# EFFECT OF DIFFERENT CONFIGURATIONS OF PHYSICAL SOLVENT BASED ACID GAS REMOVAL AND CO2 CAPTURE FOR IGCC CCS POWER PLANTS

*Vaclav NOVOTNY, Monika VITVAROVA*

*Department of Energy Engineering*
*Faculty of Mechanical Engineering*
*Czech Technical University in Prague*

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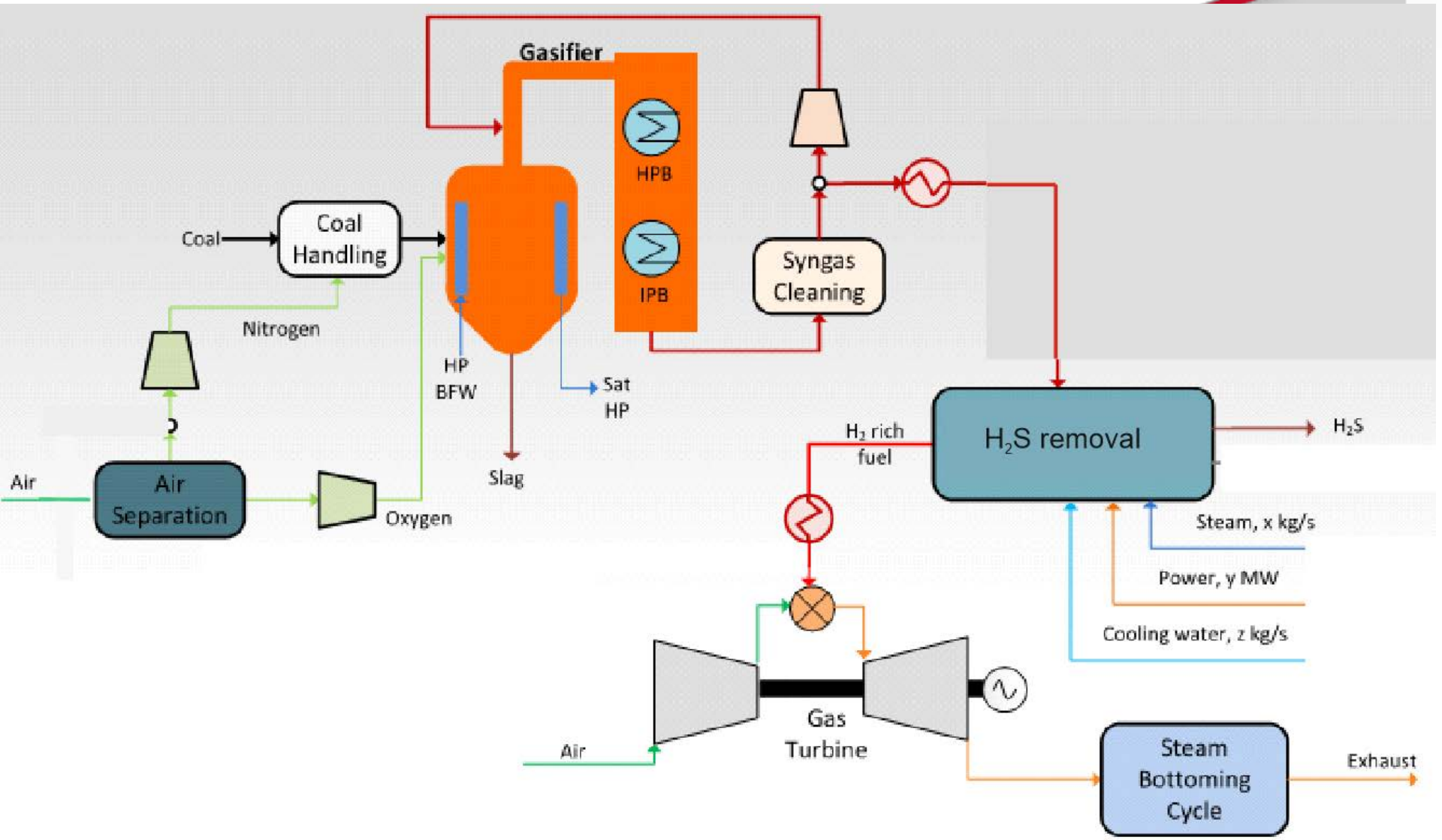
# Model Input, Reference Plants



# Selection of desulphurisation / CO2 removing solvent

CO2 and H2S capture in IGCC

- Suitable physical solvents (choice due to high CO2 / H2S content)
- In CCS-IGCC typically considered same method as for desulphurisation
- Several methods and solvents exist:
  - Selexol (dimethyl ether of polyethylene glycol)
    - In literature slightly favoured in energy demand
  - Rectisol (MeOH)
    - Cheap and commonly available solvent
  - Purisol (NMP)
  - Fluor Solvent (propylene carbonate)
  - Other

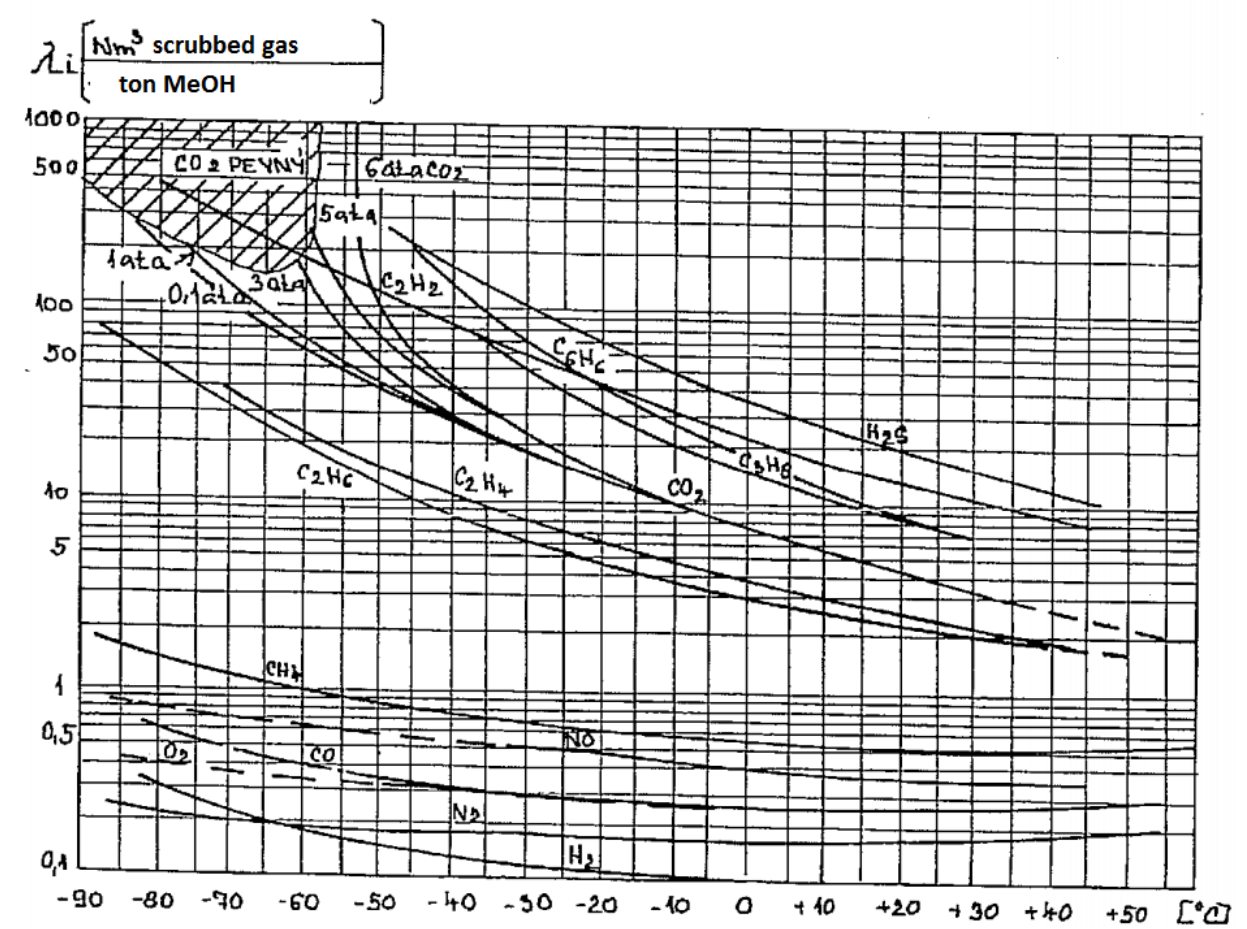
- Direct experience from Vřesová IGCC plant determined use of Rectisol system (at least for first versions of analysis)

# Selecting desulphurisation / CO2 removing solvent

| Parameter | Rectisol | Selexol |
|---|---|---|
| Regeneration heat | Higher | Lower |
| Working temperature | Lower (-20°C) | Higher (room) |
| Absorption capacity | Higher (CZ coal has high S content) | Lower |
| Selectivity H2S vs. CO2 | Lower | Higher |
| Chemical / thermal stability | Excellent (no degradation) | Limited |
| Other | No foaming, lower corrosion, lower viscosity, higher solvent loss with product, absorbs H2O | |
| Syngas application in CZ | Vřesová | N.A. |

# Rectisol system

Selectivity and loading of MeOH

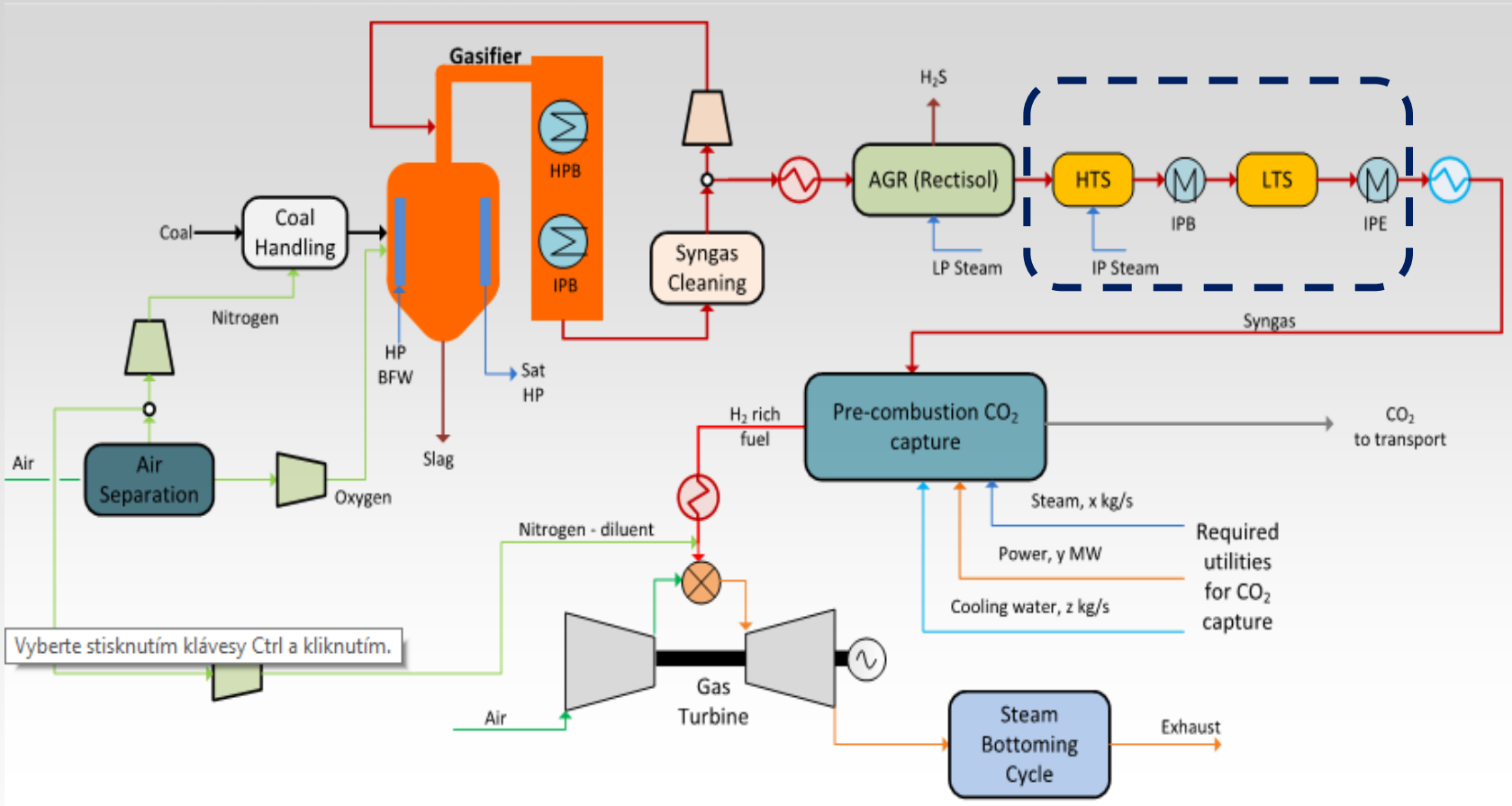



Source:
(Linde for Vřesová plant)

# Rectisol system modelling

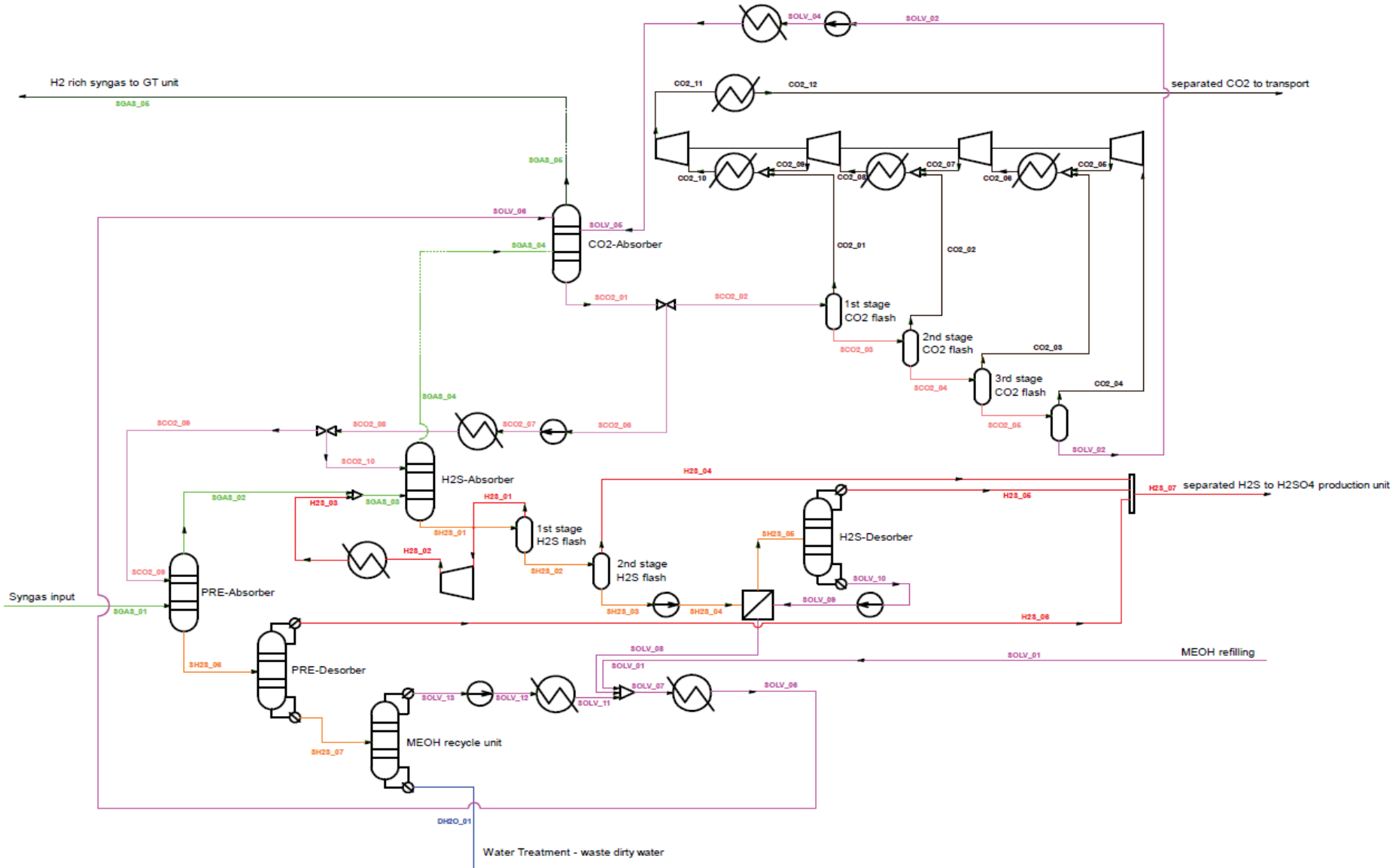
- Using Aspen PLUS plattform
- Properties set based on Peng-Robinson method
- Syngas after WGS – 97% CO conversion
- H2S removal requirement
  - 30 ppm in syngas requirement (dew point)
  - 100 ppm in CO2 requirement for transport
- CCR 60% – 90% with CO2 compression to 110 bar
- Realistic equipment efficiency, integration into the model of the whole plant

# Schemes of Integrated Gasification Combined Cycle plants with CCS



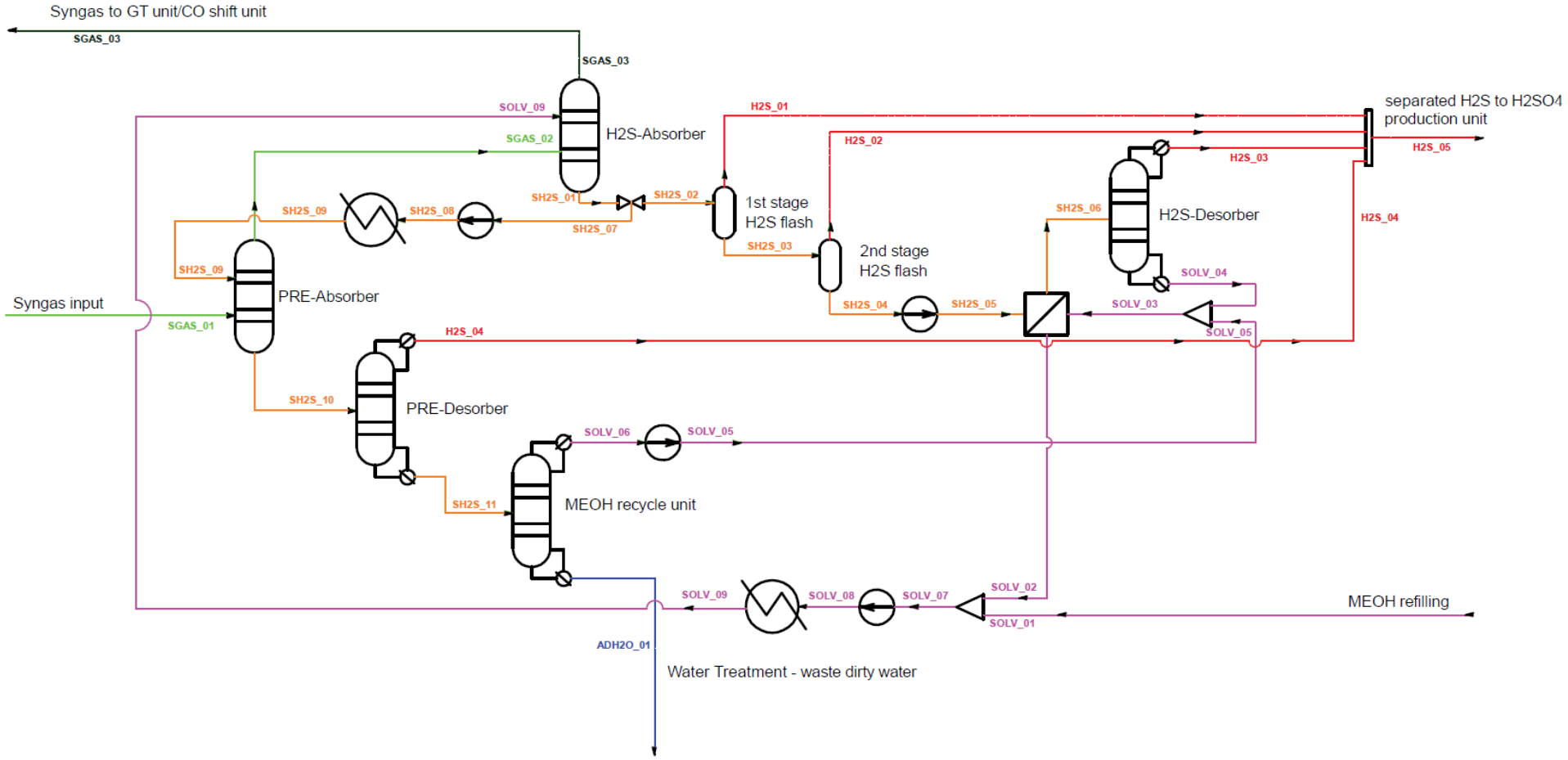
# Rectisol + WGS configurations

## - Detail of combined H2S and CO2 separation



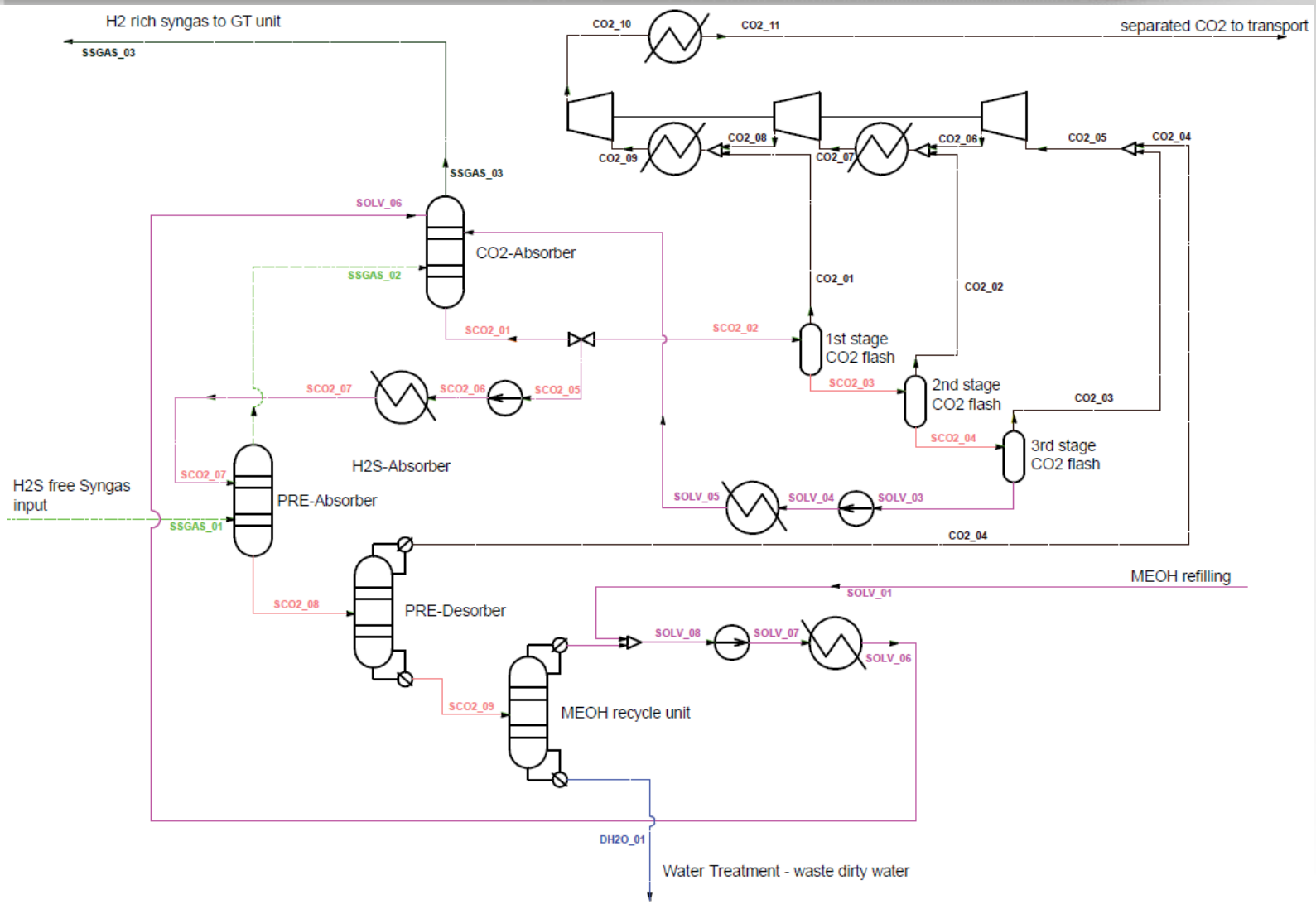
# Rectisol + WGS configurations

## - Detail of standalone AGR unit



# Rectisol + WGS configurations

## - Detail of standalone CO2 separation



# Results of combined CCS+AGR system

- Combination into a single system – overally simpler, lower costs etc.
- Due to lower selectivity between H2S and CO2 high CO2 losses in H2S offgas

  - hard to achieve very high CCR

  - required recirculation of part of H2S offgas to increase H2S partial pressure – large compressor power input, large solvent flows

  - without recirculation 19% C loss in H2S stream
- Lower steam mass flow to WGS (requirement of reheating up syngas - to 300°C)

# Results of separated CCS+AGR systems

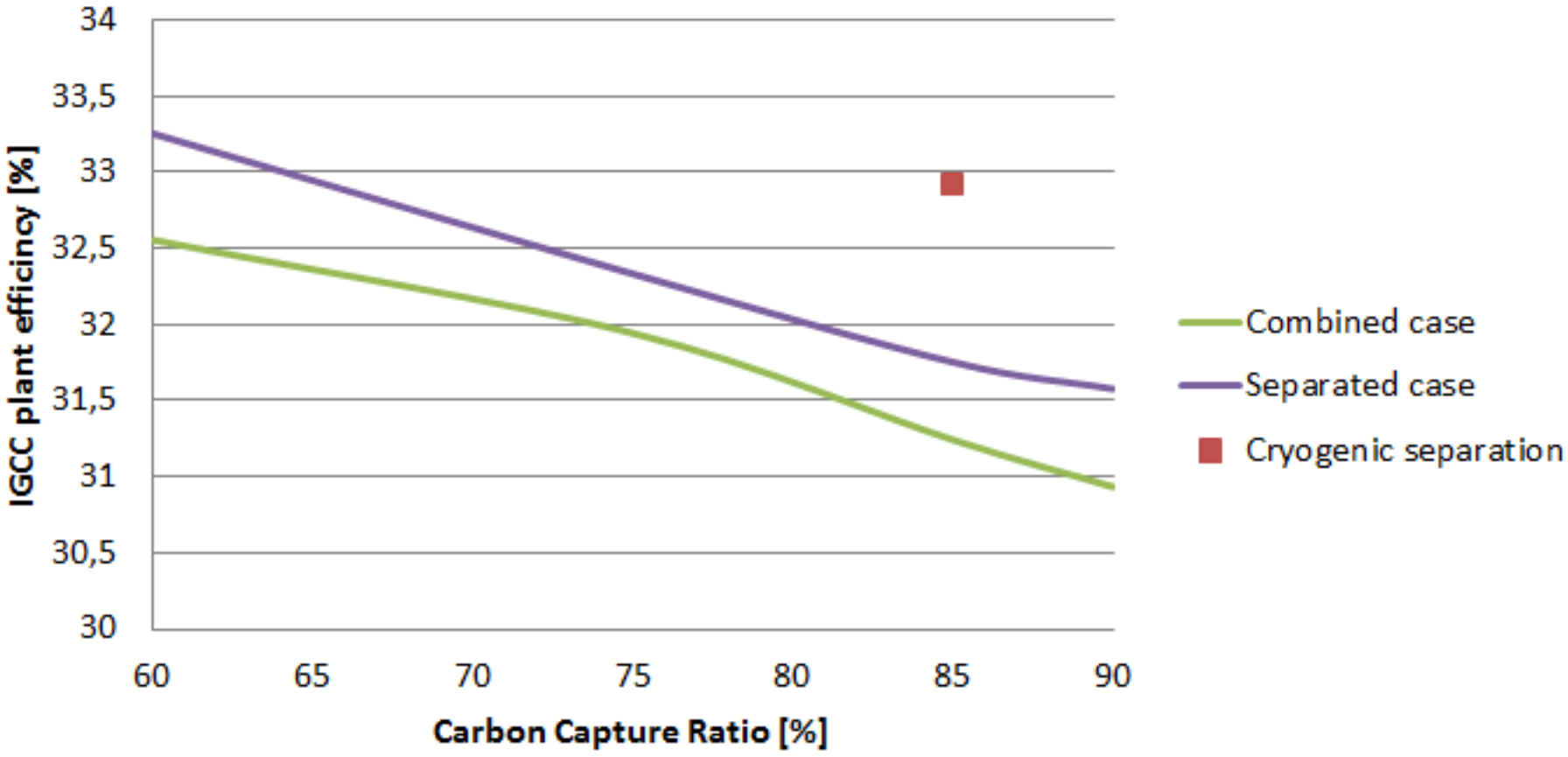
- Low CO2 loss with H2S stream without any recirculation, independent on CCR and constant (1.6% of C)
- Lower electricity consumption – no compressor
- Provides better control of the CO2 separation process independent of AGR
- More recuperation HXs, „illogical“ temperature profile (cooling down to AGR, heat up for WGS, cooling down again)
- Higher steam mass flow to WGS (requirement of reheating up syngas - to 300°C) – by 14%

# Composition of Syngas for AGR and CO2 capture (85% CCR example)

| vol % | Reference | CCS + AGR combined | CCS + AGR separated | |
|---|---|---|---|---|
| | | | AGR | CO2 separation |
| CO | 49.0 | 1.0 | 49.0 | 1.1 |
| CO2 | 5.6 | 39.0 | 5.6 | 38.7 |
| H2 | 24.6 | 52.9 | 24.6 | 53.5 |
| H2S | 0.4 | 0.3 | 0.4 | 0.0 |
| | | | | |
| CO2 in H2S stream [vol %] | 60 | 89 | 60 | - |
| [% of all C] | 1.6 | 7.3 | 1.6 | - |

# Comparison of overal plant performance

Reference plant efficiency 43.2%



# Conclusion

- Configuration with separated systems has ~ 0.6 p.p. higher efficiency across the range of CCR
- Result is outcome of omitted recirculation compressor, but higher steam consumption and worse syngas heat utilization (more recuperation)
- Alternative methods as Cryogenic separation still appear more perspective in efficiency point of view
- Comparison of same phenomenon for different solvents would be interesting

THANK YOU FOR YOU ATTENTION

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www.czech-norway-pilotccs.com
email: nfccs05@gmail.com