

Handling of Trace Components for Rectisol® Wash Units

Linde Engineering

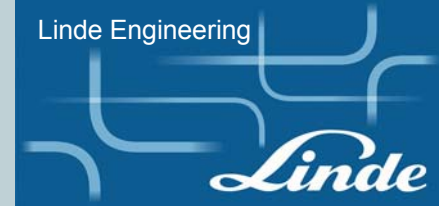
Linde

Ulvi Kerestecioğlu, Thomas Haberle
Washington DC, 08th Oct. 2008

Linde's Rectisol® Wash Process

Rectisol® Wash Unit in Jilin, China

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General Information about the Rectisol® Process



Linde's Rectisol® Wash Process

Rectisol® is a Well Proven Wash Process

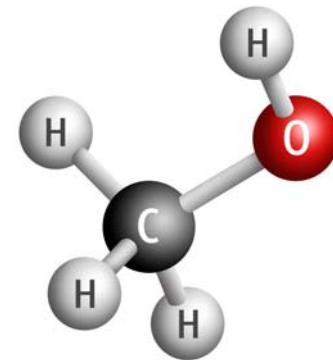
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What is Rectisol®?

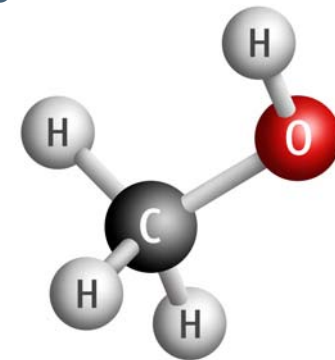
- Rectisol® was developed jointly by Linde and Lurgi in the late 50th
- Rectisol® is a physical wash process where acid gas compounds are solved in methanol and thus removed from the syngas
- Rectisol® operates favourable at low temperatures and high pressures
- Methanol is cheap, readily available and thermally and chemically stable

Methanol Molecule



Experience with Rectisol®

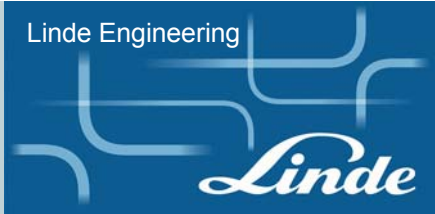
- Linde is owning and operating three running plants (Singapore and the United States)
- Linde is well experienced in handling of trace component
 - ⇒ no accumulation within the solvent loop
 - ⇒ no impurities wasting the products
- Each Rectisol® Wash Unit is developed hand tailored for customers needs and requirements
- Nearly 50 Linde Rectisol® Units are engineered world wide



Methanol Molecule

Linde's Rectisol® Wash Process

Rectisol® has References all over the World



Nearly 50 references all over the world





Main Components

- H₂
- CO

⇒ shall remain in the Feedgas

Acid Components

- CO₂
- H₂S
- COS

⇒ to be removed within the Process

Impurities

- HCN
- NH₃
- Metal Carbonyls
- H₂O

⇒ can be handled safely by Rectisol®

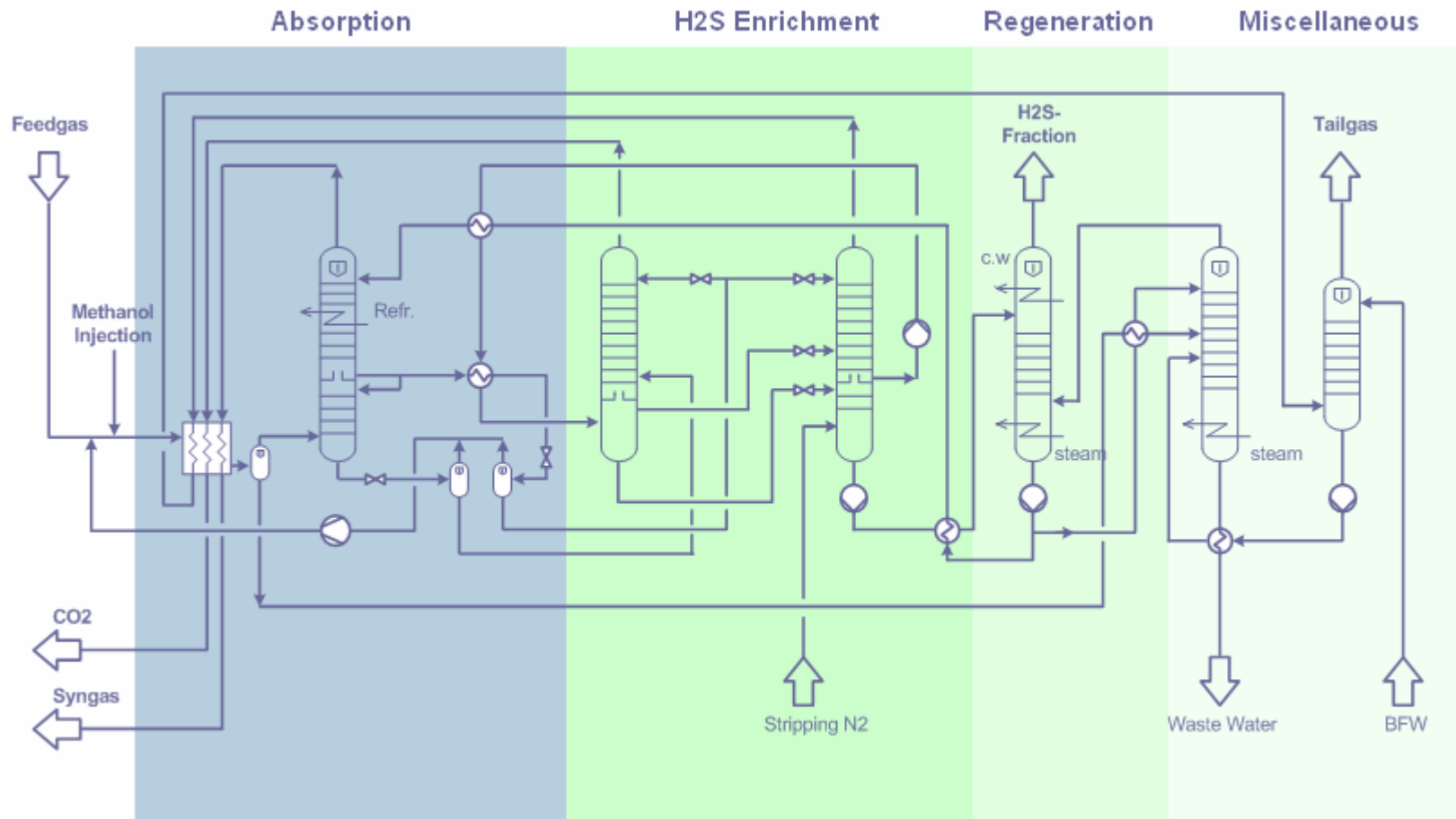
Linde's Rectisol® Wash Process

The Rectisol® Process Consists of Four Major Sub-Units

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Process Flow Diagram of a 1-Stage Rectisol®



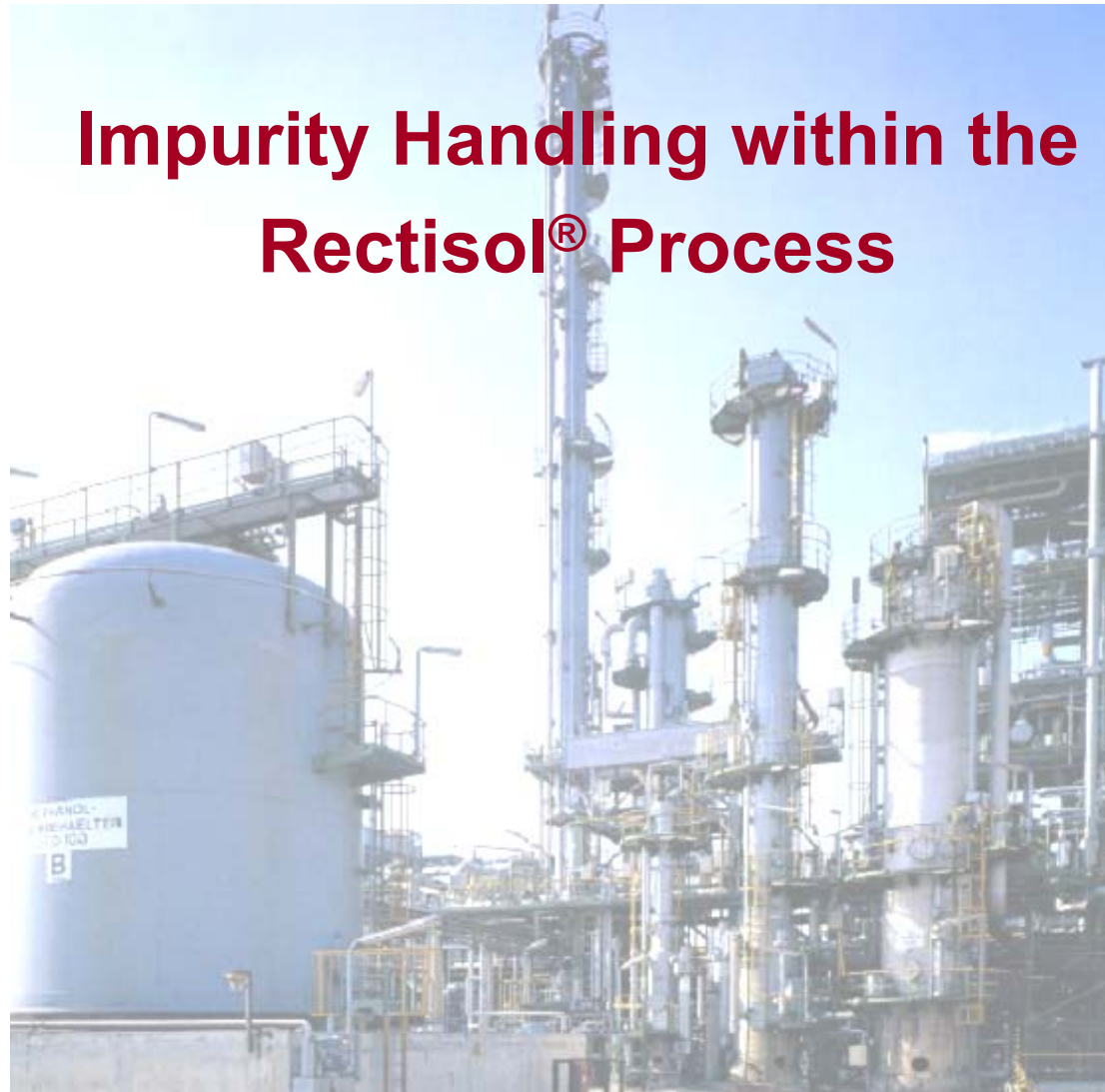
Linde's Rectisol® Wash Process

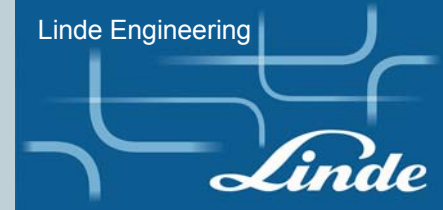
Rectisol® Wash Unit in Berrenrath, Germany

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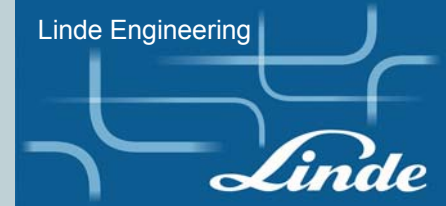
Impurity Handling within the Rectisol® Process



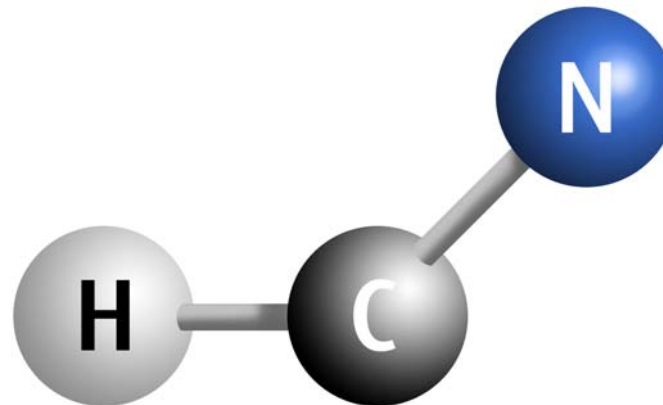


Effect of Trace Components

- Product streams may be wasted and will not meet product specification
 - Offgas streams may be wasted and will not meet environmental regulation
 - Plugged equipment may cause operational problems, lead to plant shut down, and reduces the plant availability
 - Corrosion may occur and lead to equipment /piping exchange
 - People can be harmed and the environment can be polluted
- ⇒ **Even small amounts of trace components can have a negative effect on the performance of the plant and on environment**

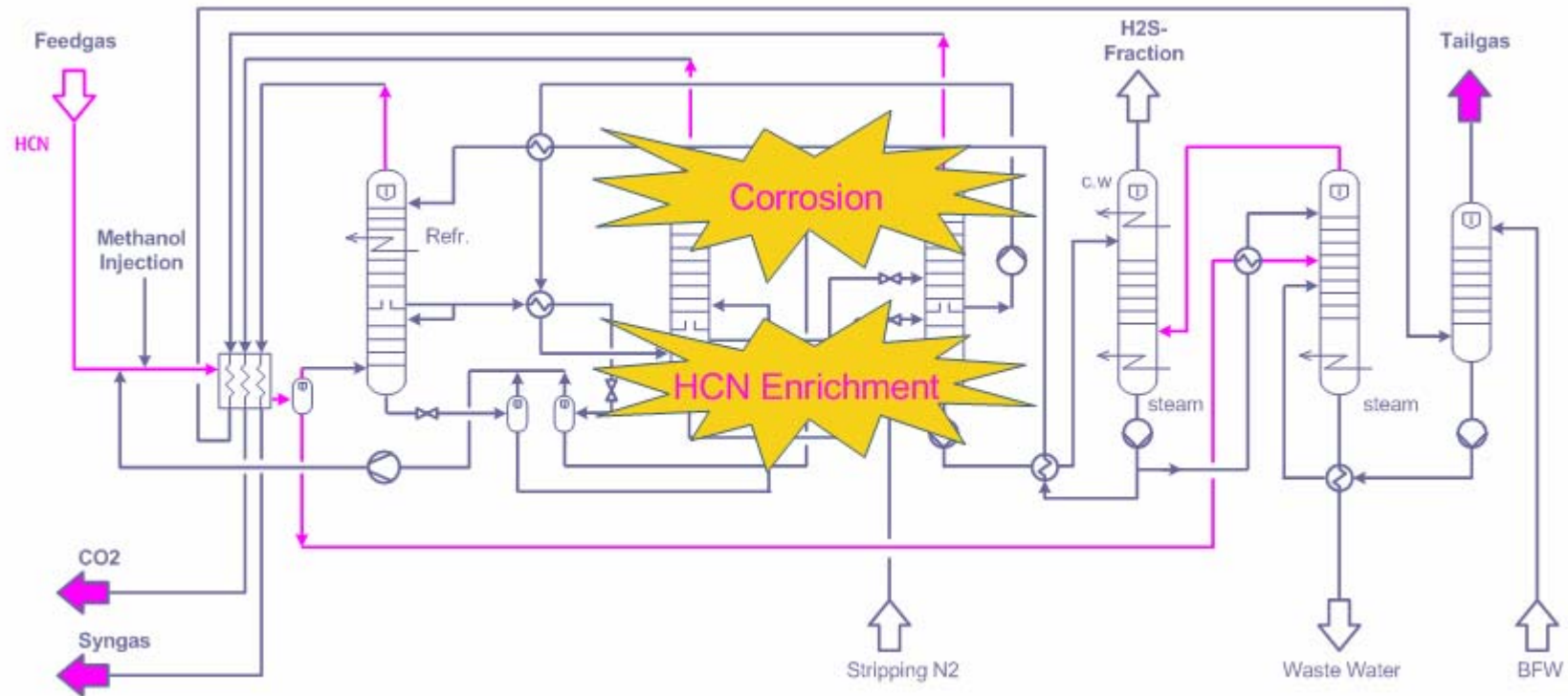
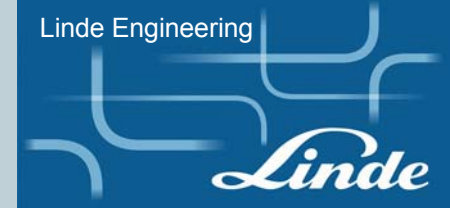


Handling of HCN



Linde's Rectisol® Wash Process

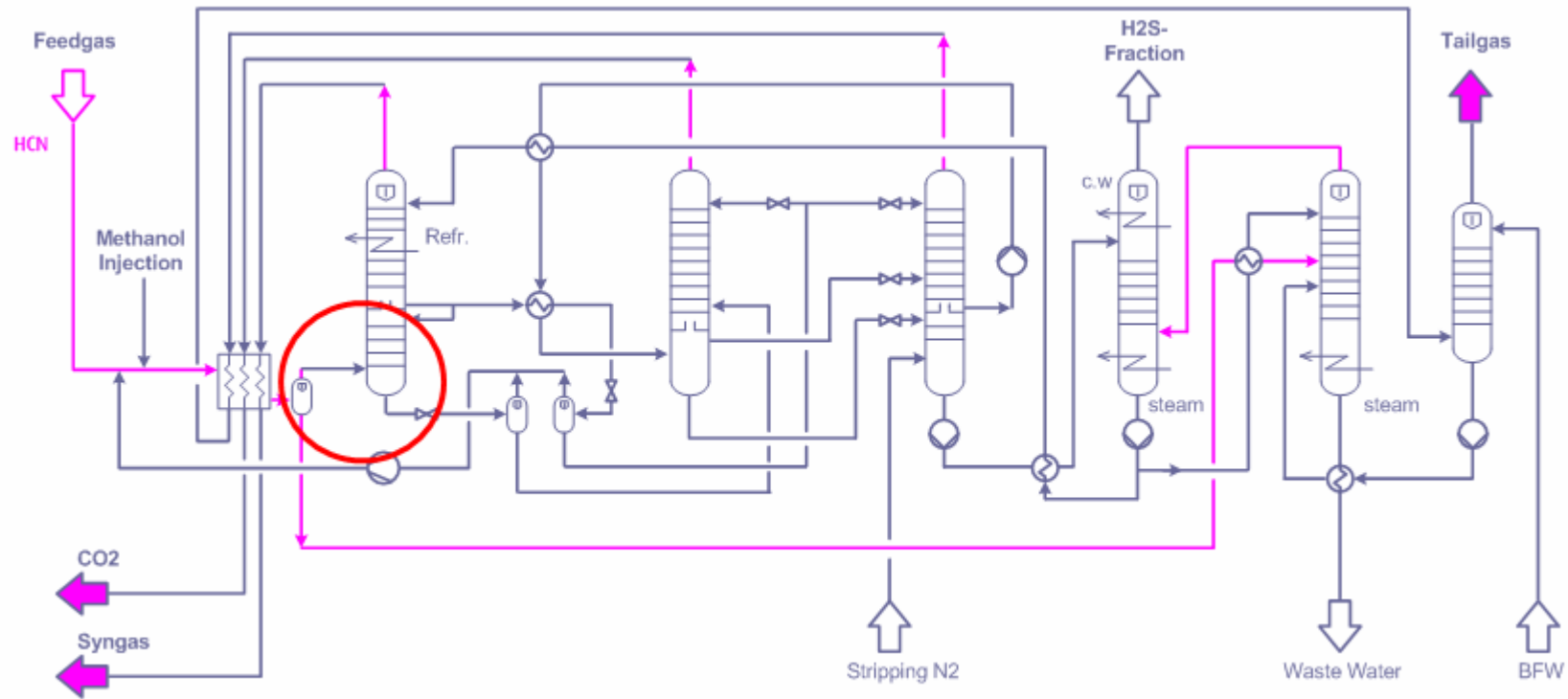
HCN will accumulate in the Methanol Loop and will cause Corrosion and pollute the Products



Linde's Rectisol® Wash Process

HCN will be Safely Separated before Entering the Methanol Loop

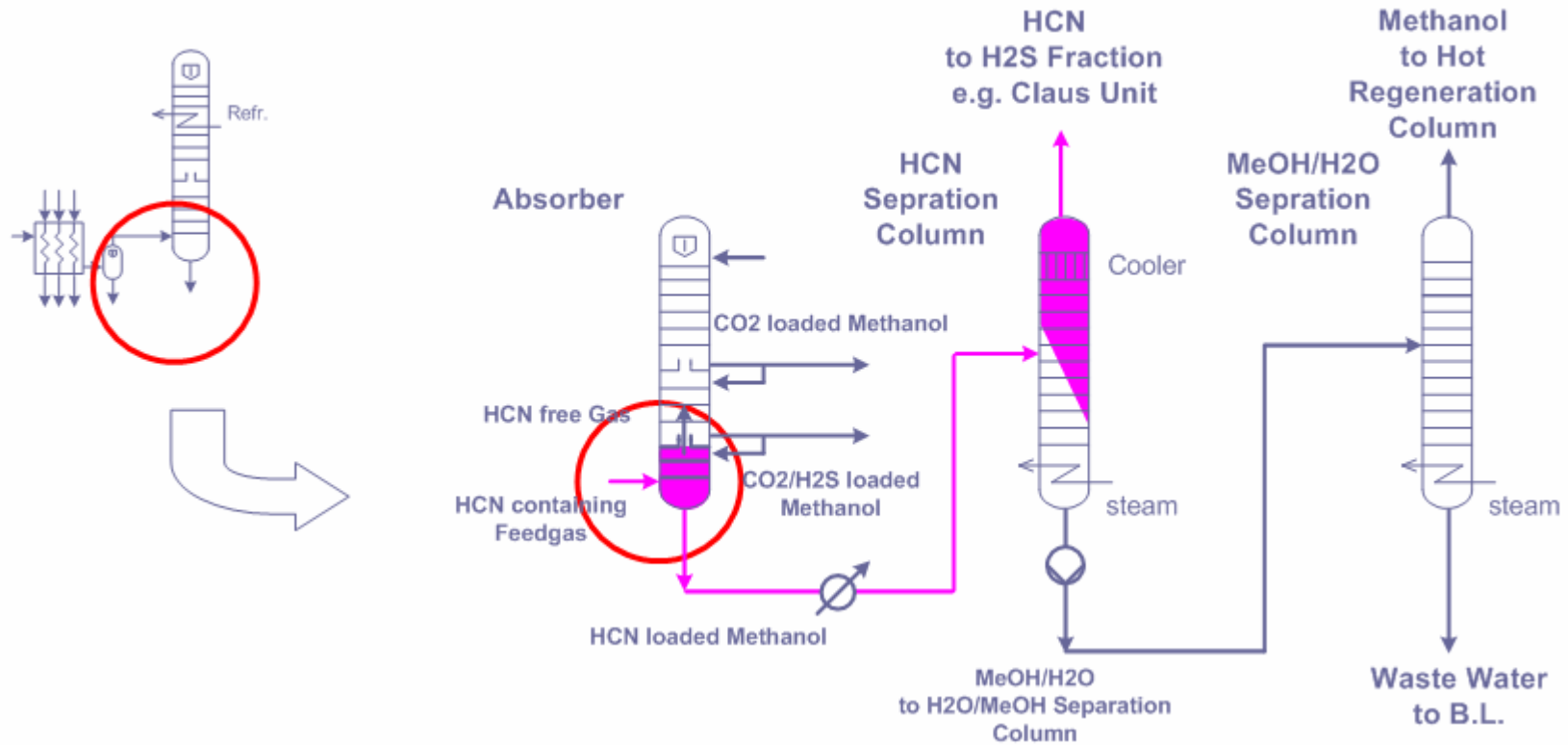
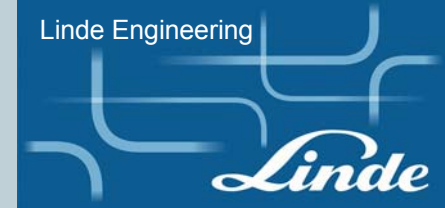
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⇒ HCN will be removed from the Syngas in a particular section of the Absorber Column

Linde's Rectisol® Wash Process

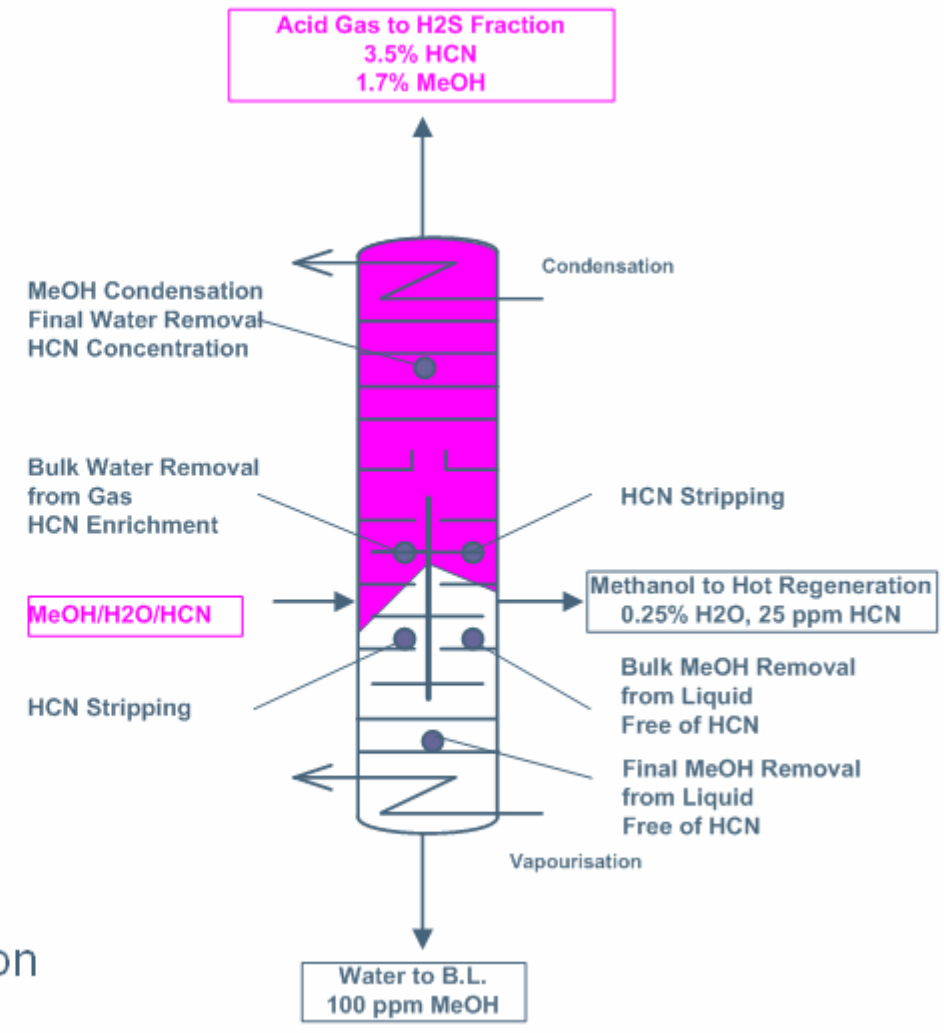
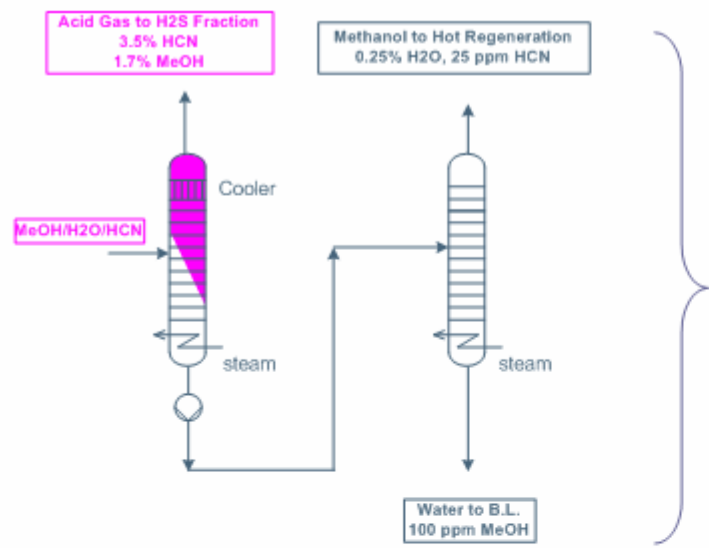
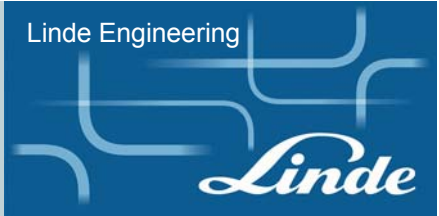
HCN will be Routed to the Sour Gas after Separation in a Column



⇒ HCN will be removed from the loaded methanol in a separate HCN Separation Column

Linde's Rectisol® Wash Process

Linde Uses a Partition Wall Column for Separation of HCN (Patent Pending)

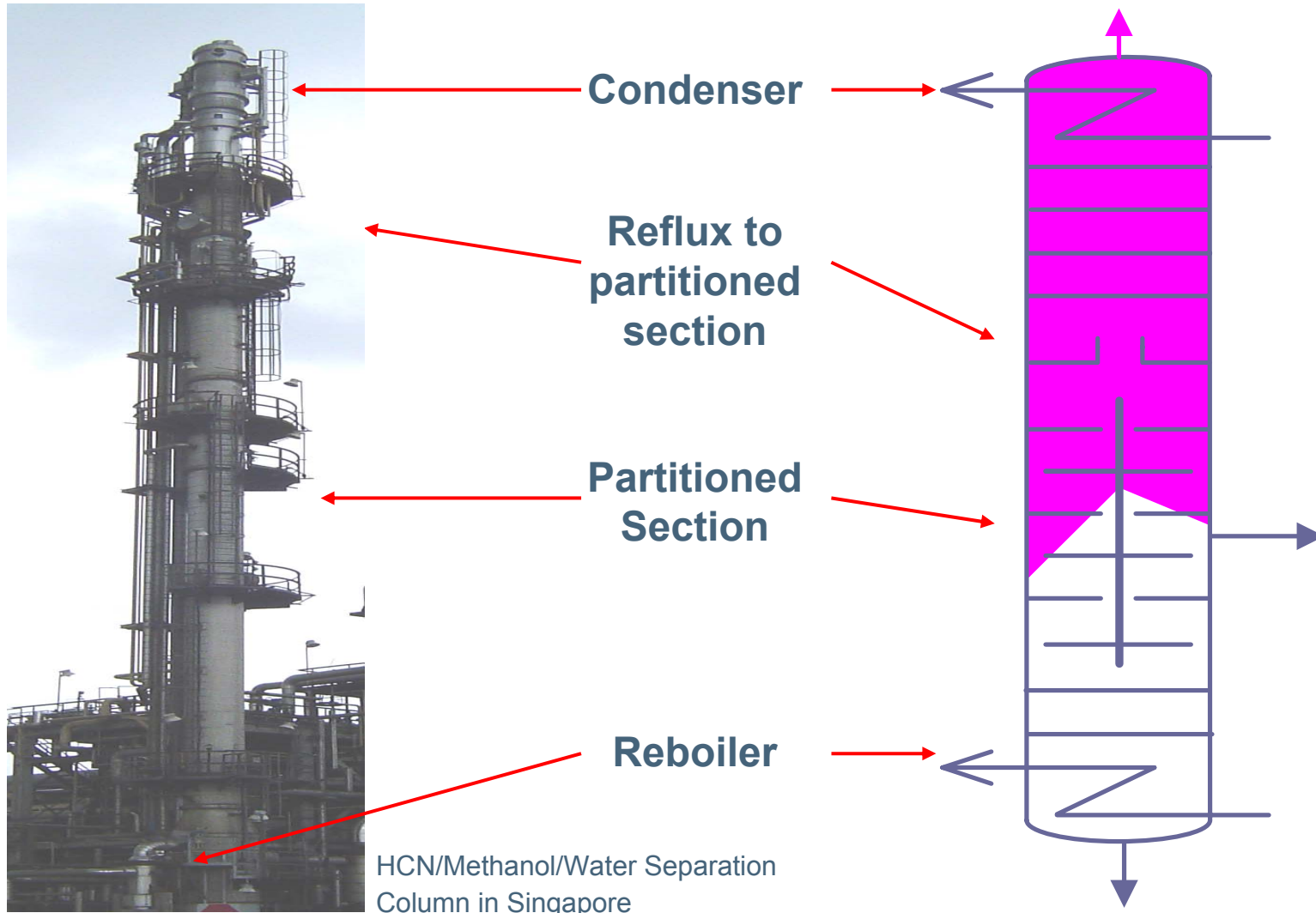
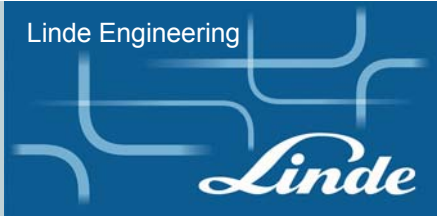


Advantages of the Partition Wall Column Design

- only one column, one reboiler
- no pump
- less required space
- less required piping, instrumentation
- less required steam consumption

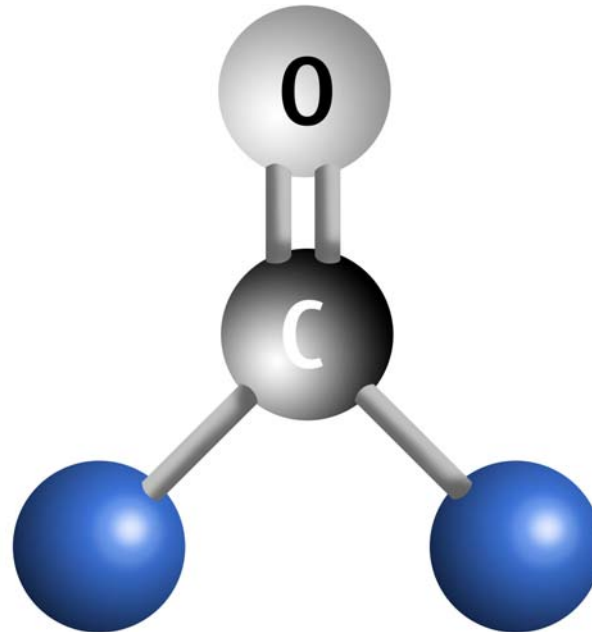
Linde's Rectisol® Wash Process

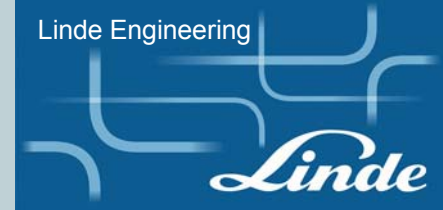
Linde Uses a Partition Wall Column for Separation of HCN (Patent Pending)





Handling of Carbonyls





Carbonyl Formation / Content

- Carbonyls have their origin in the gasification section and are not a product of the Rectisol® Wash Process
- Carbonyls are completely absorbed in the wash solvent

Main Carbonyls

- Ni(CO)₄
- Fe(CO)₅

Removal of Carbonyls

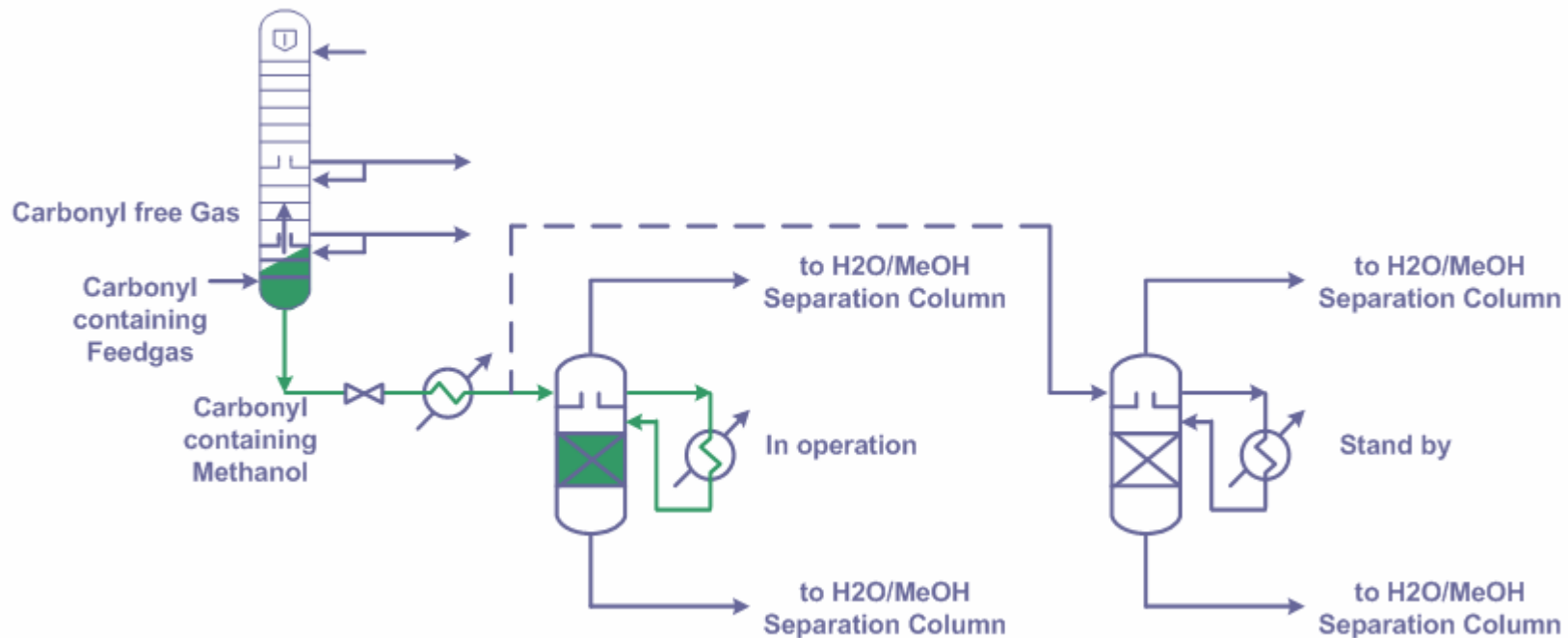
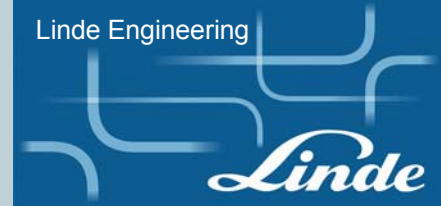
- Carbonyls will decompose under specific conditions and will lead to equipment plugging and decrease of plant availability

⇒ **Carbonyls shall decompose at designated areas within the Rectisol® Unit**

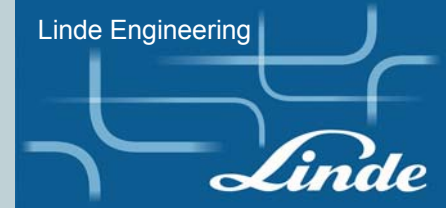
Linde's Rectisol® Wash Process

Carbonyls will be Forced to Decompose at Specified Locations within the Rectisol® Process

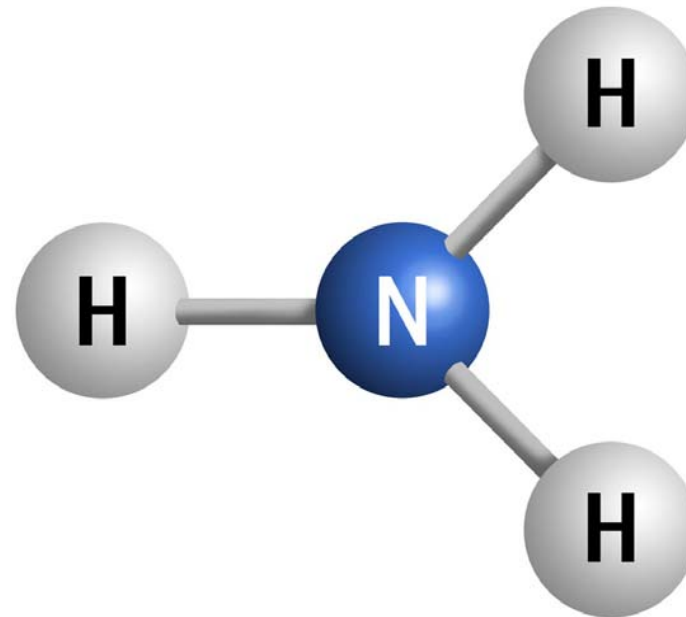
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⇒ Carbonyls are removed from the process before entering the main methanol loop

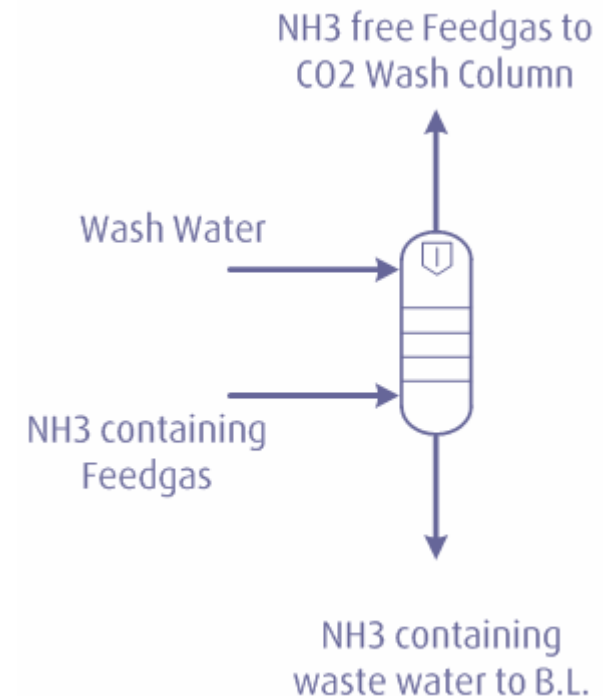


Handling of NH₃

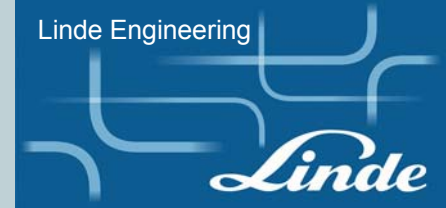


NH₃ in the Feedgas

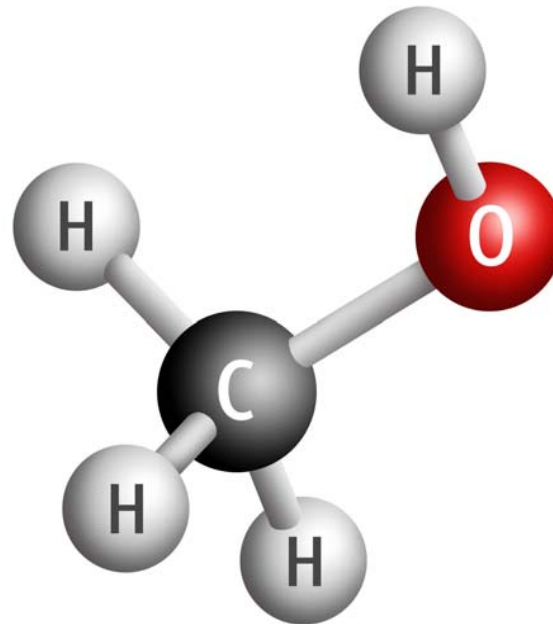
- Ammonia will form Ammoniumsulfid within the Rectisol® Wash Unit, which lead to pollution of the Product and Offgas stream. The result is a non achievement of Product and Offgas specifications.
- Ammonia will form Ammoniumcarbamate within the Rectisol® Wash Unit, which lead to plugging of Equipment and reduction of plant performance.



- ⇒ **NH₃ in the Feedgas will be reduced**
- ⇒ **Product Stream Purity can be kept**
- ⇒ **Shut Down Time due to Maintenance will be minimised**



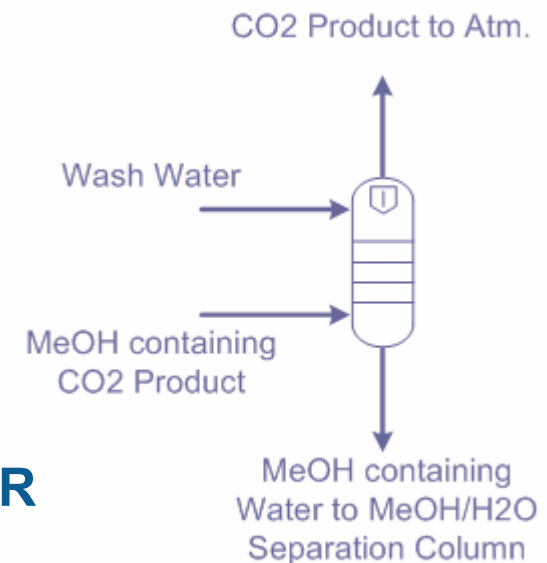
Handling of Methanol



Methanol content in the CO₂ Product to the atmosphere

Methanol has to be washed out of the CO₂ Product in order to:

- Meet environmental regulations
- Regain the methanol



Methanol content in the CO₂ Product for EOR

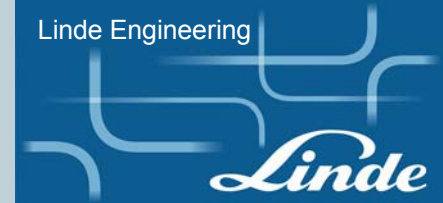
Methanol is favourable not to be replaced by water:

- Water free CO₂ Product allows CS material (e.g. piping)

Linde's Rectisol® Wash Process

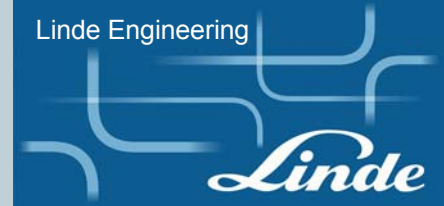
Rectisol® Wash Unit in Shaanxi Weihe, China

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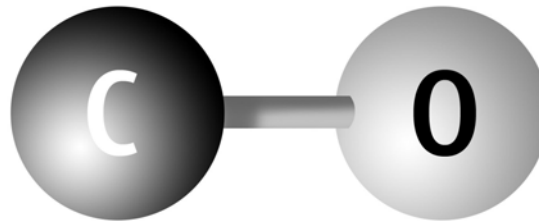


Handling of “Product Components” within the Rectisol® Process





Handling of CO



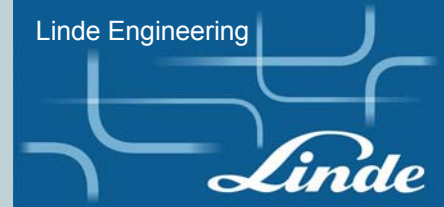


CO₂ for EOR / Sequestration

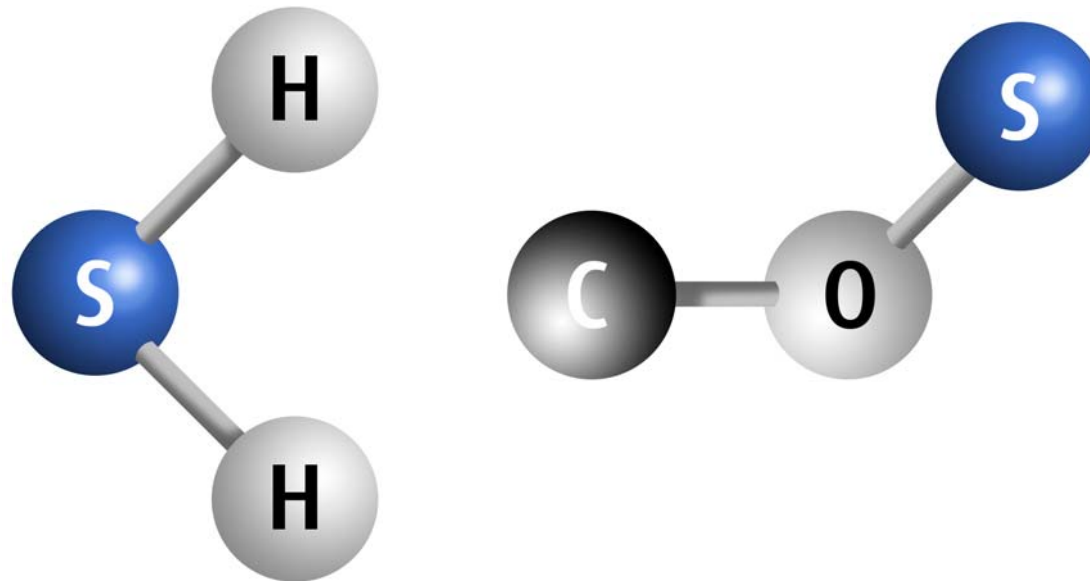
- CO₂ Purity > 98.5%
- CO₂ Recovery Rate is nearly 100%
- Delivery at different elevated pressure levels
- CO content to be met (< 200 vppm)
- Sulphur content to be met (2 – 10 mg/Nm³)

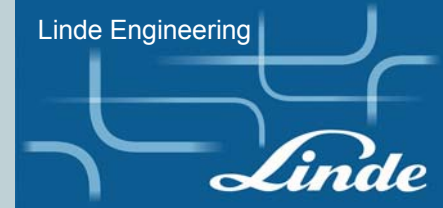
The CO content in the CO₂ Product can be reduced

- CO will be recycled back to the Feedgas by an intermediate Flash
- CO will given to B.L. as “CO Rich Fuel Gas”



Handling of H₂S / COS





Solubility of H₂S and COS

- H₂S and COS have a very high solubility in methanol
- H₂S and COS are removed simultaneously from the Syngas.
⇒ no COS hydrolyses is required
- Selective removal of CO₂ and H₂S/COS

H₂S/COS content at B.L.

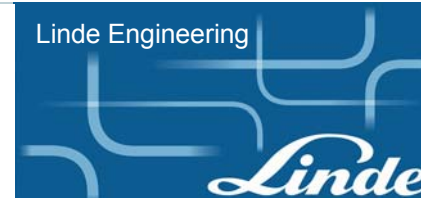
- Enriched Sulphur Fraction suitable e.g. for a Claus Unit
- Purified Syngas: < 0.1 vppm
- CO₂ Product and/or Tailgas: < 2 – 10 mg/Nm³

Linde's Rectisol® Wash Process

Lowest and Stable Sulphur Contents in the Treated Syngas are Achieved

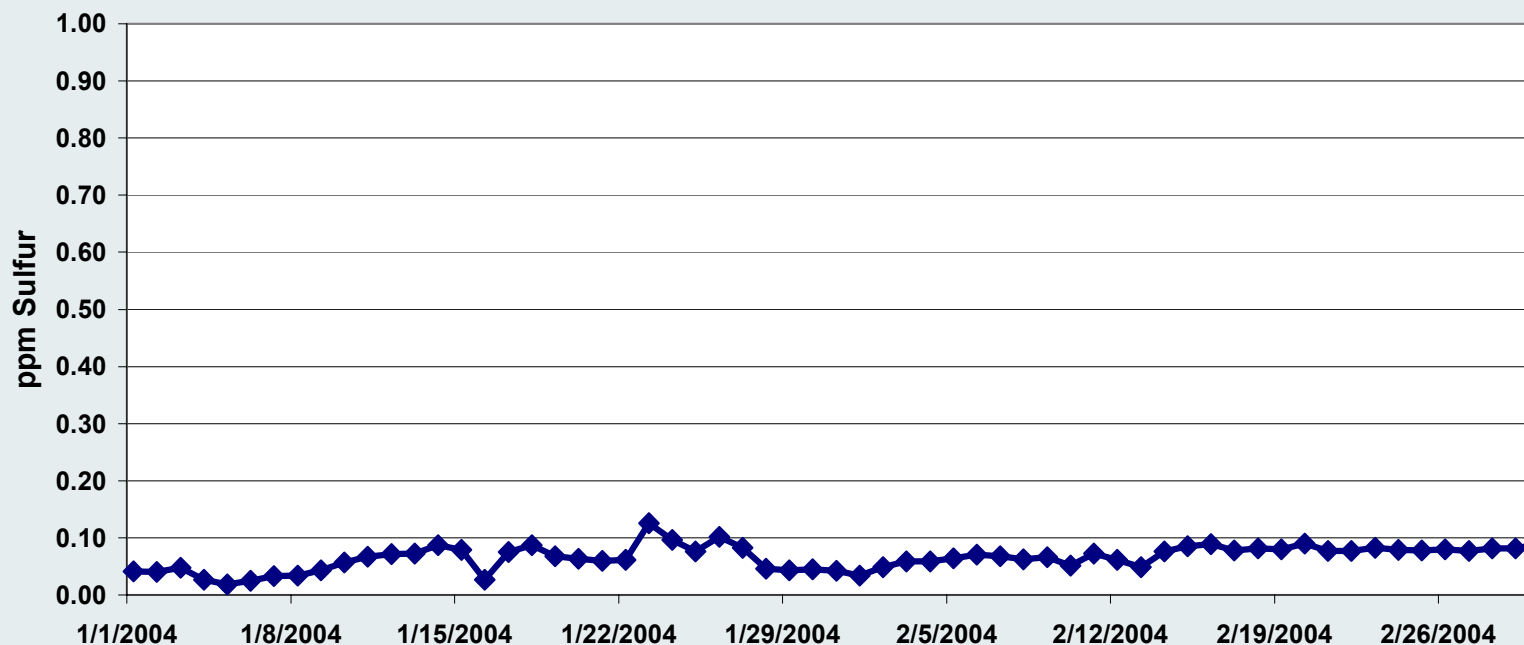
EASTMAN

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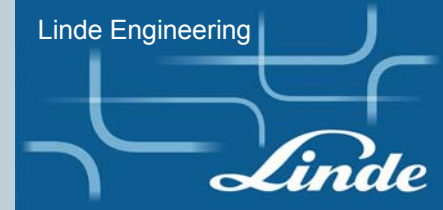


Eastman Operational Data, Jan-Mar '04

Total Sulfur in Clean Syngas, ppm

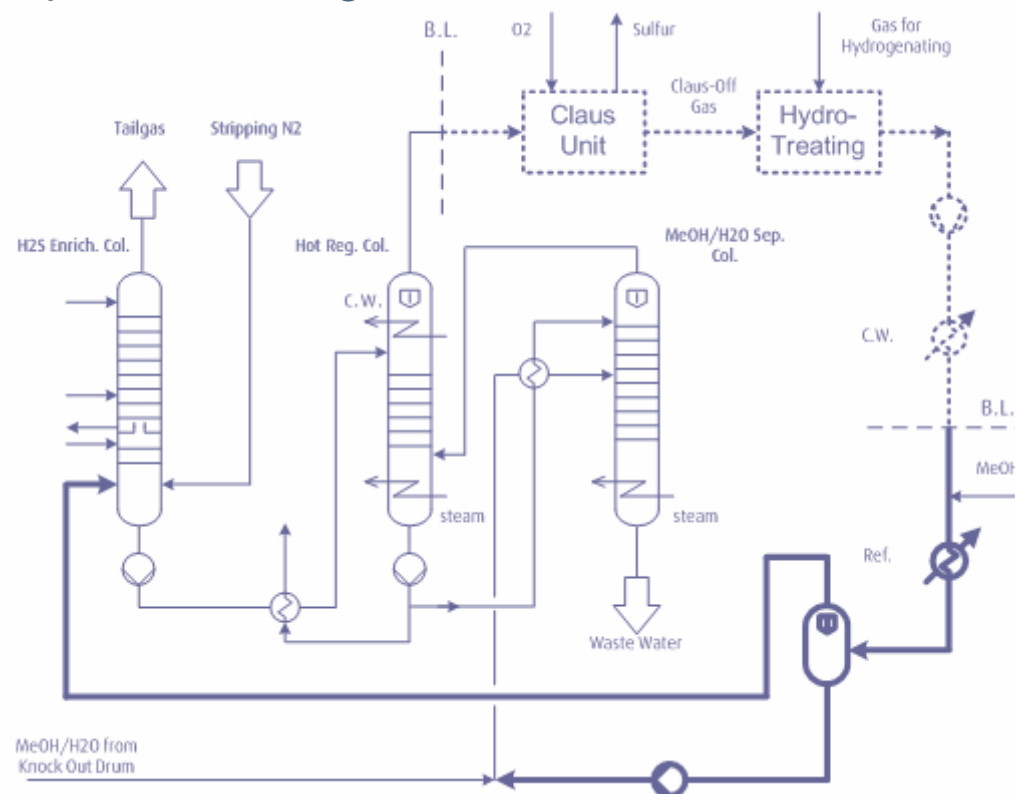


From Presentation of David L. Denton "Eastment Chemical Company – Rectisol Plant Operation Experience" at the Linde Hydrogen Production Symposium in Calgary July 2007



Emission free System

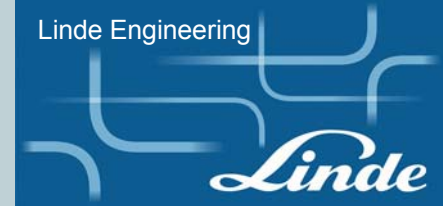
The Rectisol® Process can favourably treat Offgases from Sulphur Units (e.g. Claus Unit, SRU) to ensure sulphur free Offgas streams. No wet sulphur scrubbing downstream Claus Plant necessary.



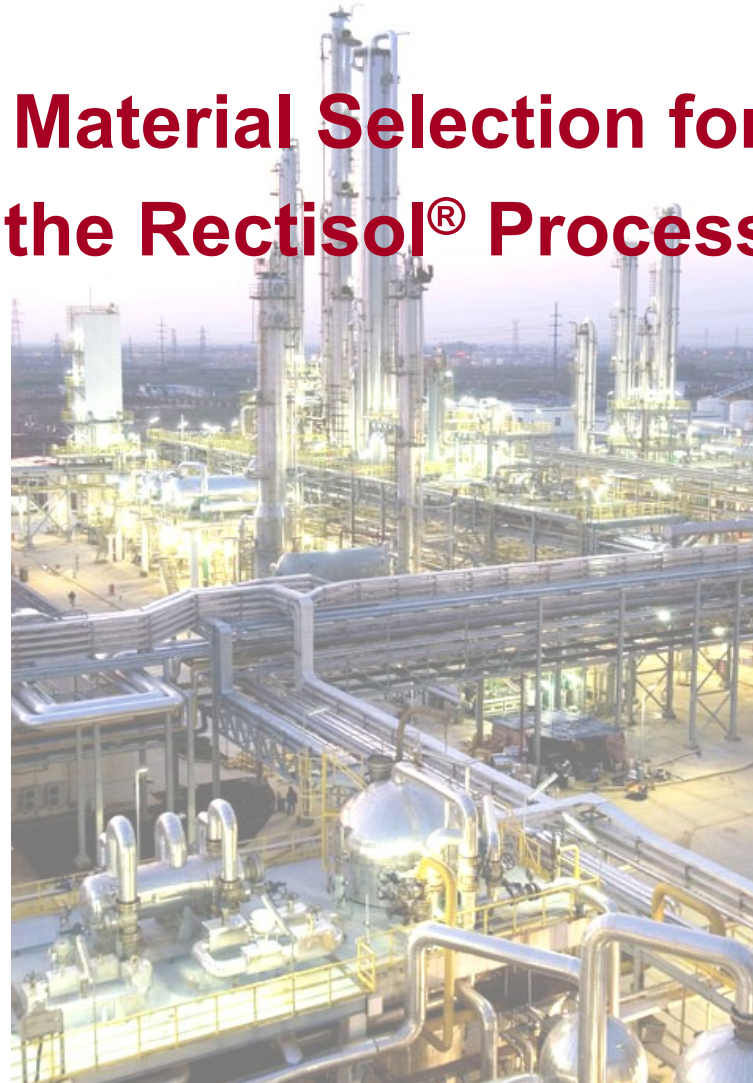
Linde's Rectisol® Wash Process

Rectisol® Wash Unit in Nanjing, China

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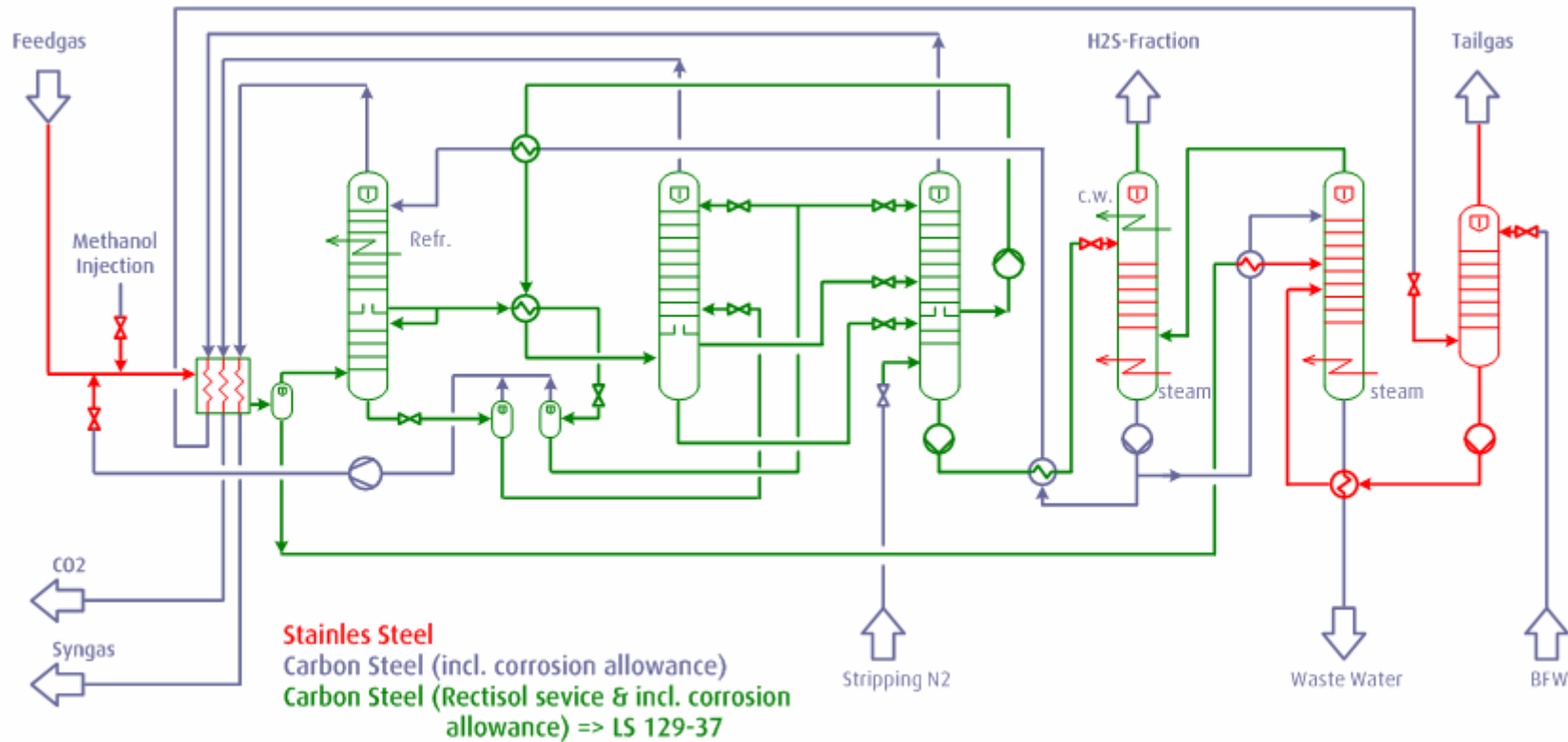
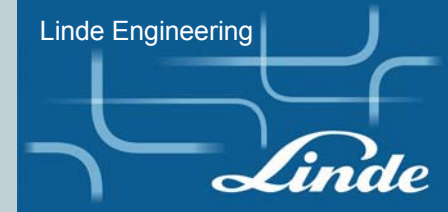
Material Selection for the Rectisol® Process



Linde's Rectisol® Wash Process

A Proper Material Selection is Important for a Trouble-Less Plant Operation

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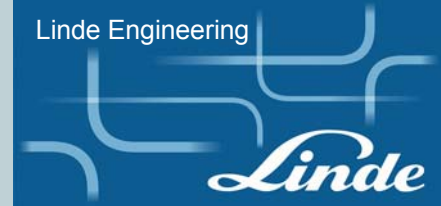


Methanol has a non corrosive service with Carbon Steel for Material. Special attention to the material selection has to be paid concerning Feedgas components and design conditions.

Linde's Rectisol® Wash Process

Rectisol® Wash Unit in Shanghai, China

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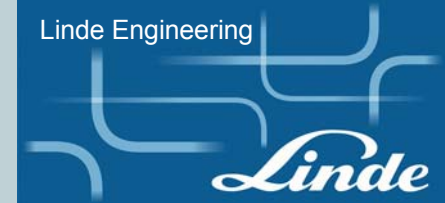
Summary



Linde's Rectisol® Wash Process

Even Small Amounts of Impurities in the Feedgas can have a Severe Impact on Plant Performance

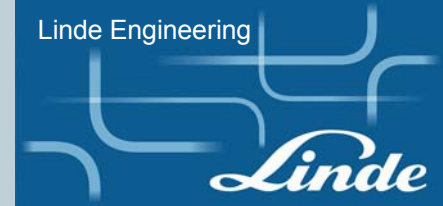
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Linde's Rectisol® Wash Process

Good Impurity Treatment Ensures a Proper Plant Performance

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**Thank you
for your attention**

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Linde

Ulvi Kerestecioğlu, Thomas Haberle
Washington DC, 08th Oct. 2008