurge Control Valves can reduce valve tuning and commissioning time needed ■ Actuation package designed to meet stroking speed requirements and also provide unmatched throttling control
Process Air Anti-surge Control Valve	<ul style="list-style-type: none"> ■ Valve can be oversized as a result of overestimating surge protection needs ■ High noise and vibration due to high pressure drops and flow rates during surge events ■ Sluggish performance caused by inadequate actuation system 	<ul style="list-style-type: none"> ■ Unstable flow impacting secondary reformer performance and operation of pneumatic instruments ■ Noise can cause control valve or piping damage ■ Poor control can cause pressure fluctuations and potential damage to the compressor 	<ul style="list-style-type: none"> ■ Fisher easy-e with Whisper Trim III or WhisperFlo trim significantly reduces noise levels ■ Fisher Optimized Antisurge Control Valves can reduce valve tuning and commissioning time needed ■ Actuation package designed to meet stroking speed requirements and also provide unmatched throttling control
CO ₂ Absorber Level Control Valve (rich amine letdown valve)	<ul style="list-style-type: none"> ■ Body and trim erosion due to outgassing effects ■ Excessive vibration due to outgassing ■ Valve can be undersized when not accounting for outgassing effects 	<ul style="list-style-type: none"> ■ Unit reliability and availability impacted by repeated maintenance ■ Undersizing of valve impacts removal of carbon dioxide and can lead to damaging downstream catalyst beds 	<ul style="list-style-type: none"> ■ Fisher easy-e with special trim tailored specifically to the severity of outgassing experienced ■ Fisher proprietary outgassing sizing methodology ensure the valve has adequate capacity to handle outgassing effects and prevent over or under sizing ■ Fisher Whisper Trim can be used to handle outgassing effects
Ammonia Letdown Drum Control Valve	<ul style="list-style-type: none"> ■ Cold temperatures impacting valve and instrument performance ■ Body and trim erosion due to possible cavitation effects 	<ul style="list-style-type: none"> ■ Valves not properly designed for low temperature can negatively impact ammonia separation and cause unnecessary rework ■ Unit reliability and availability impacted by repeated maintenance 	<ul style="list-style-type: none"> ■ Fisher easy-e with low temperature trim and extension bonnet to ensure performance at low temperatures ■ Fisher Severe Service trim can be used to handle cavitation effects

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