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**Syngas Conditioning by Lurgi  
Rectisol  
for  
IEA Task Meeting**

**May 2009**

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# Gas Treating

**Natural Gas – Oil – Coal – Biomass**



**Rectisol**



**Amine Wash**



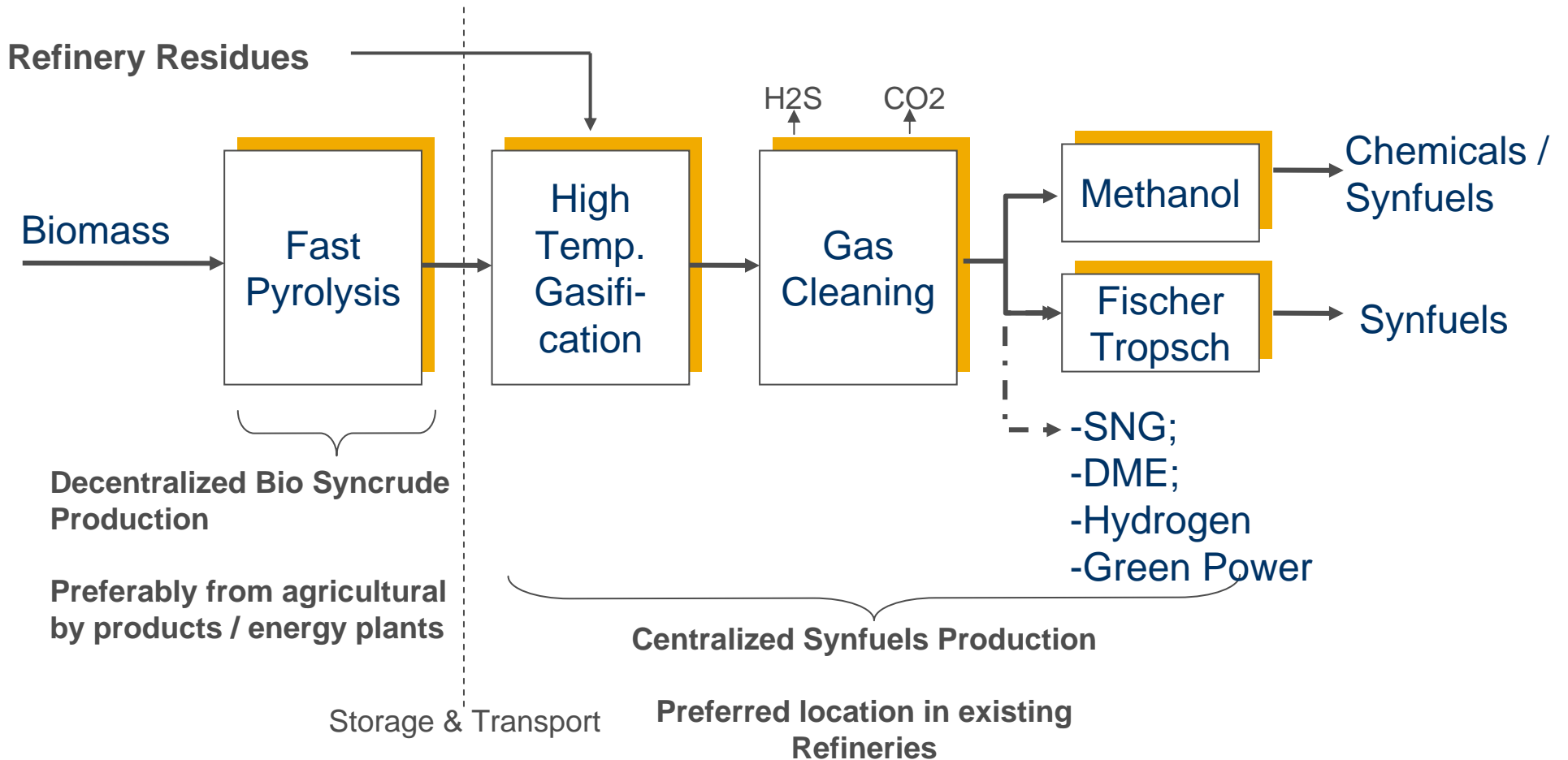
**Sulfur Recovery**



**Chemicals – Power – Fuel**

## 2. Generation Biofuels: Bioliq: „The thermo / chemical route“

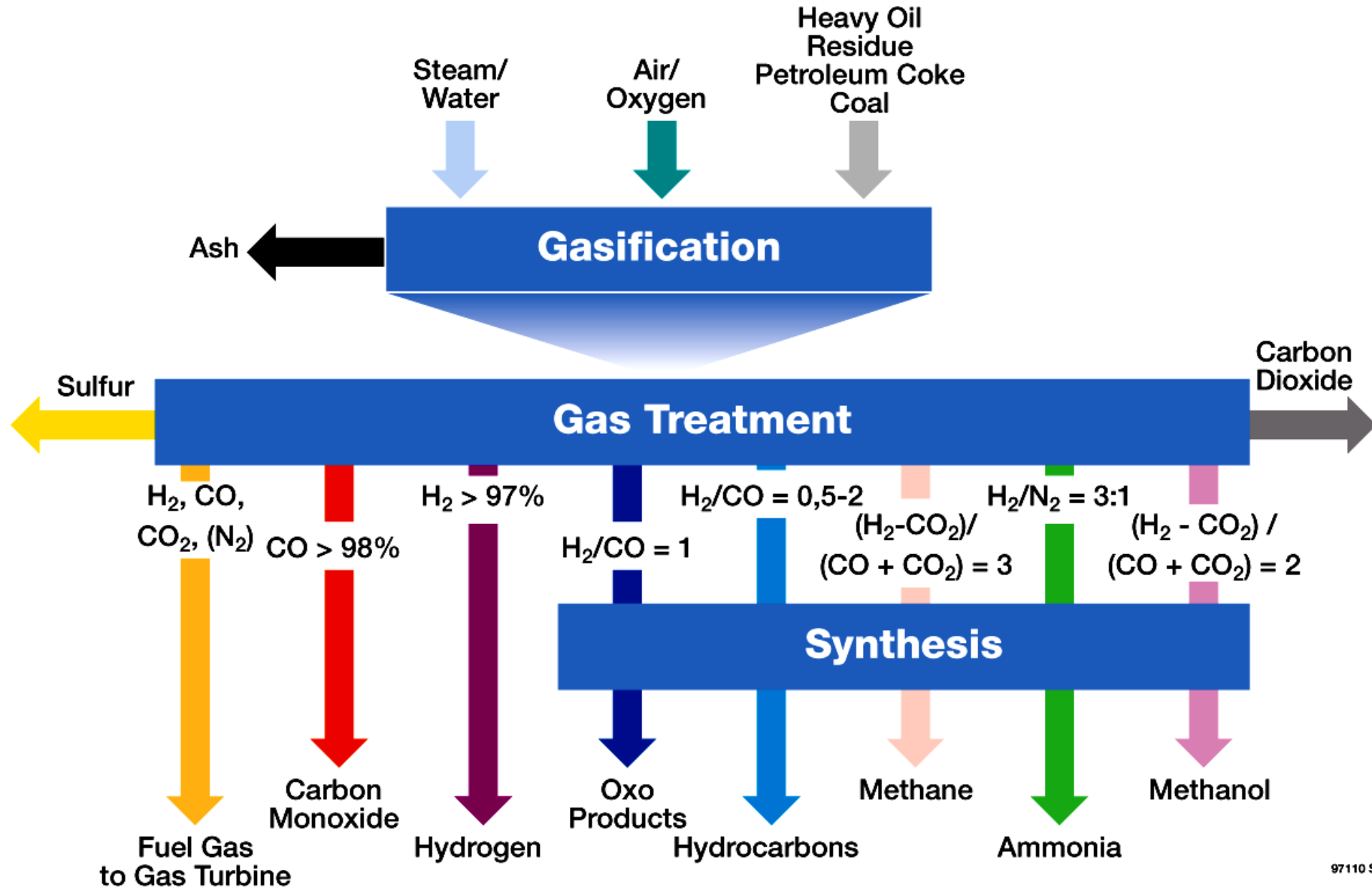
<sup>(R)</sup> Bioliq-Process: Joint Development by FZK \*) / Lurgi and sponsored by FNR\*\*)



\*) FZK: Forschungszentrum Karlsruhe

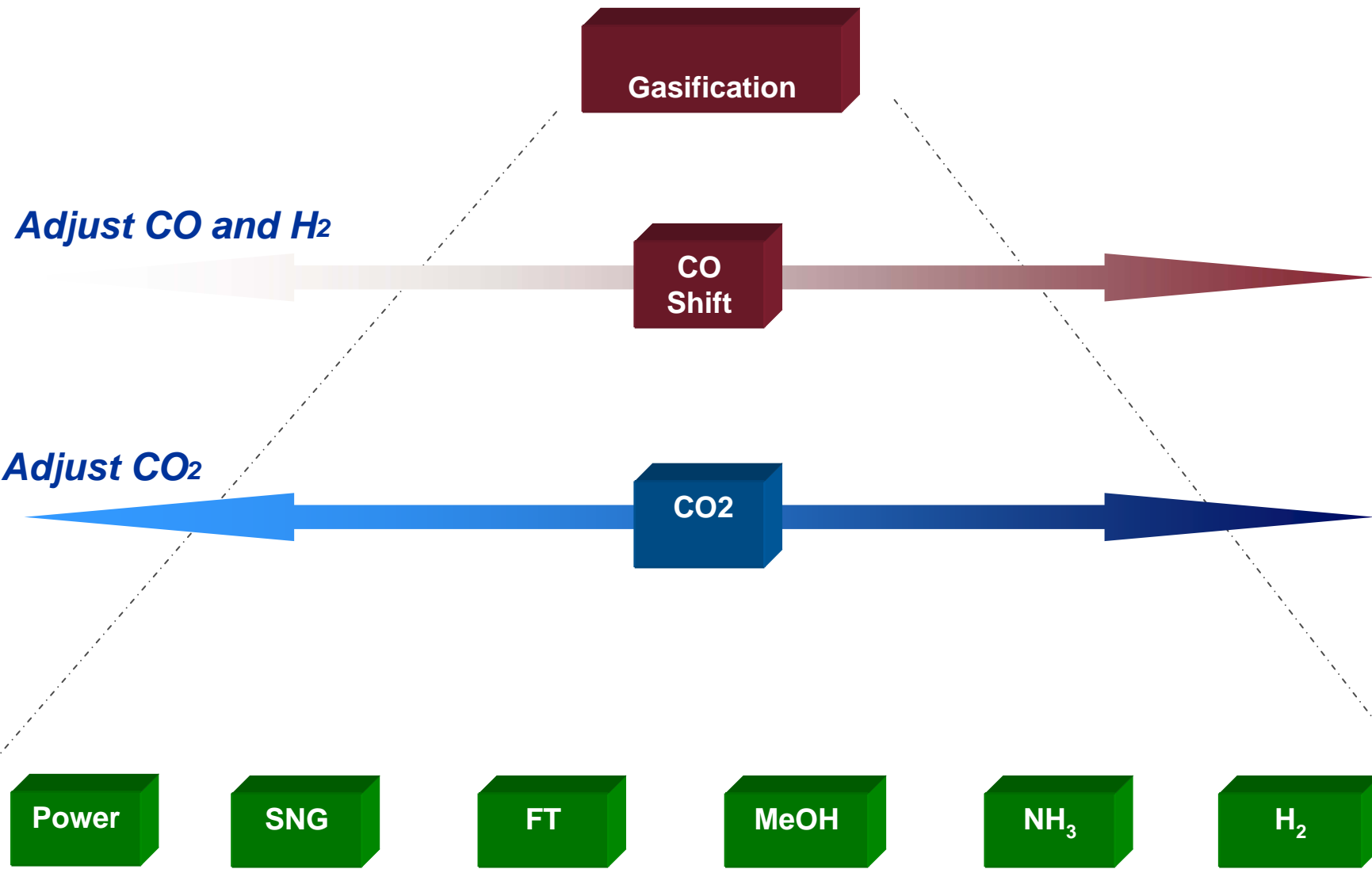
\*\*\*) FNR: Fachagentur für Nachwachsende Rohstoffe

# Gas treating adjusts stoichiometrics



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# Gas treating adjusts stoichiometrics



# Lurgi Rectisol characteristics

- **Fact overview**
- **Applications**
- **Gas cleaning comparison**
  
- **Sweet Shift & Sour Shift**
- **Process & Equipment**
  
- **Summary**

- **The Rectisol syngas purification technology has an outstanding position in the world**
  - ✓ Especially in the case of gasification
  - ✓ Also feed gas generated from coal, oil, or petcoke gasification.
  - ✓ Worldwide, nearly 90 % of the synthesis
  - ✓ Invented already in 1949 by Lurgi and Linde
  - ✓ ~ 85 Rectisol units from Lurgi
  
- **Level of acid gas removal**
  - ✓ Removal of **all sulfur components** including H<sub>2</sub>S, COS, mercaptans, etc. down to **0.08 ppmv (80 ppb)** can be guaranteed.

## ■ Trace component removal

- ✓ A very important strength of the Rectisol process is the complete **removal of trace contaminants** such as COS, HCN, NH<sub>3</sub>, **mercaptans**, mercury, Fe and Ni carbonyls, and BTX.
- ✓ As the COS is removed together with the H<sub>2</sub>S, there is no need for a COS hydrolysis reactor upstream of a Rectisol unit.

## ■ Solvent

- ✓ Utilizes deep cooled methanol as solvent

The Rectisol gas purification technology is a purely physical absorption process is carried out at low temperatures and high pressures. The absorption medium used is a liquid organic polar solvent, methanol. Mass transfer from the gas into the methanol solvent is driven by the concentration gradient of the respective component between the gas and the surface of the solvent, the last being dictated by the absorption equilibrium of the solvent with regard to this component. This means that all gas components detrimental to the downstream process stages, typically hydrogen sulfide, COS, mercaptans, hydrogen cyanide, ammonia and other harmful compounds as well as carbon dioxide are almost completely removed from gases with a small rate of circulating solvent and thus, low energy requirements. Extremely high purities - e.g. a total sulfur content of less than 0.1 ppmv- can be reached, making the product gas suitable for being fed to most syntheses without further purification steps.

The compounds absorbed are removed from the solvent by flashing (desorption) and additional thermal regeneration, so that the solvent is ready for new absorption. The Rectisol technology provides an option to recover the major part of the carbon dioxide contained in the feed gas as a pure CO<sub>2</sub> product stream. Recovery of the full amount of CO<sub>2</sub> (e.g. for sequestration) is also possible with a slightly modified process set-up.

Acid gas containing the sulfur components is routed to battery limit, usually for processing in a Claus Sulfur recovery unit.

Typically, the raw gas entering the Rectisol plant is saturated with water vapor corresponding to the inlet pressure and temperature. This water is absorbed by the solvent. To keep the water content of the solvent at a low level, a distillation unit is provided which separates the water from the solvent, producing a small off-water stream.

# Applications 2000-2008

Fertilizer plants: <sup>1)</sup>	4	China
Methanol plants:	5	China
Hydrogen and/or power:	3	China, Canada, Germany
DME production: <sup>2)</sup>	1	China
Steel reduction gas:	1	India
Coal-to-Propylene: <sup>3)</sup>	2	China
Petcoke to hydrogen & methanol:	1	USA
Petcoke to SNG:	1	USA

1) Via ammonia and CO<sub>2</sub>

2) Via methanol

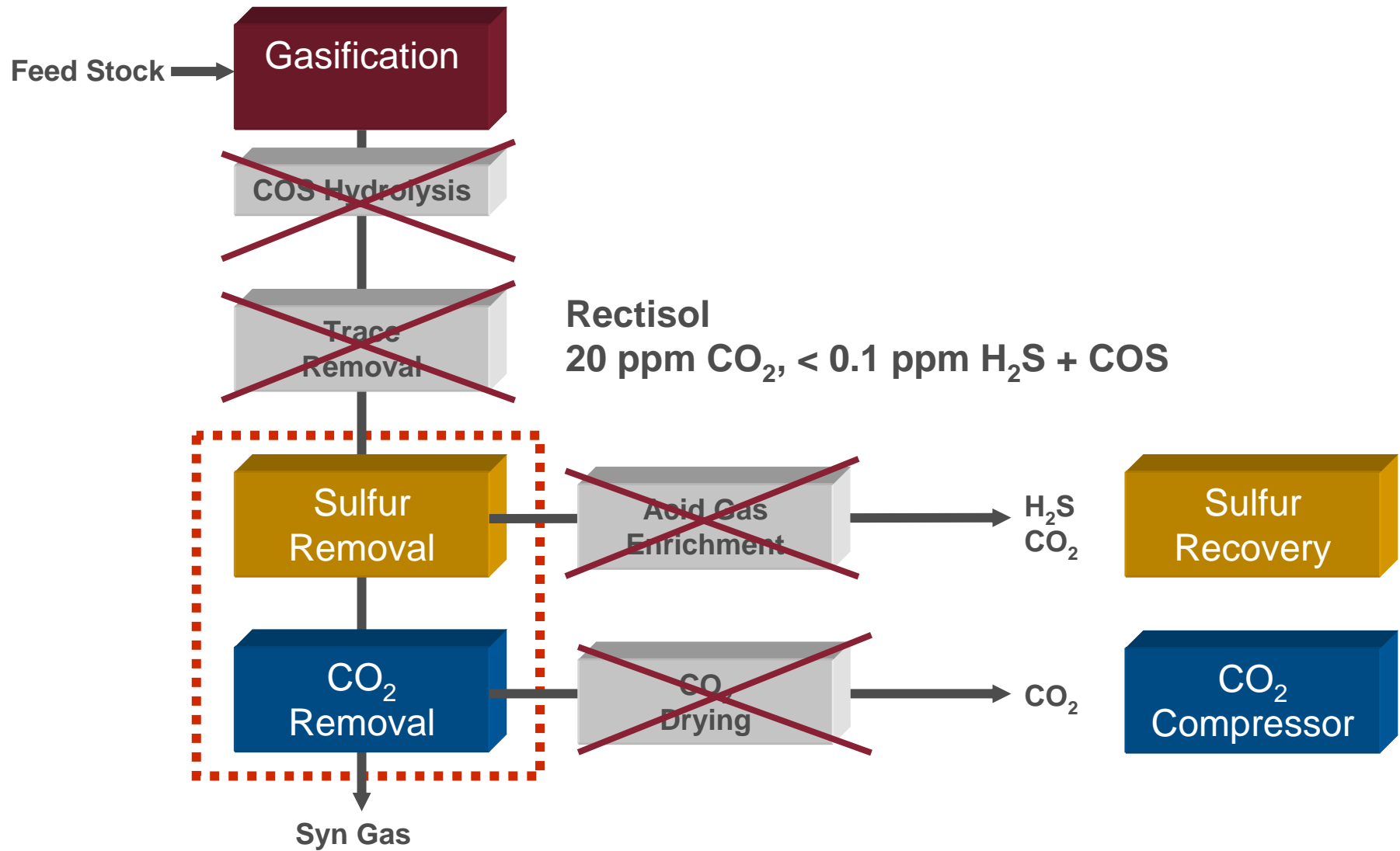
3) Via Lurgi MegaMethanol and MTP<sup>®</sup>

2000's



Syngas to MeOH  
China, 2008

# Syngas from gasification with Rectisol



# Five In One

**1. Trace contaminant removal**

**COS, CS<sub>2</sub>, NH<sub>3</sub>, HCN ...**

**2. Desulfurization**

**to synthesis feed quality  
total S < 0.1 ppmv**

**3. Bulk CO<sub>2</sub> removal**

**100 % CO<sub>2</sub> can be removed**

**4. CO<sub>2</sub> recovery**

**CO<sub>2</sub> can be purified  
total S < 5 ppmv  
No water!**

**5. Acid Gas Enrichment**

**Claus-suited acid gas  
even with low S, high CO<sub>2</sub> in feed**

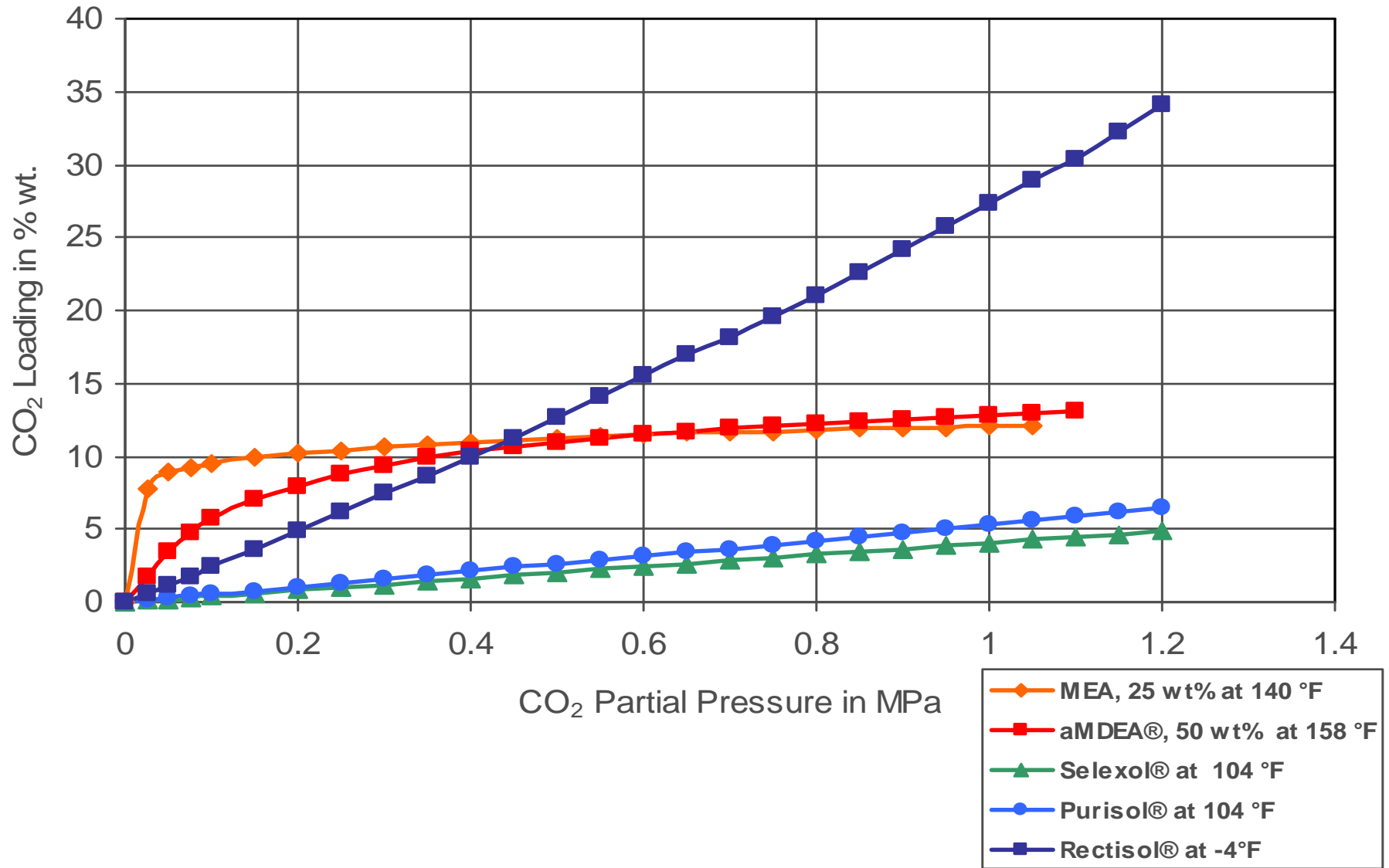
# Gas cleaning comparison

■ Rectisol	0.1	ppm	H <sub>2</sub> S + COS
	20 - 50	ppm	CO <sub>2</sub>
■ Purisol	1 - 50	ppm	H <sub>2</sub> S; <b>less</b> COS removal
	Selexol 50 - 200	ppm	CO <sub>2</sub>
■ MDEA	3 - 50	ppm	H <sub>2</sub> S; <b>no</b> COS removal
	20 - 100	ppm	CO <sub>2</sub>

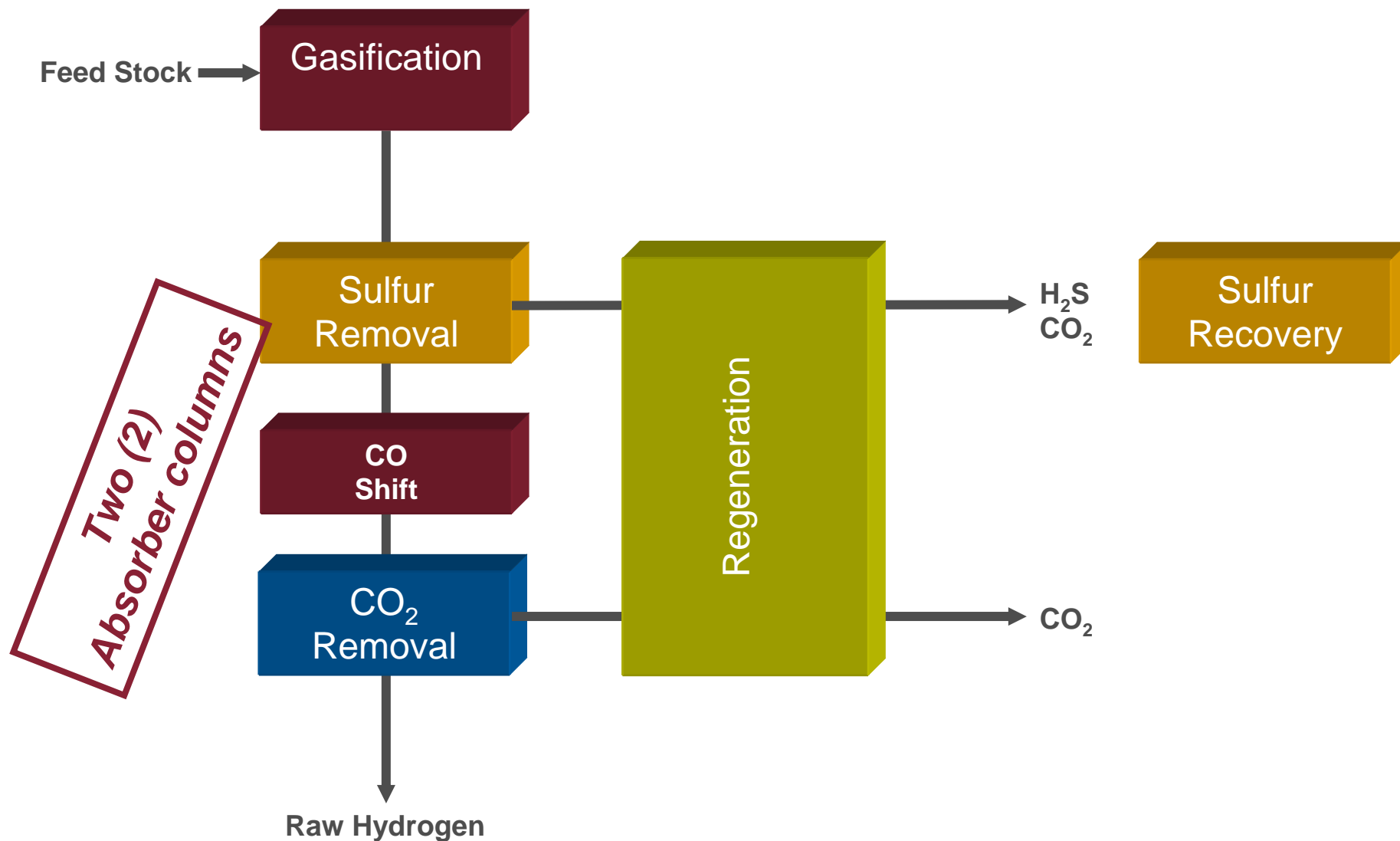
# Gas cleaning comparison

- **Rectisol**      **High solubilities of trace components**
  
- **Purisol**      **Less solubility of COS**  
  **Selexol**      **Higher selective (CO<sub>2</sub> vs S) than Rectisol**
  
- **MDEA**      **No COS removal**  
                  **Contaminants and CO are harmful to the amine**  
                  **Less selective (CO<sub>2</sub> vs S) than physical solvents**
  
- **aMDEA®**      **Activated for CO<sub>2</sub> removal**

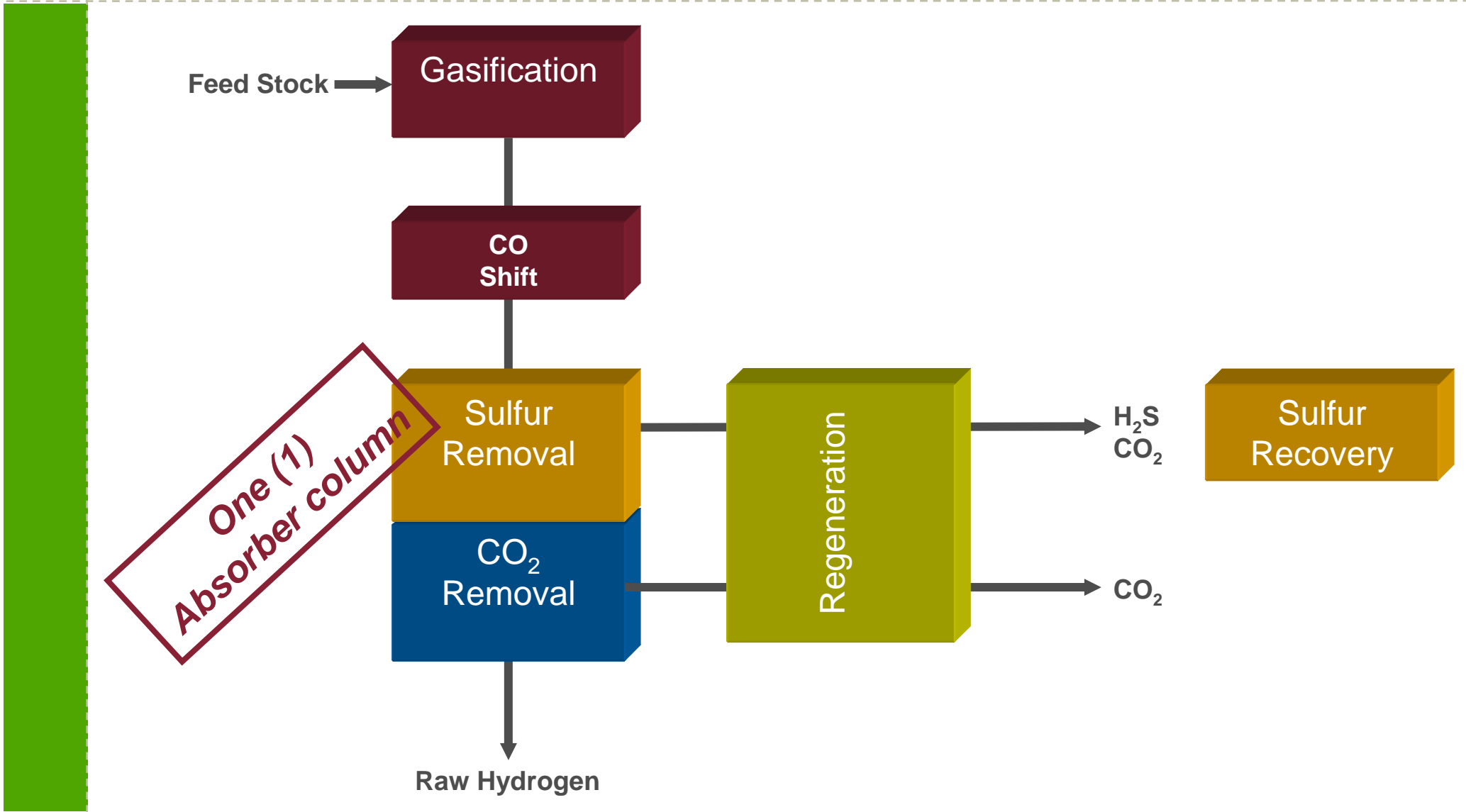
# CO<sub>2</sub> Removal



# Boiler mode with Sweet Shift



# Quench mode with Sour Shift



# One Step vs Two Step

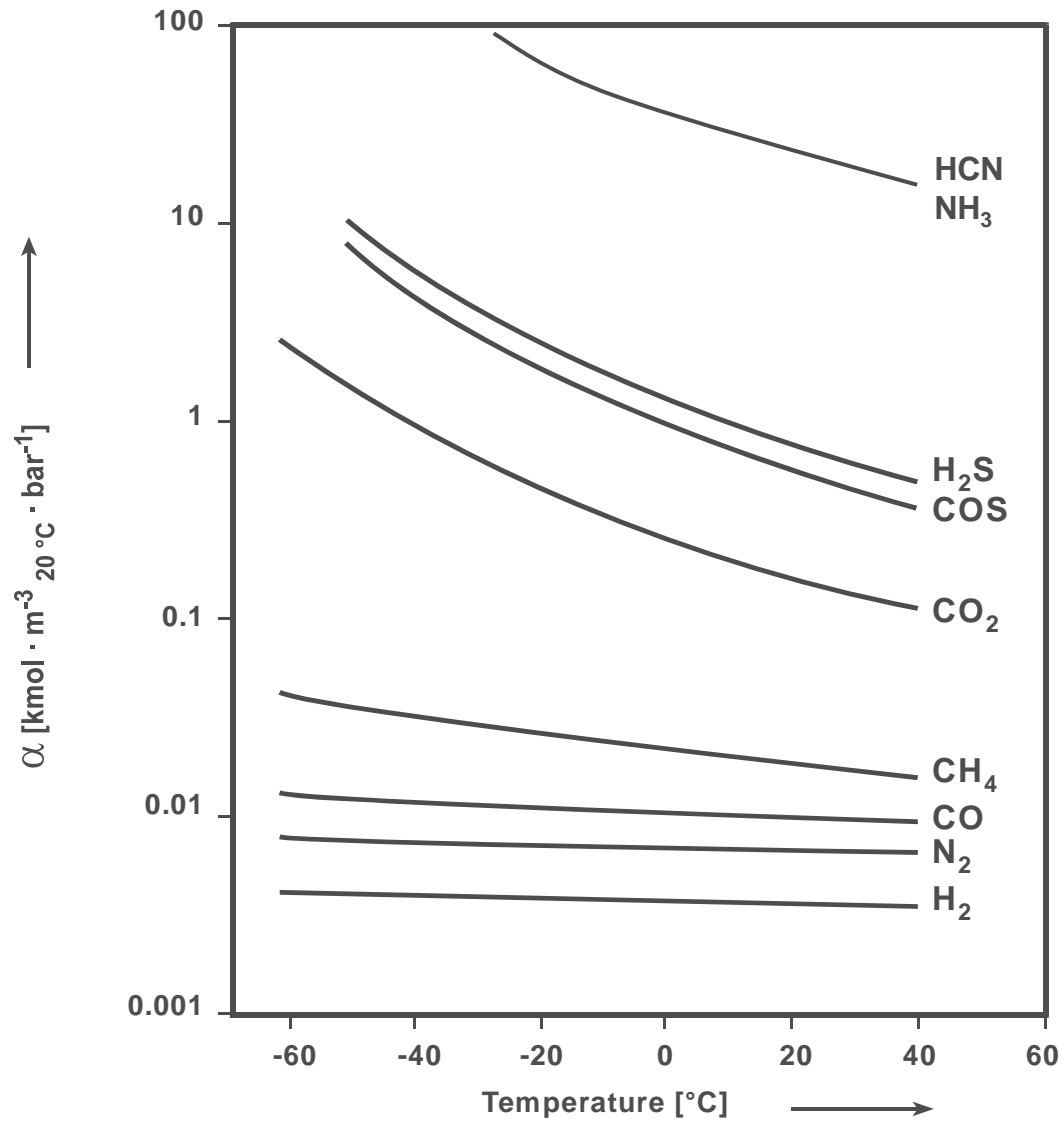
## ■ One Step Rectisol

- ✓ Removes acid gas components from shifted gas
- ✓ *Sour Gas Shift* is applied
- ✓ Gas can be treated in one absorber column

## ■ Two Step Rectisol

- ✓ Removes acid gas components from unshifted gas
- ✓ Shift conversion between sulfur and CO<sub>2</sub> removal  
*Sweet Gas Shift*
- ✓ Higher risk of fouling
- ✓ Higher CAPEX
- ✓ Lower OPEX

# Solubilities in Methanol

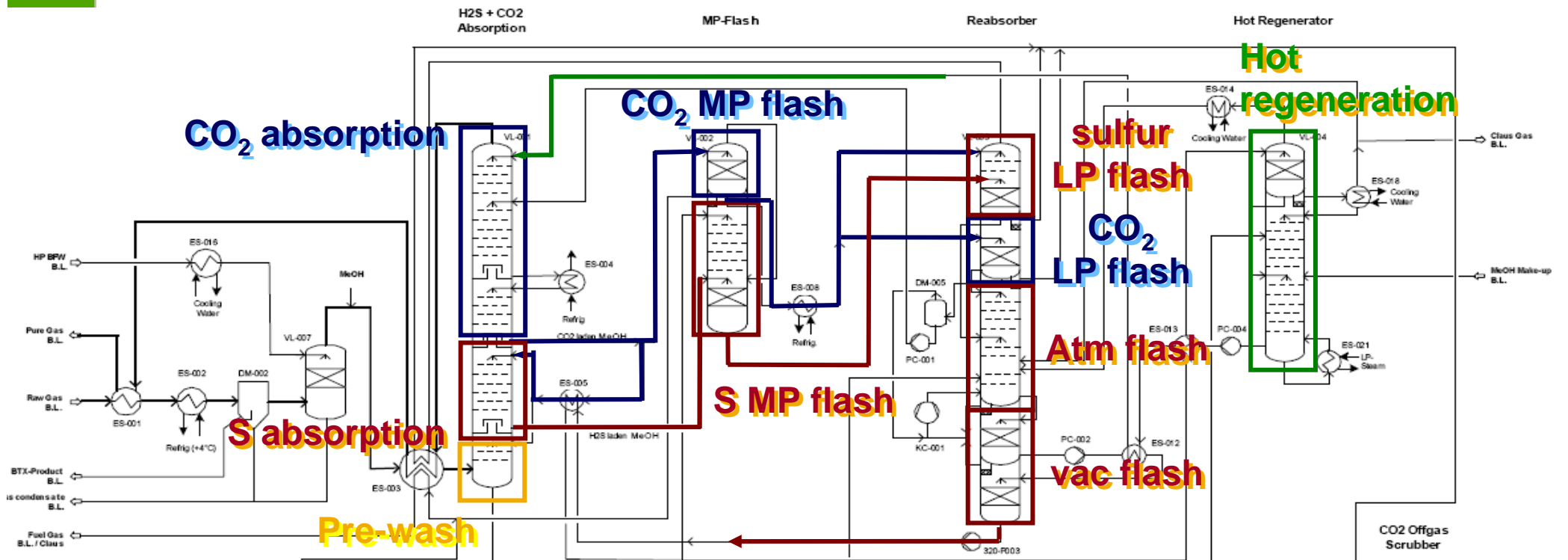


traces  
absorption

S absorption

CO<sub>2</sub> absorption

# Generic Rectisol process (quench mode)



# Process guarantees

- Raw Gas Capacity

- Syn Gas Purity      Total Sulfur      80 ppbv, max.  
                                 CO<sub>2</sub>                      ~ 2 – 3 vol%

- CO<sub>2</sub> Off Gas

- Acid Gas

# Summary

- **Rectisol is still unique**
- **Total sulfur removal**
- **Trace contaminant handling**
- **Suitable preparation of all products**
- **Six decades of history and experience**
- **Designed and operated with various upstream and downstream technologies**