

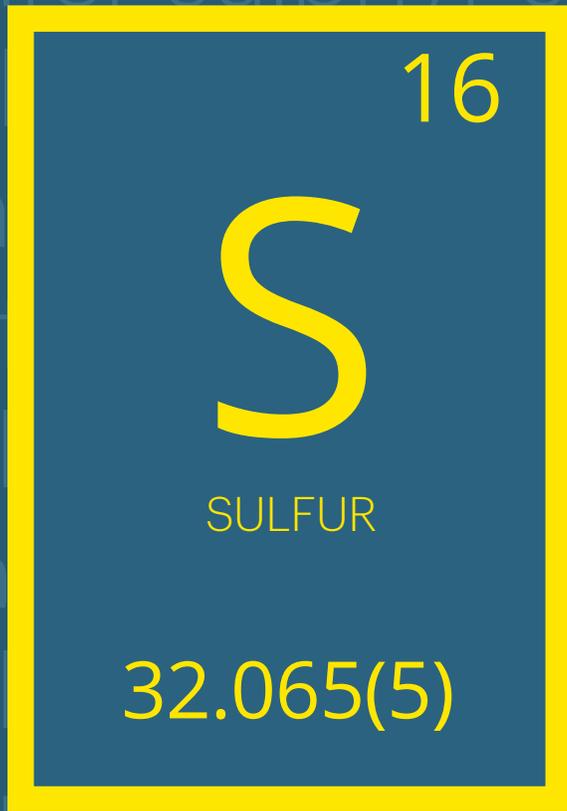


Bechtel Energy Technologies & Solutions

Sulfur Processing

Elemental Solutions for the
Energy Industry





el·e·men·tal | ,e·l·ə·men·tl |

adjective

primary or basic: features from which all other structures are built

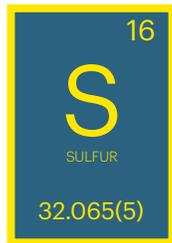
On the cover

Bechtel has been involved with oil sands since the original 1967 Suncor Energy facilities were constructed, providing both BETS technology and EPC services.

On the Suncor Upgrader project, BETS provided sulfur technology and Bechtel constructed a 2 × 537 LTPD Sulfur Complex. In 2004, an additional 537 LTPD was installed.

Sulfur Technology

Elemental solutions for the energy industry



technology is used by refineries and gas processing facilities to recover and purify sulfur as well as meet strict environmental regulations.

Bechtel Energy Technologies &

Solutions (BETS) designs and integrates our sulfur technologies into your overall sulfur processing scheme. And when complemented with other BETS technologies such as our industry leading SWSPPlusSM and ThruPlus[®] Delayed Coking technologies, you can achieve superior process optimization.

Our sulfur management experience covers a range of applications in gas processing, refining, gasification, power generation, and other related industries.

Understanding and applying technology are vital aspects of the design and construction of process plants, and individual experience is an essential element for success.

Maintaining a core technology team with in-depth experience provides the opportunity to apply proven design techniques, continue the development of design improvements, and keep abreast of emerging technologies.

BETS Sulfur Technology:

- Gas and liquid treating
- Combustion system design
- Sulfur plant heat exchanger design
- Refractory system design
- Piping layout and planning
- Piping stress analysis
- Control instrumentation and systems
- Materials handling
- Environmental permitting
- Modularization

The combination of our talent in sulfur technology, our record of effective teamwork, and our coordination of all sulfur recovery related activities in the Sulfur Technology Center produces a synergistic effect that fulfills our customers' needs and delivers the quality expected from Bechtel.

That's why **building a better world with technology** starts with us.

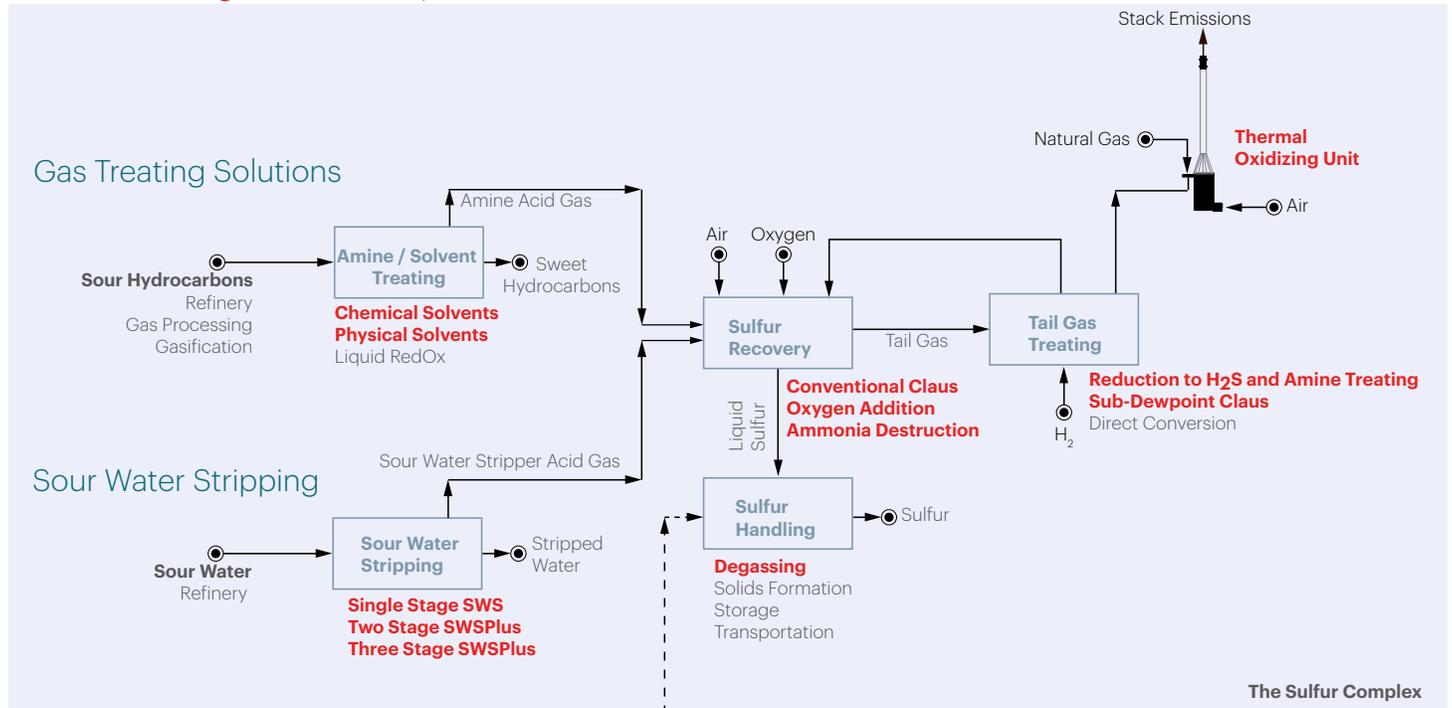
At left

How do YOU spell element 16?

sulfur, sulphur, S, sulphure, soufre, 硫磺, 황, sulphre, sulphure, sulpher, sulfer, sulphyr, solpre, Çufre, soufre, soulphre, solfre, sulfre, solfo, zolfo, schwefel, enxôfre, cepa, θείο, zolfo, zwafel, azufre, siarka, **BETS**

Our Processes & Services

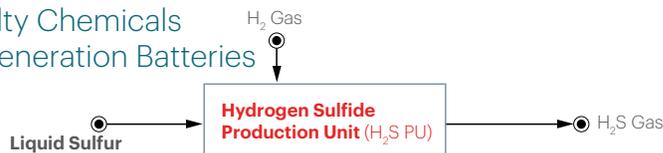
Licensed Technologies and Core Competencies



High Pressure Sour Gas



Mining & Metals Specialty Chemicals Next Generation Batteries



Pipelines



Flue Gas SO_x Removal

Fluidized Bed Combustion
Wet Limestone
SO₂ & CO₂ Removal System

Special Services

Studies
Technology Selection
Operator Training
Start-up Assistance
Troubleshooting

Environmental Compliance

Regulatory Analysis
Compliance Plans
Permitting

The Sulfur Technology Center provides a wide range of services from technology selection to unit startup. Our integrated project team provides:

Technology evaluation

- Capital cost estimates
- Operating cost estimates
- Plot area requirements
- Performance guarantee analysis
- Licensing requirements and costs

Process design (Basic packages)

- Process Flow Diagrams
- Stream Summaries
- Equipment List
- Process Datasheets
- Catalyst & Chemical Summary
- Utility Summary
- Instrumentation data
- Preliminary Piping & Instrumentation Diagrams

Process design (Extended packages — additions to the Basic package)

- Line Designation Tables
- Instrument Lists
- Utility Flow Diagrams
- Flare & Relief data
- Control philosophy
- Detailed Piping & Instrumentation Diagrams

Environmental assistance

- Regulatory analysis
- Compliance plans
- Permitting

Detailed design guidance

- Plot plan and elevation drawings
- Waste heat exchangers
- Sulfur condensers
- Specialized steam tracing
- Metallurgy recommendations
- P&ID reviews
- HAZOP reviews
- Ranges for critical instruments
- Distributed Control System screen layouts

Operations

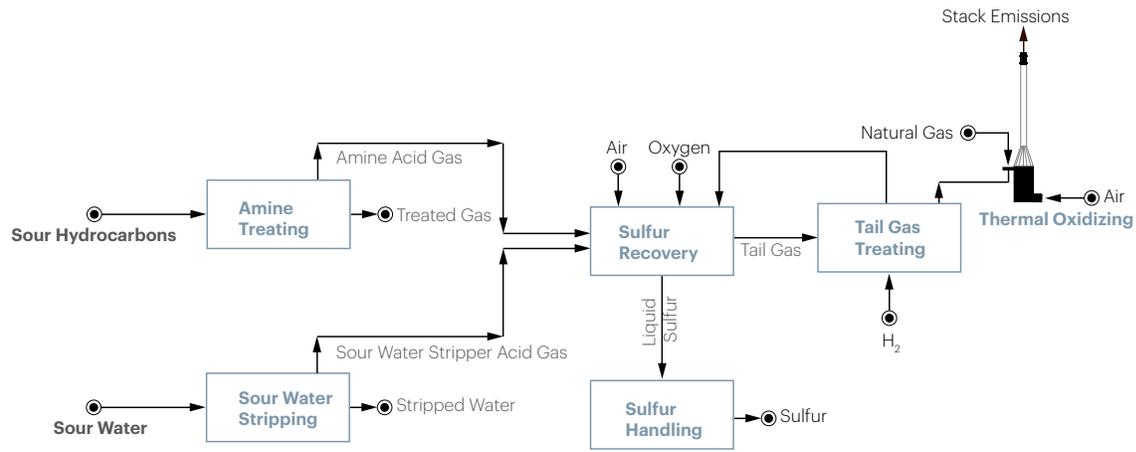
- Preparation of operating guidelines
- Operator training
- Startup assistance

Troubleshooting

- Instrumentation redesign
- New equipment design
- Unit debottlenecking

Special studies

- Plant surveys
- Operating conditions optimization



The Sulfur Complex

Bechtel Enhanced Sulfur Technology. Do you have the BEST Sulfur Complex?

The sulfur complex consists of an Amine Treating Unit, Sour Water Stripper, Claus Sulfur Recovery Unit(s), hydrogenation/amine Tail Gas Treating Unit, Sulfur Degassing Unit, Thermal Oxidizing Unit, and stack.

This complex processes sour gas (or liquid) and sour water from various refinery or natural sources. The sour gas is processed in an Amine Treating Unit (ATU) to produce sweet gas. A solution of amine and water is used to absorb the H_2S and CO_2 . The ATU regenerates the amine solution and produces an Amine Acid Gas (AAG) stream for processing in the Claus Sulfur Recovery Unit (SRU).

The sour water is processed in the Sour Water Stripper (SWS) and returns the stripped water to the facility for reuse. The SWS produces a Sour Water Stripper Acid Gas stream (SWSAG) that contains H_2S and ammonia (NH_3). The SWSAG is further processed in the Claus SRU.

For enhanced sour water stripping, BETS offers the SWSPlusSM Process. This allows 2-stage or 3-stage sour water treating with separate recovery of a high purity H_2S stream and a high purity NH_3 stream for sale as a commodity, use in fertilizers, or as chemical feedstocks. With SWSPlusSM, operators can realize an increase of almost 3 tons of H_2S processing for every ton of NH_3 recovered, improving SRU production, efficiency, and availability.

The Claus SRU processes the AAG and the SWSAG and produces liquid sulfur. The SRU recovers 92-97% of sulfur based on fresh feed. The tail gas from the SRU is processed in a hydrogenation/amine type of Tail Gas Treating Unit (TGTU). The TGTU generates an acid gas stream (TGTU-AG), which is recycled to the SRU. The overall sulfur recovery for the SRU and TGTU is between 99.8% and 99.98%.

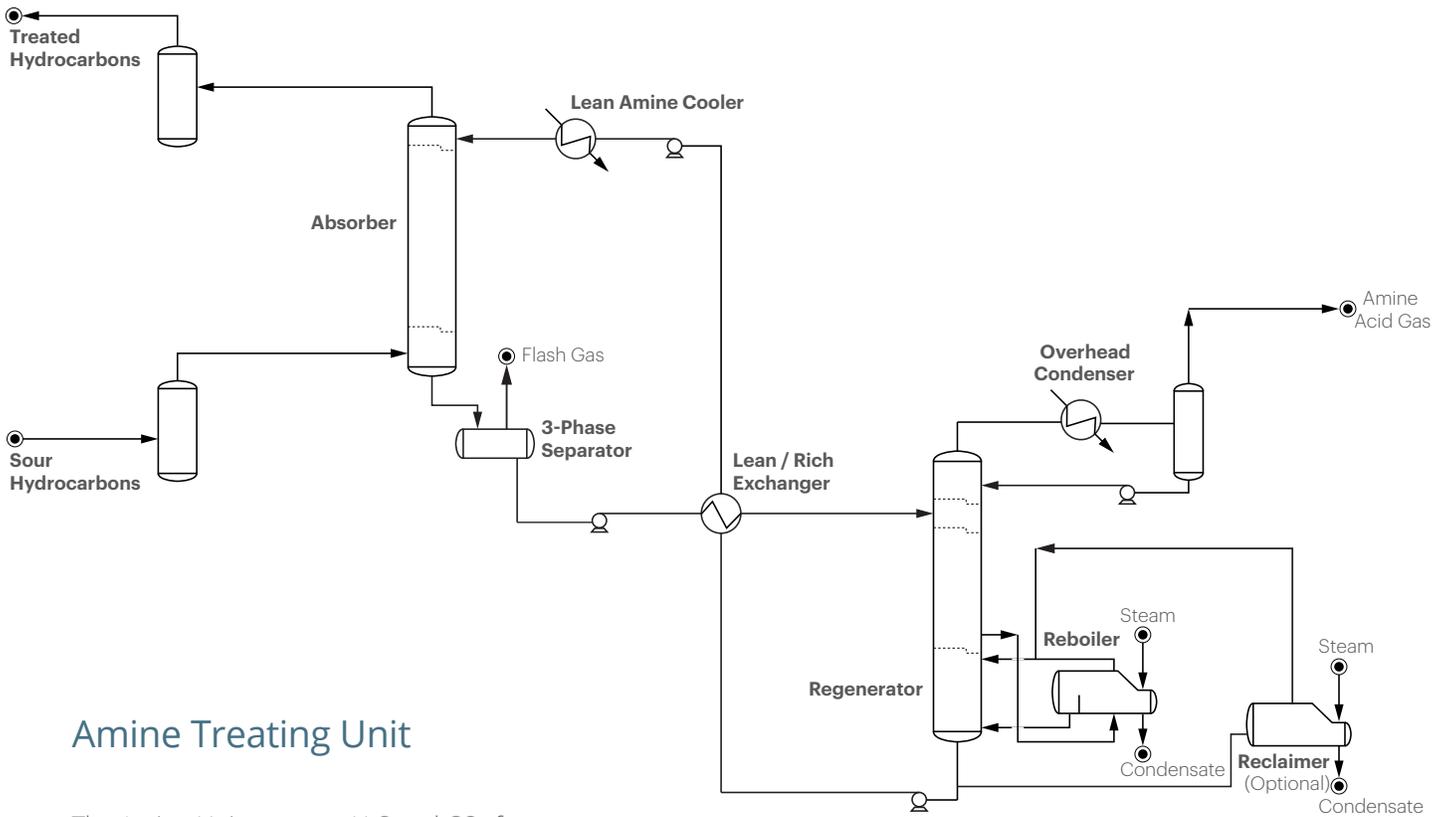
The Sulfur Degassing Unit (SDU) removes the residual H_2S in the liquid sulfur from the SRU and produces a low H_2S concentration liquid sulfur product for sale.

The Thermal Oxidizing Unit (TOU) processes the effluent gas from the TGTU (or the SRU when the TGTU is down) and discharges to the atmosphere through a tall stack.

Do you have the **BEST** sulfur plant?

World Bank project financing now requires 150 mg/Nm³ of SO_2 in the effluent to the atmosphere. That translates into a guaranteed sulfur recovery of at least 99.98%, which is far beyond the 99.5% recovery that traditional sulfur complexes are capable of achieving. The Bechtel Enhanced Sulfur Technology (BEST) takes a holistic approach to sulfur complex design, reducing or eliminating potential sources of sulfur emissions from the feed of the complex all the way to the Thermal Oxidizer.

BEST in class technology. Guaranteed.



Amine Treating Unit

The Amine Unit removes H_2S and CO_2 from the sour gas (or liquid) in the facility.

Sour gas is received in the sour gas knockout drum to remove any water or liquid hydrocarbons and then goes to the amine absorber. Lean amine is contacted with the sour gas and removes H_2S and CO_2 . The sweet gas exits the absorber through a treated gas knockout drum and is returned to the facility.

The rich amine from the bottom of the absorber goes to the three-phase separator where the light hydrocarbons are flashed out of the amine and heavy hydrocarbons are separated from the amine. The rich amine is then heated in the Lean/Rich Exchanger and fed to the regenerator column. Steam generated in the reboiler heats the amine and removes the H_2S and CO_2 from the amine. The lean amine from the regenerator is cooled in the Lean/Rich Exchanger and the Lean Amine Cooler and is returned to the absorber.

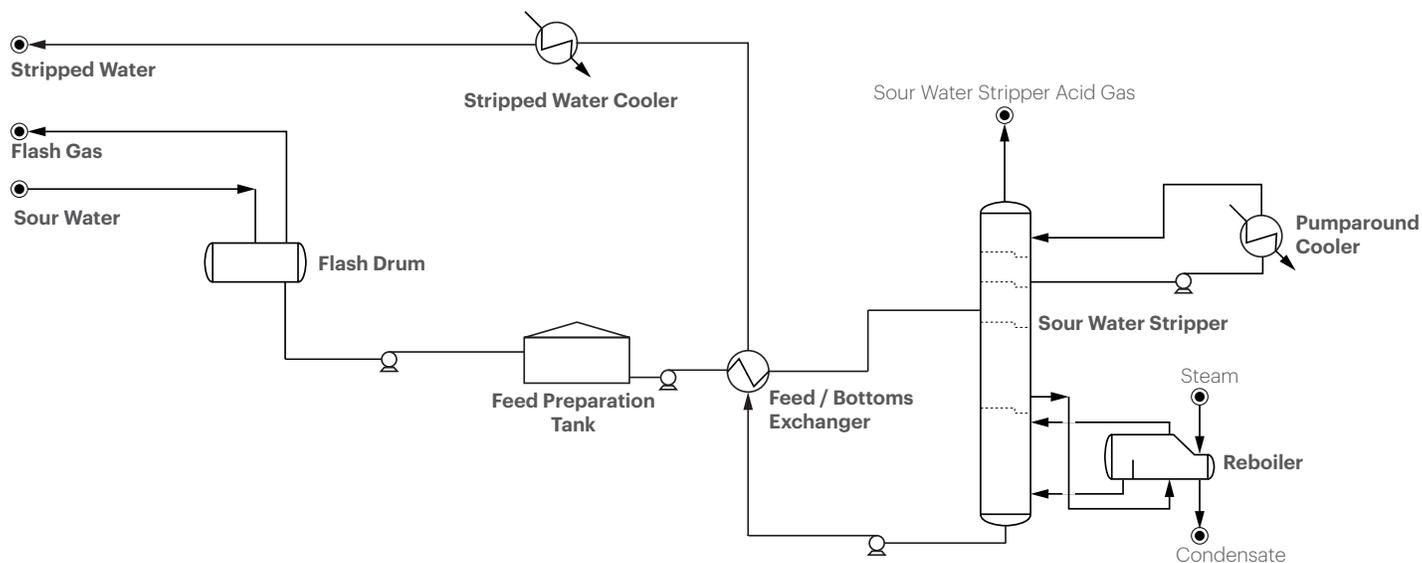
The H_2S and CO_2 removed from the amine is cooled in the Overhead Condenser and sent to the SRU for further processing.

BETS Processes & Specialties

Conventional Amines	Specialty Solvents
• MEA	• FLEXSORB®
• DGA	• GAS/SPEC™
• DEA	• OASE® (formerly aMDEA®)
• MDEA	• SELEXOL™
• DIPA	• SULFINOL®
	• UCARSOL™

Design optimization can evaluate cost based on TIC or NPV for:

- Air cooling vs. cooling water exchangers
- Shell & tube vs. plate & frame Lean/Rich Exchangers
- Regeneration tray count vs. reboiler duty
- Packing vs. trays



Conventional Sour Water Stripping Unit

The Sour Water Stripper removes H_2S and NH_3 from the sour water generated in the facility.

The sour water is received in the Flash Drum where light hydrocarbons are flashed off. The sour water is then fed to the Feed Preparation Tank where the feed is mixed and stabilized. Liquid hydrocarbons entrained in the sour water are separated and removed in the Feed Preparation Tank.

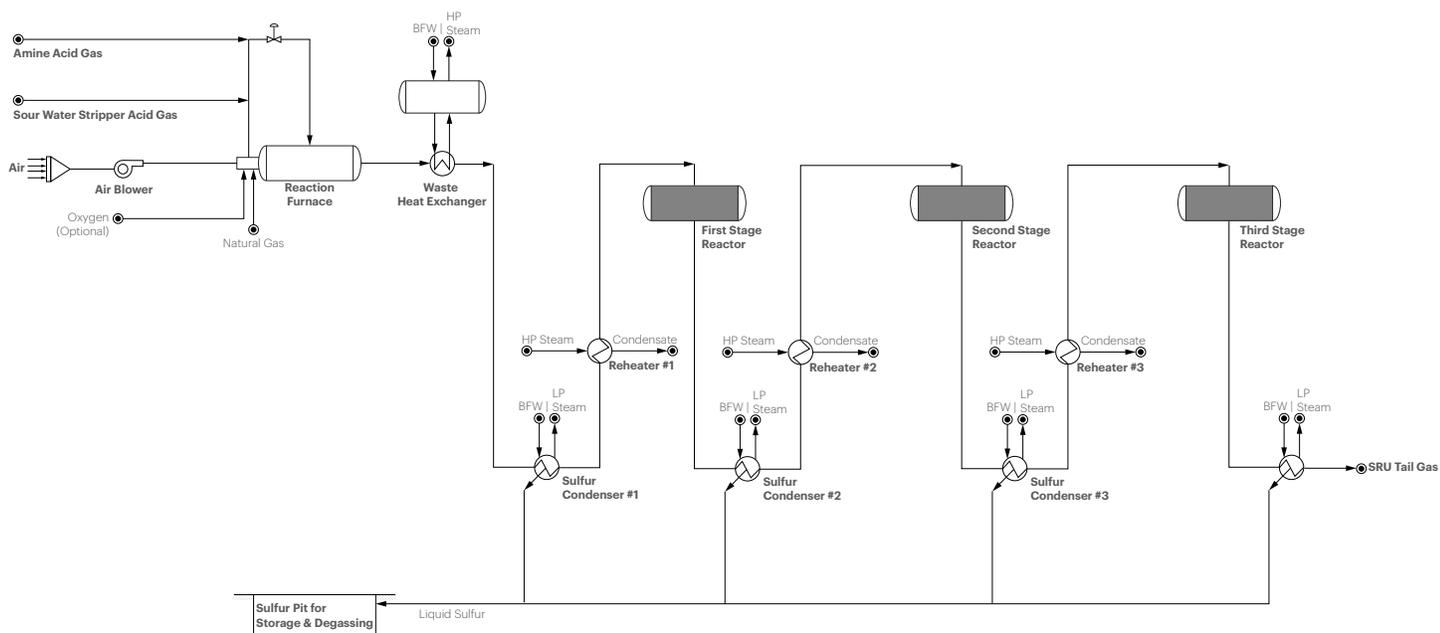
The sour water is then heated in the Feed/Bottoms Exchanger and fed to the stripper column. Steam generated in the reboiler heats the water and strips the H_2S and NH_3 from the water. The stripped water from the stripper is cooled in the Feed/Bottoms Exchanger and the Stripped Water Cooler and returned to the facility. Tower vapors are cooled using the Pump-Around Cooler, and the overhead H_2S and NH_3 are sent to the SRU for further processing.

Design optimization can evaluate cost based on TIC or NPV for:

- Air cooling vs. cooling water exchangers
- Shell & tube vs. plate & frame Feed/Bottoms Exchangers
- Stripping tray count vs. reboiler duty
- Packing vs. trays

Properties

• Feedstocks	Water with dissolved NH_3 and H_2S
• Products	Stripped Water, Acid Gas ($H_2S + NH_3 + H_2O$)
• Operating Pressure Range	10 - 20 psig (34 - 69 kPag)
• Operating Temperature Range	<240 - 270°F (<115 - 135°C)



Sulfur Recovery Unit

The SRU receives feed from the Amine Treating Unit and the Sour Water Stripper and converts the H_2S into liquid sulfur. The unit also destroys the NH_3 and hydrocarbons in the feed and converts them into nitrogen, water vapor, carbon monoxide, and CO_2 . Overall sulfur recovery is 92-97% , not including effects of the TGTU.

The Amine Acid Gas and the Sour Water Stripper Acid Gas feeds are partially combusted in the Reaction Furnace and some sulfur is produced. The process gas is cooled in Waste Heat Exchanger generating HP steam. In Sulfur Condenser #1, the gas is further cooled, the sulfur condensed, and liquid sulfur is removed. The remaining process gas is then sent through two or three catalytic reactor stages where additional sulfur is created. Each catalytic stage consists of a reheat exchanger, a catalytic reactor, and a sulfur condenser. The sulfur formed in the catalytic reactors is condensed and removed in subsequent sulfur condensers.

Liquid sulfur flows into the Sulfur Pit for storage and/or degassing. The effluent from the SRU is sent to the Tail Gas Treating Unit for additional processing.

Design optimization can evaluate cost based on TIC or NPV for:

- Number of Catalytic Stages with Tail Gas Treating Unit
- LP Steam generating pressure
- HP Steam generating pressure
- Oxygen enrichment levels (None / Basic / Enhanced)
- Unit redundancy

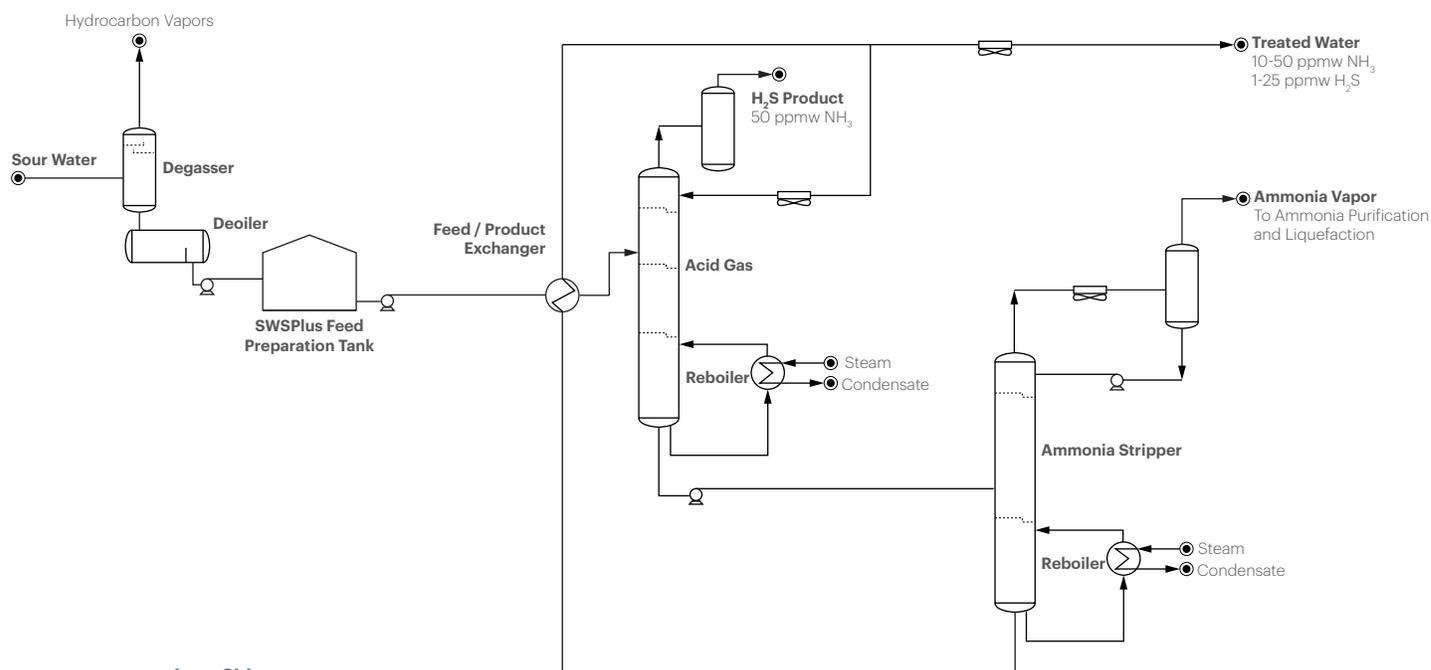
BETS Processes & Specialties

Claus Technology

- Ammonia Destruction
- Low Concentration H_2S Feeds
- Basic or Enhanced Oxygen Enrichment
- Steam / Hot Oil / Electric / Fired Reheaters
- Liquid Sulfur Degassing

Liquid REDOX

- LO CAT®
- SulFerox®



SWSPPlusSM Process

The commercially proven SWSPPlusSM technology separately recovers hydrogen sulfide (H₂S) and ammonia (NH₃) from sour water. The innovative two-stage stripping process yields acid gas with less than 50 ppmw NH₃ and a high purity gaseous or liquid NH₃ product. The produced stripped water is of excellent quality, making it suitable for reuse as:

- Make-up water
- Coke drum quench water
- Desalter wash water

For every **1 ton** of NH₃ removed, approximately **3 tons** of H₂S can be processed in the downstream Sulfur Recovery Unit (SRU). Removing NH₃ allows for effective debottlenecking of the SRU train and increased reliability.

Process Description

After degassing and feed stabilization, the sour water is distilled two separate times. The Acid Gas Stripper recovers high purity H₂S, while the Ammonia Stripper recovers NH₃ from the treated water.

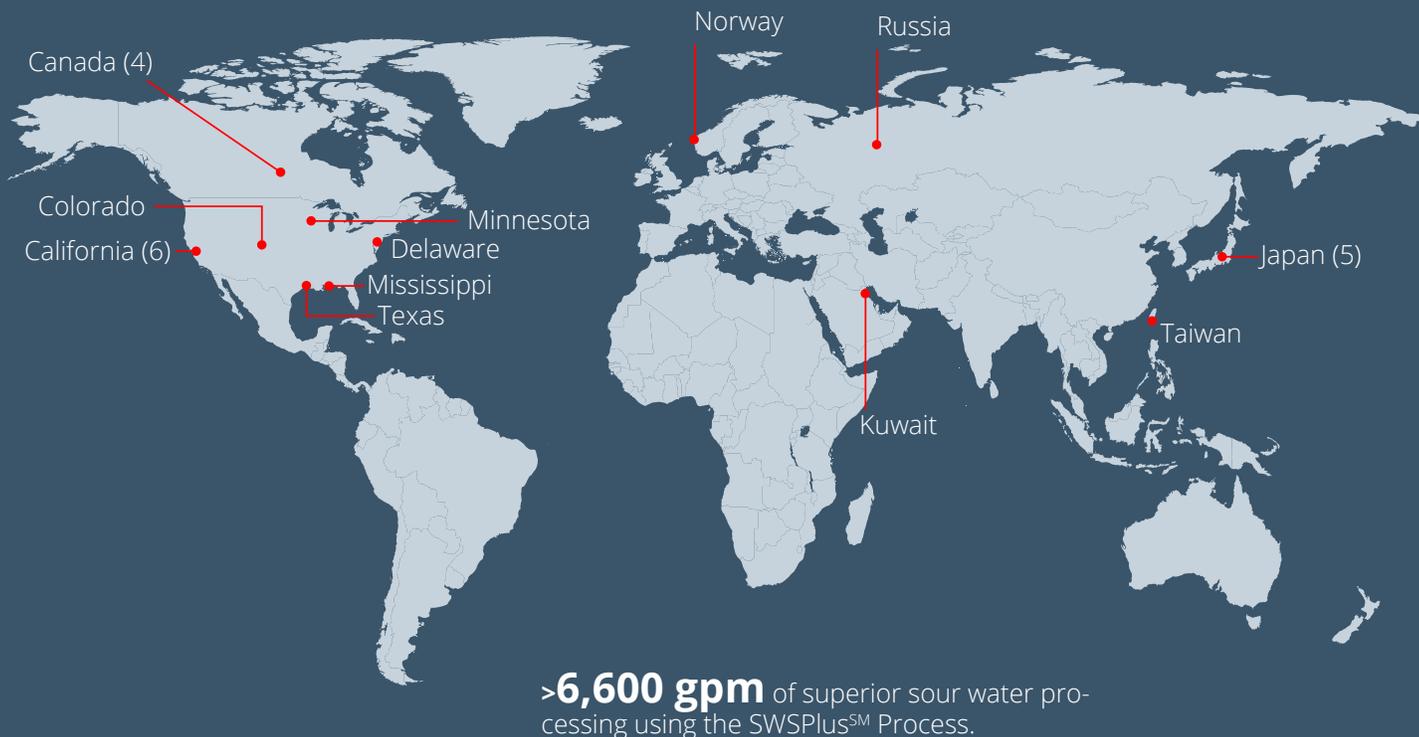
Ammonia from the Ammonia Stripper can either be incinerated or recovered as high purity anhydrous or aqueous ammonia, suitable for use in the chemicals or fertilizer manufacturing industries.

Properties

• Feedstocks	Water with dissolved NH ₃ and H ₂ S
• Products	Stripped Water, Low Ammonia content Acid Gas, Ammonia (Gaseous / Anhydrous / Aqueous)
• Operating Pressure Range	<200 psig (<690 kPag)
• Operating Temperature Range	<350°F (<175°C)

Global Experience

The SWSPlusSM Process has been proven in >20 leading refineries worldwide since 1966 with capacities ranging from 2 gpm to over 1,500 gpm.



Our Key Offerings

Technology Licensing:

- SWSPlus – recover ammonia from sour water
- ThruPlus® Delayed Coking
- Gas processing, sulfur treating & processing (H₂S, BSAT)
- Lube base oils & waxes
-

Front-End Consulting /

Technology Collaboration Services:

- Refinery
- Gas processing
- Petrochemicals
- Upstream field development
- Alternative energy

28

Reference units

50+ years

Experienced, proven technology

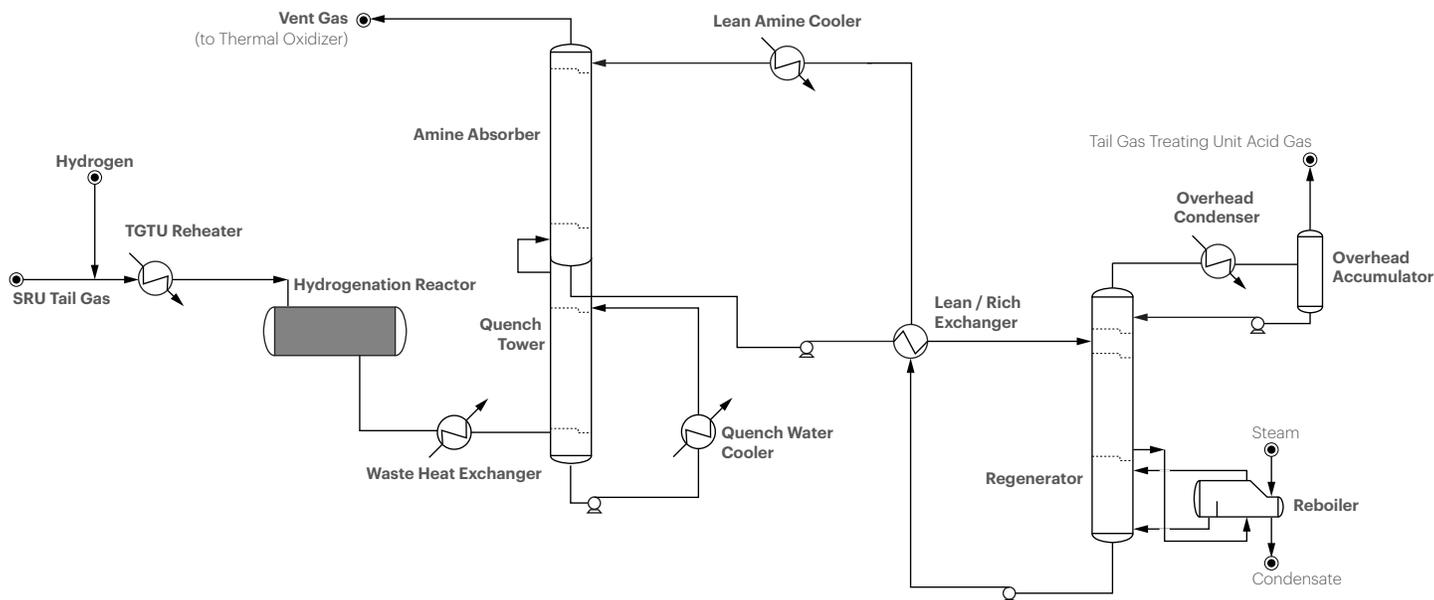
15-35% OPEX

20-40% CAPEX

Savings with a Bolt-On Absorber

up to

25% less Carbon Intensity
than conventional Haber process



Tail Gas Treating Unit

The Tail Gas Treating Unit converts the small amount of sulfur compounds (3-8%), which were not converted in the SRU, into H_2S and recycles them back to the SRU to be recovered as elemental sulfur.

The SRU tail gas is mixed with hydrogen, heated, and sent to the Hydrogenation Reactor where essentially all of the sulfur compounds are converted into H_2S . The gas from the Hydrogenation Reactor is cooled in the Waste Heat Exchanger and the Quench Tower. Excess water is removed in the cooling process and is sent to the Sour Water Stripping Unit.

The cooled gas is then sent to the absorber column where lean amine removes the H_2S and some of the CO_2 from the gas stream. The remaining gas (vent gas) is sent to the TOU.

The rich amine from the absorber is heated in the Lean/Rich Exchanger and fed to the Regenerator. Steam generated in the reboiler heats the amine and removes H_2S and CO_2 from the amine. The lean amine from the Regenerator is cooled in the Lean/Rich Exchanger and the Lean Amine Cooler and is returned to the absorber.

The H_2S and CO_2 removed from the amine is cooled (and water removed) in the Overhead Condenser and recycled to the SRU for re-processing.

Design optimization can evaluate cost based on TIC or NPV for:

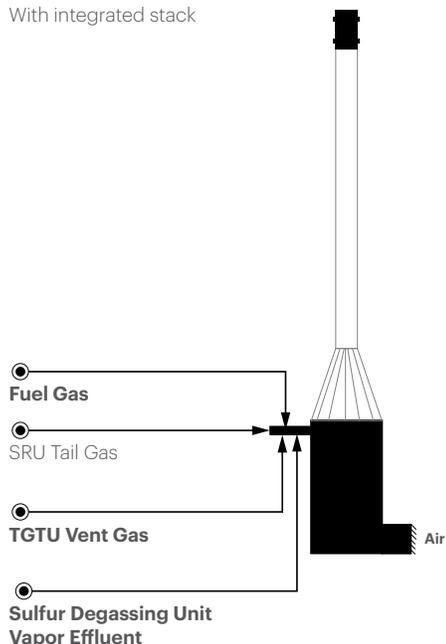
- Air cooling vs. cooling water exchangers
- Shell & tube vs. plate & frame Lean/Rich Exchangers
- Waste Heat Exchanger vs. spray quench
- Regeneration tray count vs. reboiler duty
- Packing vs. trays

BETS Processes & Specialties

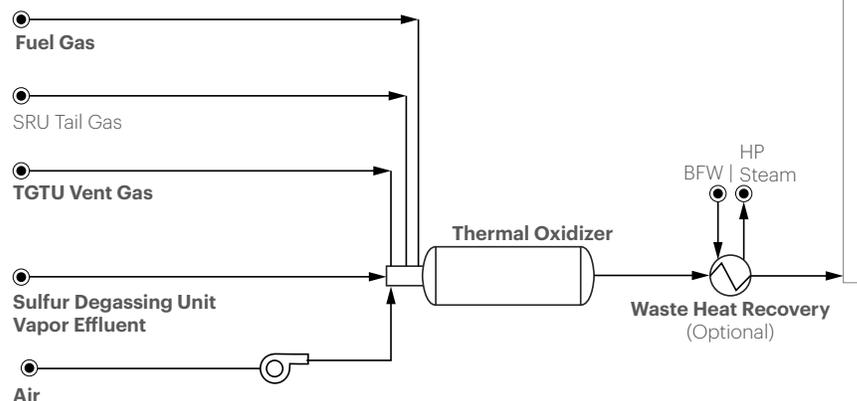
Tail Gas Treatment Technologies

- Conventional designs for 150-250 ppmv total sulfur
- Specialty solvent designs for 10 ppmv H_2S in the absorber effluent or 150 mg/Nm³ SO_2 in the TOU effluent
- Sub-dewpoint Claus

Thermal Oxidizer
With integrated stack



Thermal Oxidizer
With separate thermal oxidizer + heat recovery + stack



Thermal Oxidizer

The TOU receives feed from the Tail Gas Treating Unit, the SRU (if the TGTU is down), the Sulfur Pit, and/or the Sulfur Degassing Unit. These feeds are heated and combusted with fuel gas to convert all of the remaining compounds into sulfur dioxide, water vapor, CO₂, and nitrogen. The hot process gas is then discharged safely to the atmosphere through a tall refractory lined stack. Depending on unit-specific needs, some units have separate thermal oxidizers and stacks while others include waste heat recovery.

Design optimization can evaluate cost based on TIC or NPV for:

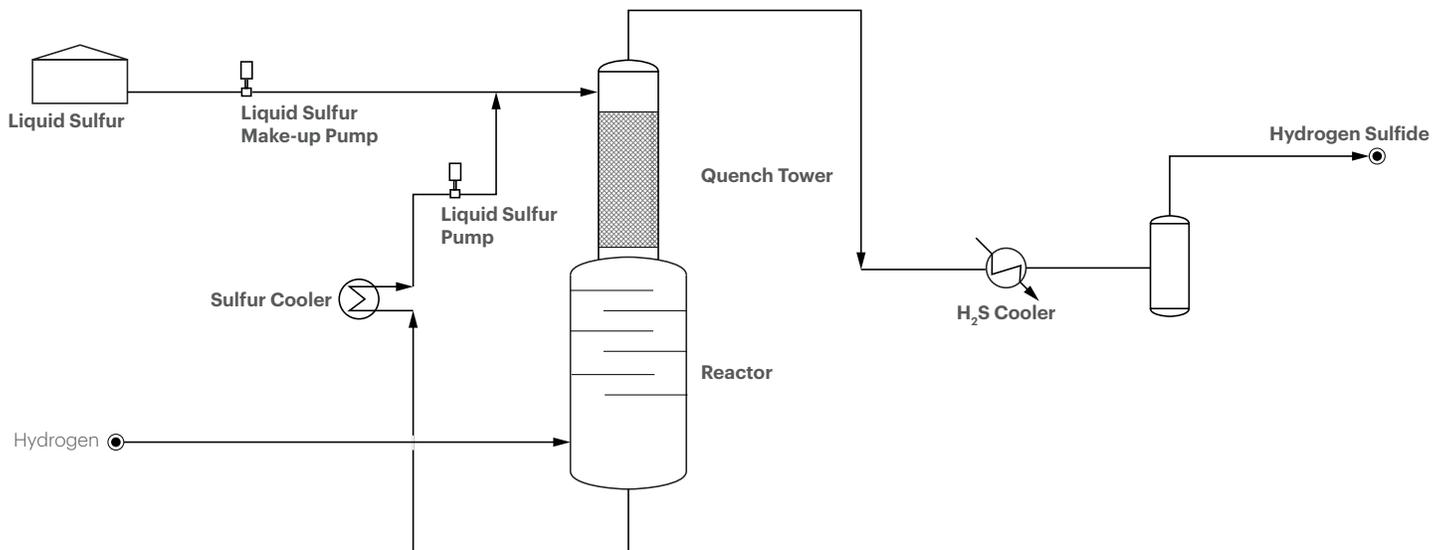
- Waste heat recovery
- Single or multiple steam levels for waste heat recovery
- Integrated thermal oxidizer and stack vs. separate equipment
- Free standing vs. supported stack

BETS Processes & Specialties

Tail Gas Incineration

- Integrated incinerator + stack
- Separate incinerator/stack with or without waste heat recovery
- Special fuel-assisted flare





Hydrogen Sulfide Production Unit

The H₂S Production Unit (H₂S PU) produces a high-quality H₂S product gas from hydrogen and liquid sulfur. This licensed technology has exclusively been provided to the mining and specialty chemicals industries since 1957.

The H₂S PU consists of a Reactor, Quench Tower, and downstream H₂S Cooler.

The unit processes liquid sulfur and hydrogen gas in the reactor and produces H₂S as a product. Sulfur in the H₂S product is removed in the Quench Tower and H₂S Cooler. Recovered sulfur is returned to the process for reuse.

Process Description

Hydrogen is fed into a trayed reactor where it contacts liquid sulfur from the Quench Tower, producing H₂S according to the following equation:



The produced H₂S exits the reactor and enters the Quench Tower and H₂S Cooler where the hot reaction gas is cooled and the sulfur contained in the H₂S gas from the Reactor is removed.

Some of the cooling and condensation required in the Quench Tower is provided by circulating sulfur from the reactor through the Sulfur Cooler.

Molten sulfur make-up to the plant is combined with recirculated liquid sulfur. The sulfur make-up is filtered to minimize the amount of solids that are introduced into the process. Solids build-up in the reactor is controlled by removing a blow-down stream of sulfur from the reactor.

Properties

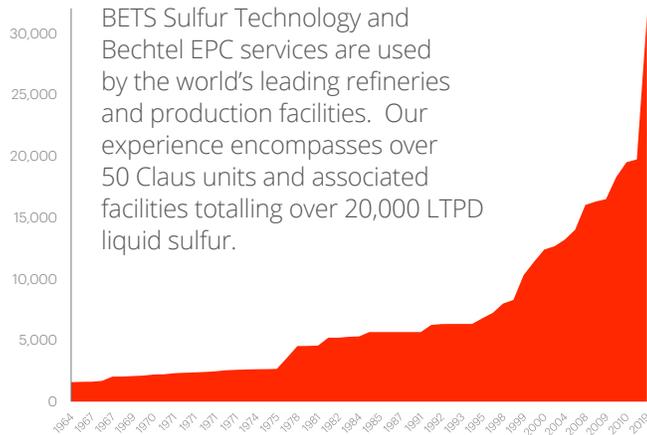
• Feedstocks	99.9%+ H ₂ and Claus quality sulfur
• Products	99%+ H ₂ S
• Operating Pressure Range	>100 psig (> 7 bar)
• Operating Temperature Range	500°F + (260°C +)

At left

BETS personnel provided process technology to the Eastman Chemical Company in Kingsport, TN, for two SRU trains at 40 LTPD each (total 80 LTPD). The Kingsport site is one of the largest chemical manufacturing sites in North America and produces chemicals, fibers, and plastics.

Our Experience

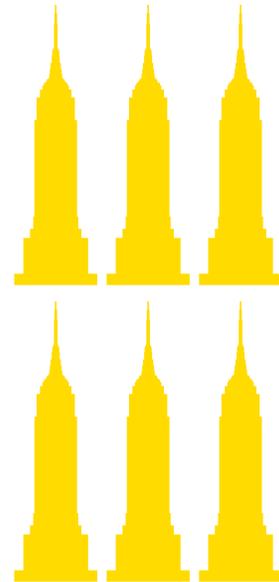
Sulfur Complexes



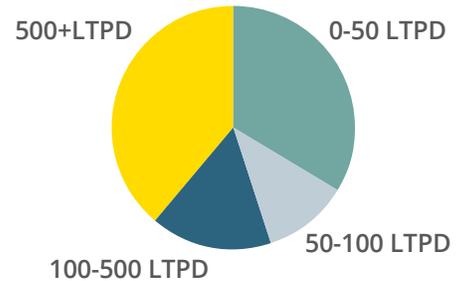
20,000 LTPD

That's enough sulfur to completely fill

six Empire State Buildings in 1 year, or...



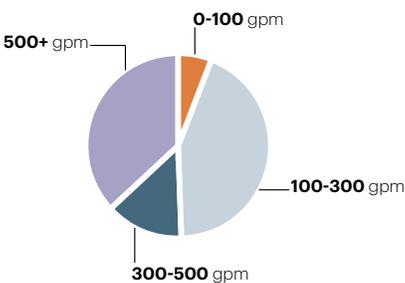
...pave a two-lane highway **8.5" deep** with sulfur in a year from



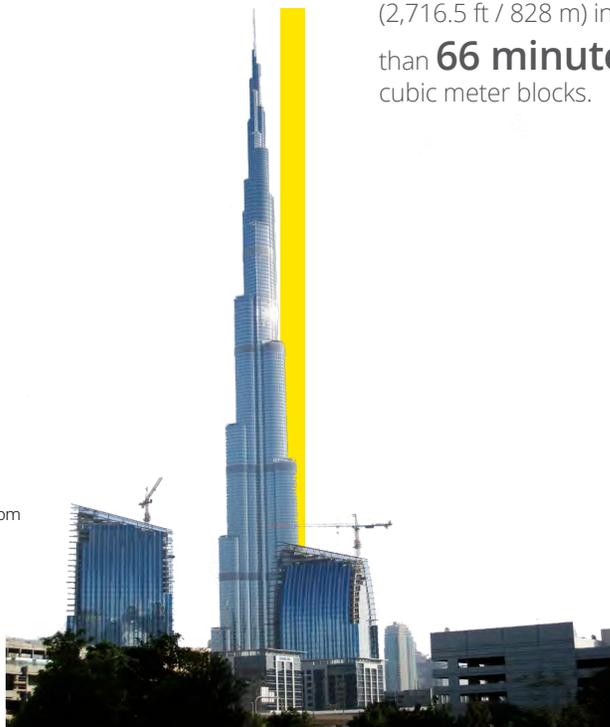
Our experience is in various feed capacities ranging from 0.5 to over 3900 MTPD.

SWSPPlusSM Process

>25 leading refineries have debottlenecked their SRU capacity with our technology since 1966 with varying SWSPPlusSM processing capacities from 20 gpm to over 1,600 gpm.



or would reach the top of the world's tallest building, the **Burj Khalifa** (2,716.5 ft / 828 m) in less than **66 minutes** in cubic meter blocks.



H₂S Production Units

BETS technologies don't just destroy H₂S. We also have technology to produce it.

H₂S is a key feedstock in the Mining & Metals and Specialty Chemicals industries, including the latest generation batteries.

Since 1957, BETS has licensed more than **12** H₂S Production Units with a total installed capacity of **368** LTPD and ranging in capacities from 2.5 to 64 LTPD.



Emerging Technologies

Research & Development

Over 2,000 employees at Bechtel Corporation are actively involved in research and development. As part of Bechtel's ongoing commitment to building a better world, BETS is actively engaged in Sulfur Technology development and is currently working to commercialize new processes to reduce sulfur recovery operating costs as well as solve pipeline sulfur deposition complications.

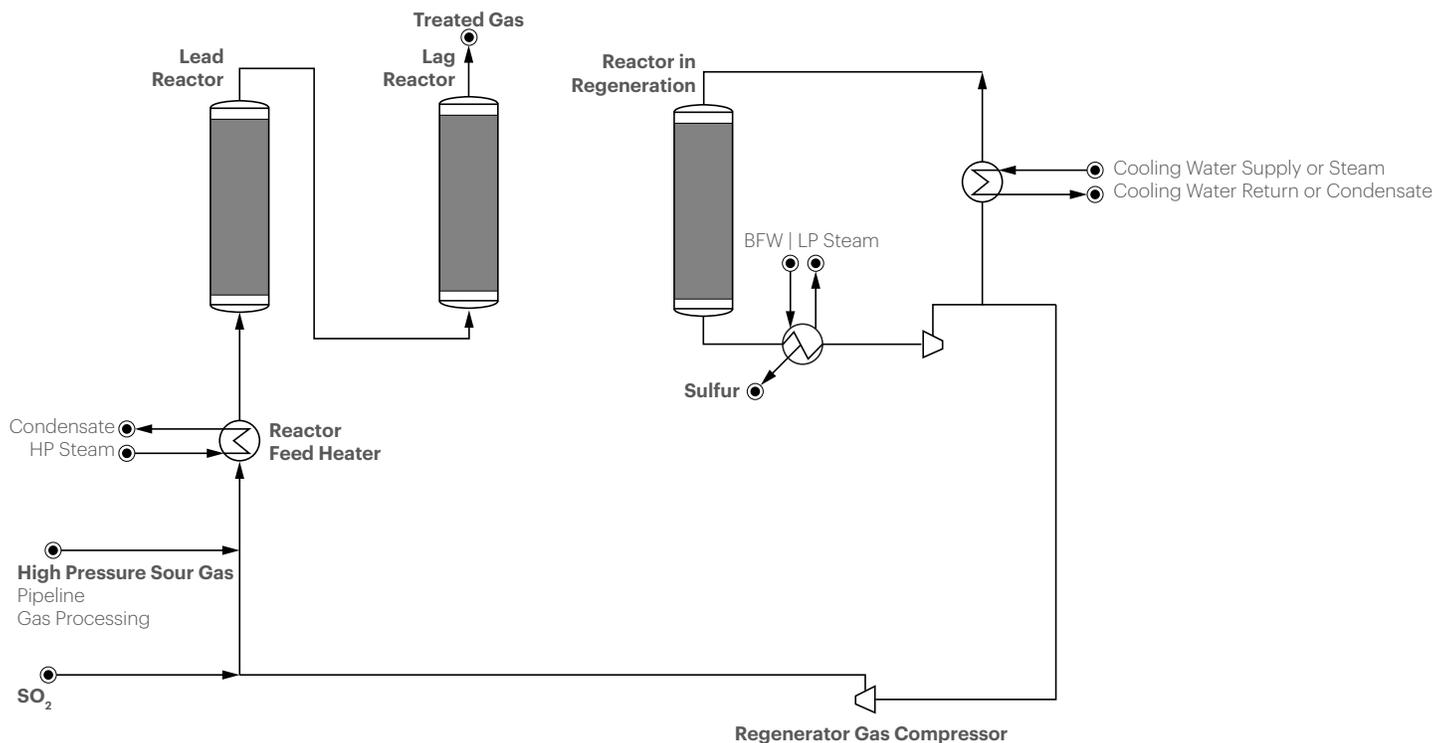
New technologies for new challenges

Bechtel Pressure Swing Claus (BPSC)

The Bechtel Pressure Swing Claus process can reduce plant capital and operating costs by 15-20% as it eliminates many of the typical processes associated with a sulfur complex.

Bechtel Sulfur Adsorbent Technology (BSAT)

The Bechtel Sulfur Adsorbent Technology addresses industry challenges with elemental sulfur deposition in pipelines or processing units by completely removing the elemental sulfur with no loss of production.



Bechtel Pressure Swing Claus

Overview

The Bechtel Pressure Swing Claus (BPSC) is a new, single-step sulfur removal and recovery technology that operates at full process pressure and at moderate temperatures. The technology can reduce plant capital cost by 15-20% and improve operating efficiency. The advantages of removing the sulfur separately from the gas, which can contain any amount of CO₂, are twofold:

- The process reacts and removes the H₂S leaving the gas at pressure.
 - For applications in the hydrocarbon industry, this eliminates processing CO₂ when the CO₂ content is already below desired levels. It can be also used to debottleneck an existing amine system.
 - For applications in the Gasification/Power Industry, this enhances the mass going to the turbine in an integrated gas combustion cycle power generation system, increasing the power recovery.
 - If removal of most of the CO₂ is also desirable, then a simple physical solvent with flash regeneration can be used.
 - The sulfur was removed upstream, therefore, the solvent does not need to be regenerated severely to meet sulfur specifications. This results in significant OPEX savings in the solvent system.
- BPSC eliminates the Tail Gas Incineration Unit, reducing fuel gas utilization as well as improving the emissions profile of the Sulfur Complex. Additionally, operators may realize an improved onstream factor.

Bechtel Pressure Swing Claus technology eliminates the separation of H₂S & CO₂ from process streams to reduce capital and operating costs.

The Process

The process involves gas conditioning, reaction over a conventional Claus catalyst at sub-dewpoint conditions, and regeneration by pressure swing and/or heating. This allows sulfur formation, collection, and separation in a single unit. Multiple reaction stages can be used to achieve very low treated gas sulfur content.

The gas stream is mixed with sulfur dioxide, heated, and processed in the catalytic unit(s) of the sulfur recovery process. In this sub-dewpoint Claus process, the sulfur species are converted to liquid elemental sulfur and collected on the catalyst. The liquid sulfur is removed during catalyst regeneration. BPSC reactors can be connected in a series of between 1 and 5 stages to subject the sour gas stream to several iterations of sulfur removal.

When the catalyst in the sub-dewpoint Claus process reactor loses its effectiveness, the reactor is taken offline for regeneration. A spare reactor can be put online to take its place.

The loaded, ineffective reactor is regenerated by a sequence of steps that removes the adsorbed sulfur and restores the bed catalytic activity.

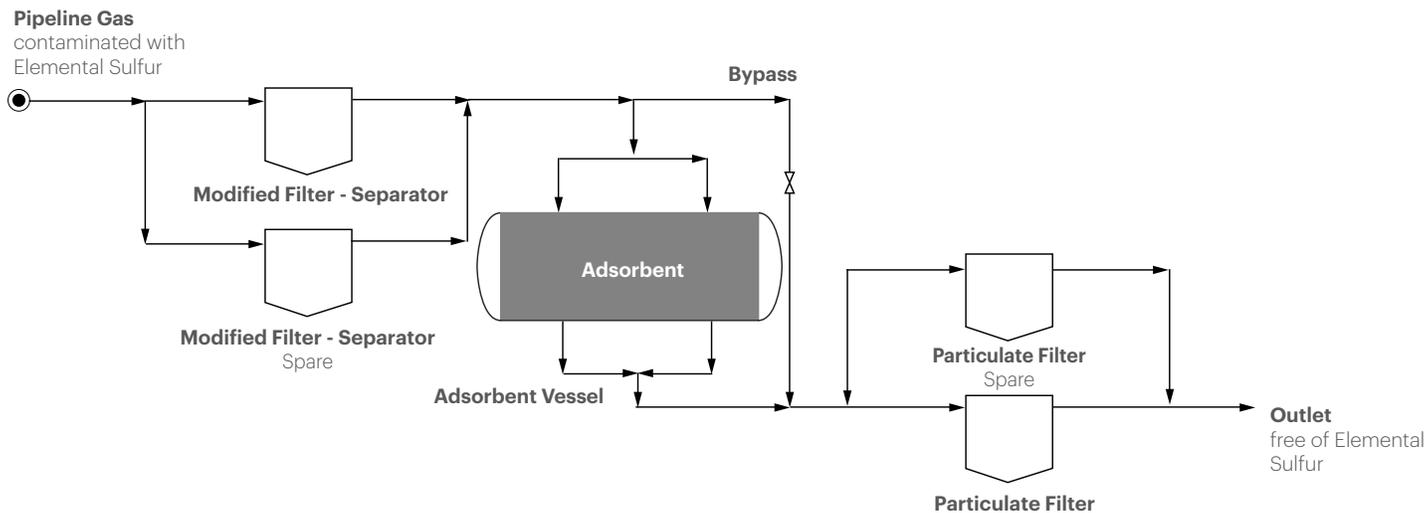
Gas produced from regeneration is recycled through the system to improve efficiency and reduce emissions.

Sulfur dioxide for the Claus reaction can be provided by the facility or generated in a proprietary system using sulfur from the BPSC.

Degassing of the liquid sulfur and solidification can also be provided, if desired. The produced vapors are recycled through the reactor system in a similar manner to the gas produced from regeneration.

Properties

• Feedstocks	High-pressure sour gas
• Products	Claus quality elemental sulfur + high pressure, very low sulfur content treated gas
• Operating Pressure Range	< critical pressure of feedstock
• Operating Temperature Range	250-500°F (121-260°C)



Bechtel Sulfur Adsorbent Technology (Patent Pending)

Overview

More and more reports from industry reflect the presence of elemental sulfur deposition in pipelines, regulators, flow meters, and downstream process equipment. Problems include:

- Erratic flow meter readings
- Turbine damage
- Plugged control valves and regulators leading to:
 - Poor process control
 - Regulator failure (pilot or main valve)
 - System overpressure if the valve fails to close
 - Heavy maintenance requirements to prevent a shutdown of operations

The problem cannot be filtered out because the elemental sulfur is **dissolved** in the vapor phase. It is not a particulate or dust, but is **dissolved** in the vapor phase much like water or CO₂. After the pipeline particulates have been removed, further filtration only induces a pressure loss and accompanying Joule-Thomson cooling. This lowers the solubility of elemental sulfur and causes additional elemental sulfur to leave the vapor phase and deposit on downstream equipment.

It is not uncommon to see a filter housing with an inlet that is clean, but an outlet that is coated with a yellow or grey colored dust. The Bechtel Sulfur Adsorbent Technology (BSAT) solves the root cause of this problem rather than treating the symptoms.

The Process

The BSAT system is located downstream of any pipeline pig collection system, slug catcher, and a modified filter separator.

The first particulate filter catches any small pipeline particulates that might plug the adsorbent; the second particulate filter after the adsorbent is to catch any adsorbent fines that might slip out of the adsorbent vessel.

Because of the low concentrations of sulfur in natural gas, the vessel size is governed by pressure loss rather than adsorbent capacity. The unit design typically results in an expected life of 6 months to 6 years based on a sulfur saturated inlet gas.

Advantages

- The sulfur adsorbs onto the active surface area
- No chemicals are needed for processing other than the adsorbent, which is changed about every 6 months to 6 years
- Filters are the only regular consumables
- No heating, cooling, or pumping
- Minimal operator attention
- Treats the real problem (the presence of sulfur) instead of treating symptoms (plugged equipment)

Properties

• Feedstocks	High pressure gas containing elemental sulfur
• Products	Sulfur-free gas
• Operating Pressure Range	< critical pressure of feedstock
• Operating Temperature Range	Typical Pipeline Operating Temperatures



Publications, Presentations, Papers, and Patents

"Systems and Methods for Ammonia Purification", **U.S. Patent No. 10,266,418.**

"Systems and Methods for High CO2 Ammonia Purification", **U.S. Patent No. 10,850,226.**

"Systems and Methods for Removing Hydrogen Sulfide from an Ammonia Stream", **U.S. Patent Nos. 10,315,153 & 10,456,735 & 10,843,122.**

"Systems and Methods for Enhanced Separation of Hydrogen Sulfide and Ammonia in a Hydrogen Sulfide Stripper", **U.S. Patent No. 10,702,799 & 10,022,650.**

"The Community SWSPPlus Concept: Turning Trash to Treasure", **RefComm, Galveston, Texas, USA, 2023.**

"Improve Your SRU with SWSPPlus". **North American Refining Technology Conference (NARTC). Houston, Texas, USA. 2023.**

"To Claus or not to Claus?", **Petroleum Technology Quarterly, Q1 2023.**

"War Stories", **Laurance Reid Gas Conditioning Conference (LRGCC), Norman, Oklahoma, USA, 2021.**

"Options for Venting Sulfur Pits and Sulfur Tanks", **RefComm, Galveston, Texas, May 2018.**

"Bechtel Sulfur Adsorbent Technology", **American Filtration Society Fall Conference, St. Louis, Missouri, USA, 2017.**

"Unload Your Sulphur Plant and Make Money, Too", **Bottom of the Barrel Technology Conference, Bahrain, 2016.**

"Sulfur Capacity Expansion Options", **RefComm, Galveston, Texas, USA, 2016.**

"Downsizing a Claus Sulfur Recovery Unit", **RefComm, Galveston, Texas, USA, 2016.**

"Elemental Sulphur Deposition: Problems and Solutions", **LNG-18, Perth, Australia, 2016.**

"Systems and Methods for Concentrating Sour Water Feed to a WWT", **PCT Application 2016.**

"Using WWT for Sulphur Capacity Addition", **18th Annual Asian Refining Technology Conference, Bangkok, 2015,**

"Profiting from Sour Water in Changing Global Climate", **Asia Tech, Kuala Lumpur, 2014.**

"Innovative Elemental Sulphur Adsorbent – Part 1", **SOGAT, Abu Dhabi, United Arab Emirates, 2014.**

At right

BETS provided process technology and Bechtel performed EPC for a 2 × 114 LTPD Sulfur Complex at the Duke Edwardsport Integrated Gasification Combined Cycle Power Plant.

"An Effective Solution for Elemental Sulfur Deposition in Natural Gas Systems", **Oil & Gas and Chemical Processing Filtration and Separations Conference, Houston, Texas, USA, 2014.**

"Sulfur Safety", **Laurance Reid Gas Conditioning Conference, Norman, Oklahoma, USA, 2014.**

"BHTS Sulfur Technology Overview", **Semana de Tecnología para Proyectos en PEMEX, Ciudad de México, México, 2013.**

"BHTS WWT Technology: Ammonia Recovery from Sour Water", **Semana de Tecnología para Proyectos en PEMEX, Ciudad de México, México, 2013.**

"Revisiting WWT", **20th Annual Brimstone Sulfur Symposium, Vail, Colorado, USA, 2013.**

"Analysis of SRI AC-ABC and Bechtel Pressure Swing Claus Technologies for Pre-Combustion Carbon Capture", **Eleventh Annual Conference on Carbon Capture, Utilization & Sequestration, Pittsburgh, PA, 2012.**

"Bechtel Sulfur Adsorber Technology Concept and Status Presentation", **TBG, Transpetro, Petrobras, et al, Rio de Janeiro, Brasil, 2011.**

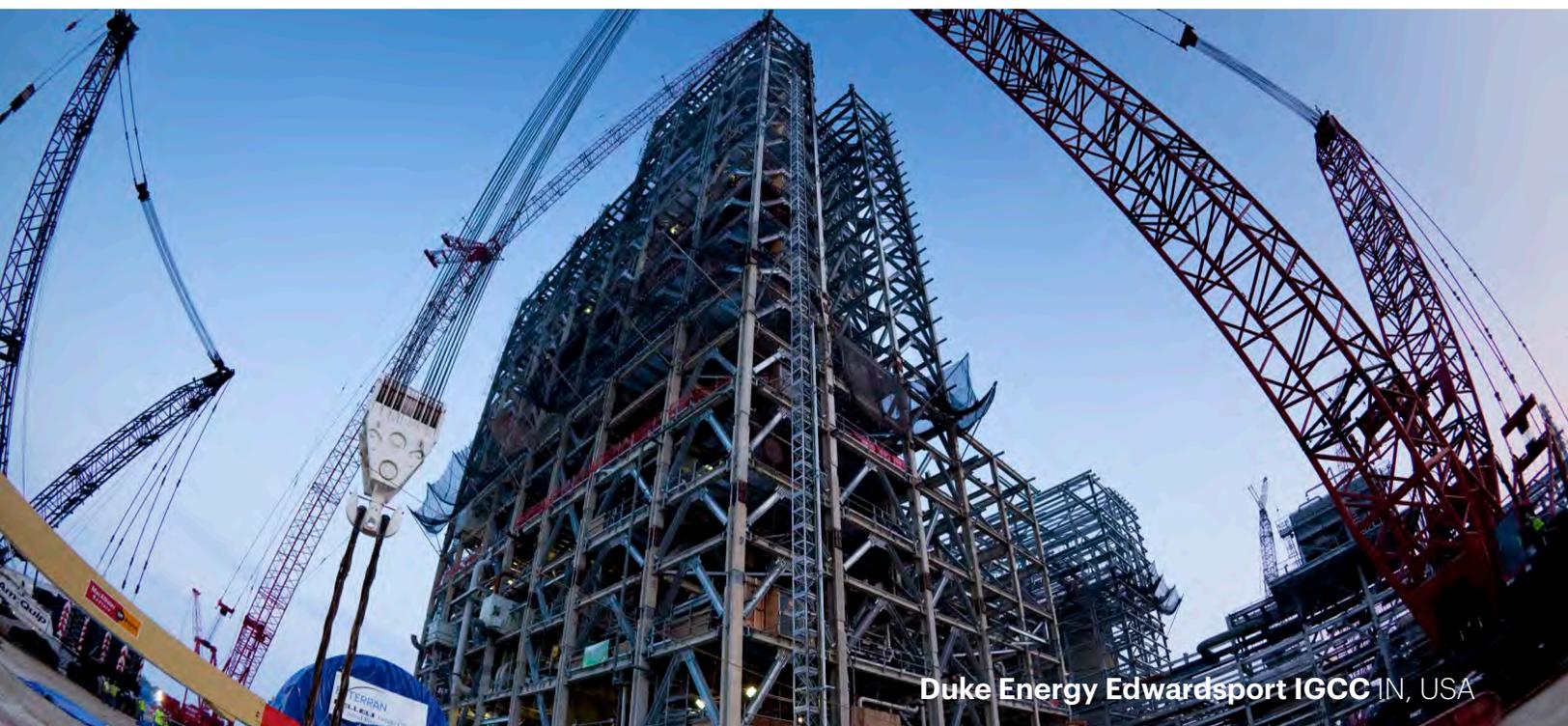
"Systems and Methods for Removing Elemental Sulfur from a Hydrocarbon Fluid", **PCT Application in 2011.**

"Bechtel Pressure Swing Claus Sulfur Recovery Technology," **International Pittsburgh Coal Conference, 2009.**

"Modified Claus Sulfur Recovery Unit Equipment," **Laurance Reid Gas Conditioning Conference, 2000.**

"Sulphur Solidification Methods," **The International Journal of Hydrocarbon Engineering, October, 1997.**

"Here Are Ways to Increase Sulfur Processing Capability," **Oil & Gas Journal, May 22, 1989.**





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Our Bechtel Energy Technologies & Solutions (BETS) group provides technology and subject matter experts focused on delivering for our customers as they tackle the challenges of the Energy Transition. Bechtel delivers optimized solutions to help our customers realize lower capital costs, shorter times-to-market, and projects with lower carbon emissions.

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