General Information about the Rectisol® Process
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
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
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

Process Flow Diagram of a 1-Stage Rectisol®

Diagram showing the flow process with segments for Absorption, H2S Enrichment, Regeneration, and Miscellaneous, with various process flow components such as Feedgas, CO2, Syngas, Methanol Injection, Refrigeration, H2S Fraction, Stripping N2, Waste Water, and BFW.
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

![HCN molecule diagram]
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

⇒ 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 in the Methanol Loop will Lead to Plugging of Equipment and will Cause Plant Shut Downs
Linde’s Rectisol® Wash Process

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

⇒ Carbonyls are removed from the process before entering the main methanol loop
Handling of NH3
Linde’s Rectisol® Wash Process
NH3 is Removed from the Feedgas by a Simple Water Wash Column

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 molecule diagram]
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)
Handling of “Product Components” within the Rectisol® Process
Handling of CO
Linde’s Rectisol® Wash Process

CO2 as Product has to meet Product Specification

**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 Operational Data, Jan-Mar ’04
Total Sulfur in Clean Syngas, ppm

From Presentation of David L. Denton “Eastman Chemical Company – Rectisol Plant Operation Experience”
at the Linde Hydrogen Production Symposium in Calgary July 2007
Emission free System

The Rectisol® Process can favourable treat Offgasses from Sulphur Units (e.g. Claus Unit, SRU) to ensure sulphur free Offgas streams. No wet sulphur scrubbing downstream Claus Plant necessary.
Material Selection for the Rectisol® Process
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.
Summary
Linde’s Rectisol® Wash Process

Even Small Amounts of Impurities in the Feedgas can have a Severe Impact on Plant Performance
Linde’s Rectisol® Wash Process
Good Impurity Treatment Ensures a Proper Plant Performance
Thank you for your attention