CO2 CAPTURE BASED ON SOLVENT (RECTISOL)

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CO2 CAPTURE AND STORAGE IN THE CONDITIONS OF THE CZECH REPUBLIC
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CO_2/H_2S capture based on solvent methods

- 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

Selecting of solvent method for CO_2/H_2S capture

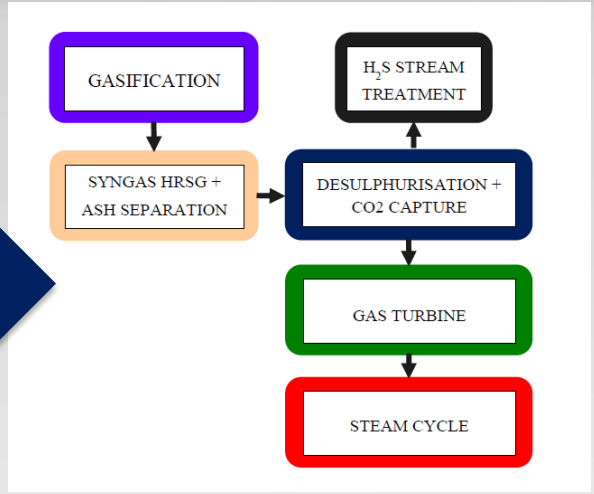
Parameter	Rectisol	Selexol
Regeneration heat	Higher	Lower
Operating temperature	Lower (-20°C)	Higher (room)
Absorption capacity	Higher (Czech lignite has high S content – (1-3%))	Lower
Selectivity H2S vs. CO2	Lower	Higher
Chemical / thermal stability	Excellent (no degradation)	Limited
Other	No foaming, lower corrosion, lower viscosity, higher solvent loss with product, absorbs H2O	
Syngas application in CR	IGCC power plant Vřesová	N.A.

Rectisol system modelling

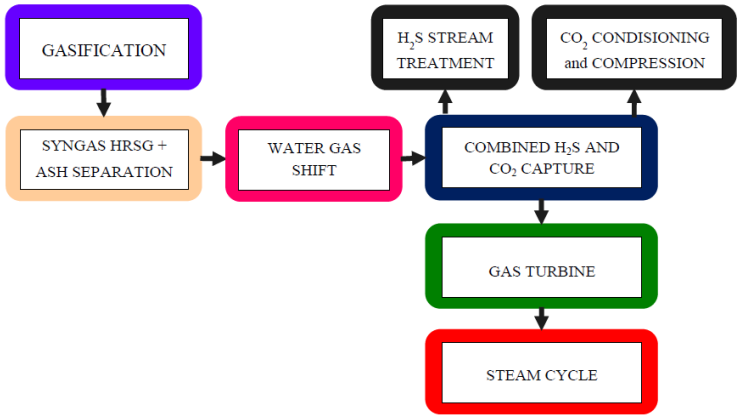
- using Aspen PLUS platform
- properties set based on Peng-Robinson method
- H_2S removal requirement
  - 30 ppm in syngas requirement (dew point)
  - 100 ppm in CO_2 requirement for transport
- CCR 85% with CO_2 compression to 110 bar
- Realistic equipment efficiency, integration into the model of the whole plant

Rectisol wash proces - Detail of combined H_2S and CO_2 capture

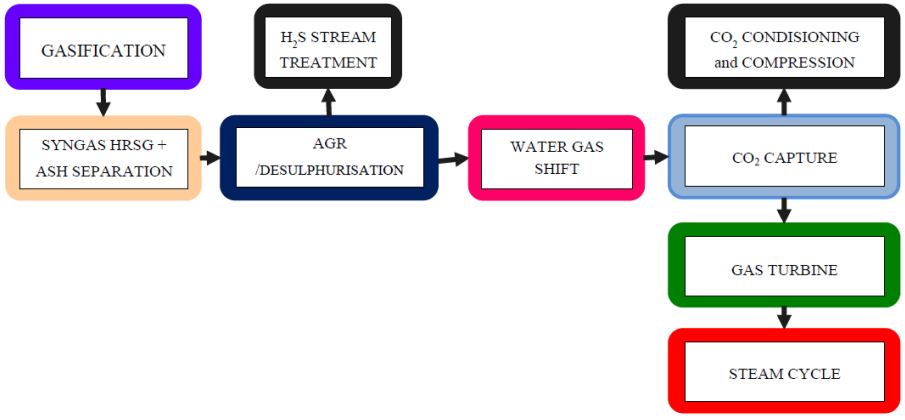
AGR configuration without CO_2 capture



COMBINED H_2S AND CO_2 CAPTURE



AGR AND CO_2 CAPTURE – separate configuration



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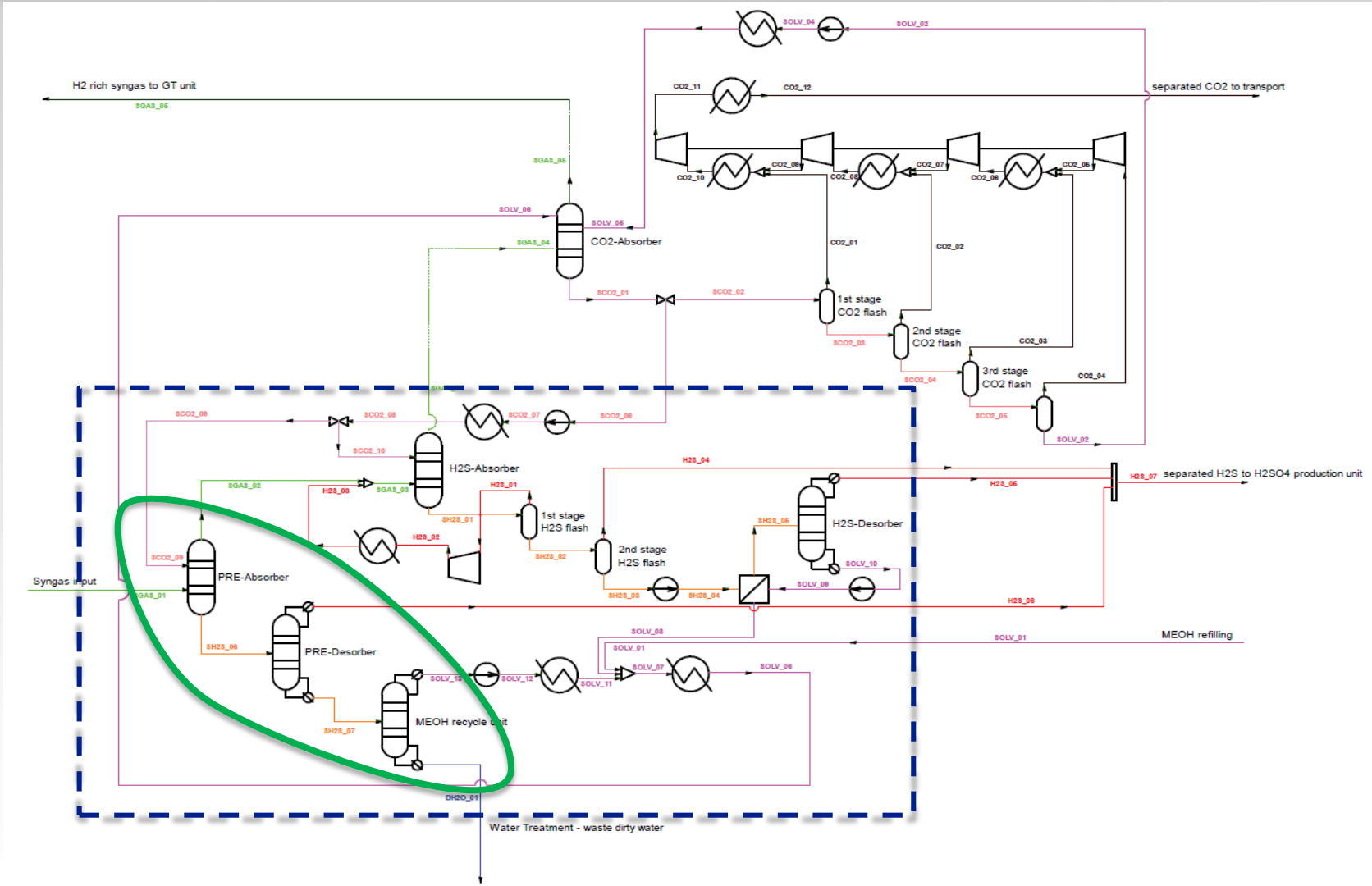
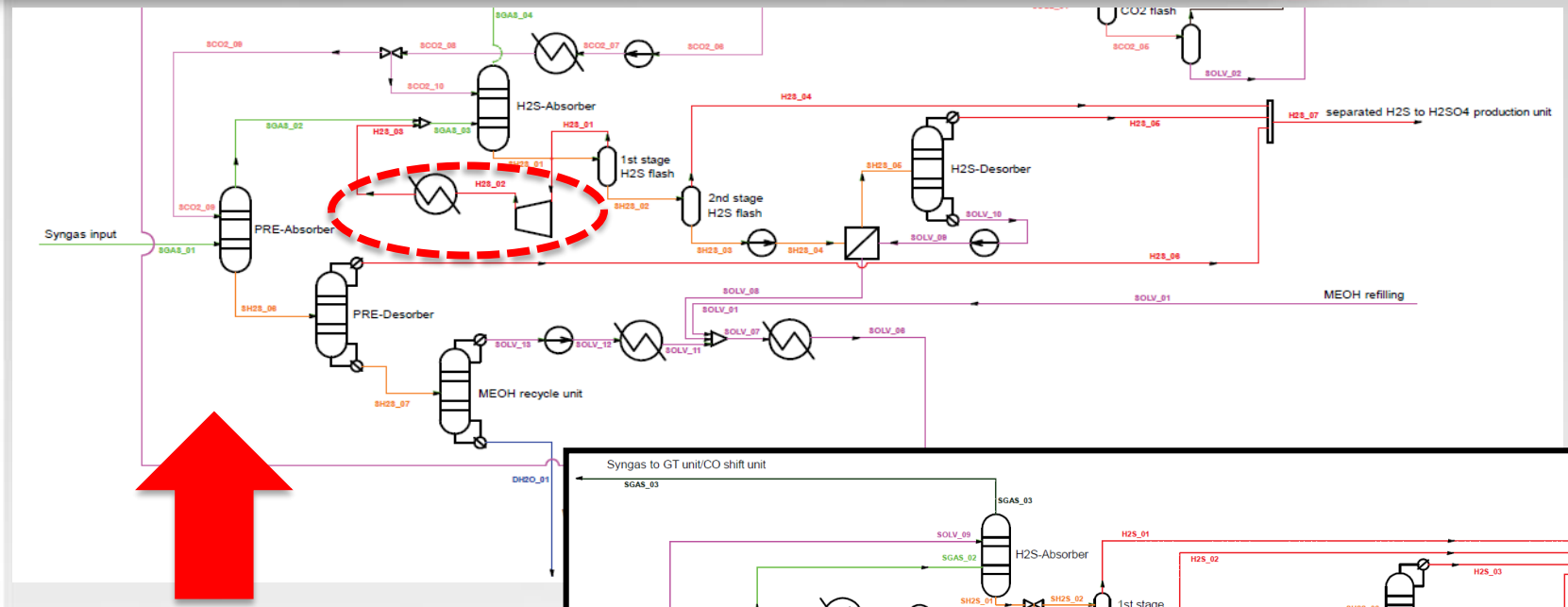
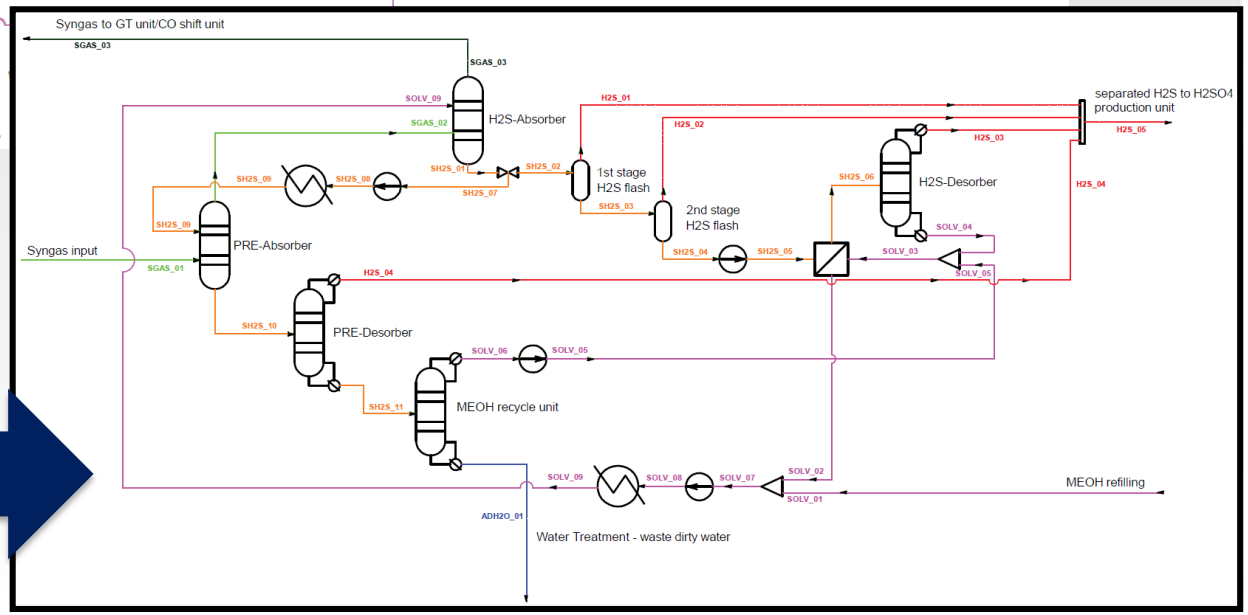


Rectisol wash proces - Comparison H_2S capture (combined and separated)





H_2S capture part in combined CO_2/H_2S capture

separated H_2S capture

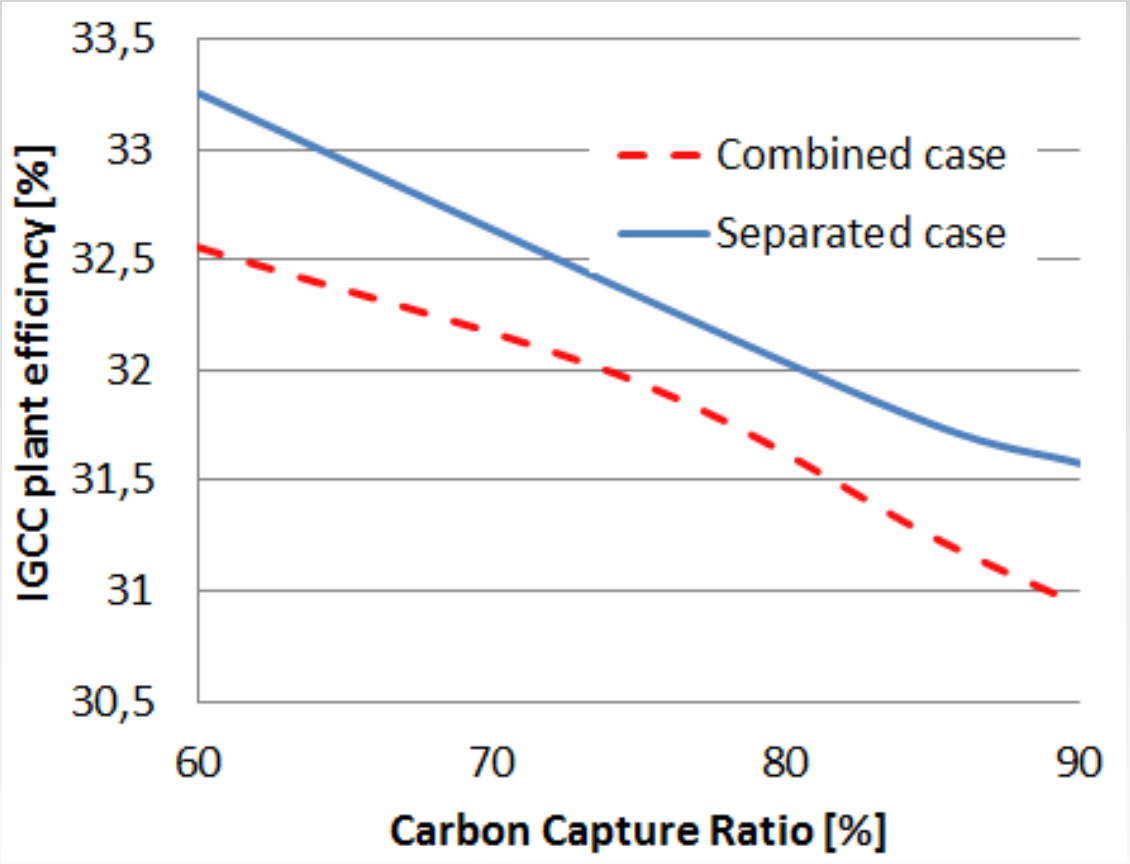
Separated and combined H_2S/CO_2 capture configuration – H_2 rich syngas compositon

Parameter	Combined	AGR+CO_2	
	H_2S+CO_2	AGR	CO_2
CO [vol %]	1.0	49.0	1.1
CO_2 [vol %]	39.0	5.6	38.7
H_2 [vol %]	52.9	24.6	53.5
H_2S [vol %]	0.3	0.4	0.0
CO_2 in H_2S stream [vol %]	89	60	-
[% of all C]	7.3	1.6	-

General results of comparison of separated and combined H_2S/CO_2 capture configuration

Combined H_2S and CO_2 capture unit	AGR unit + CO_2 capture unit
• In comparison with single system – in overall simpler, lower CAPEX etc. • Due to lower selectivity between H_2S and CO_2 high CO_2 losses in H_2S offgas ✓ required recirculation of part of H_2S offgas to increase H_2S partial pressure – higher power consumption (compressor), solvent flow ✓ without recirculation 19% C loss in H_2S stream • Lower steam mass flow to WGS (requirement of reheating up syngas - to 300°C)	• Low CO_2 loss with H_2S stream without any recirculation • Lower electricity consumption – no compressor • Provides better control of the CO_2 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%

Separated and combined H_2S/CO_2 capture configurations – efficiency

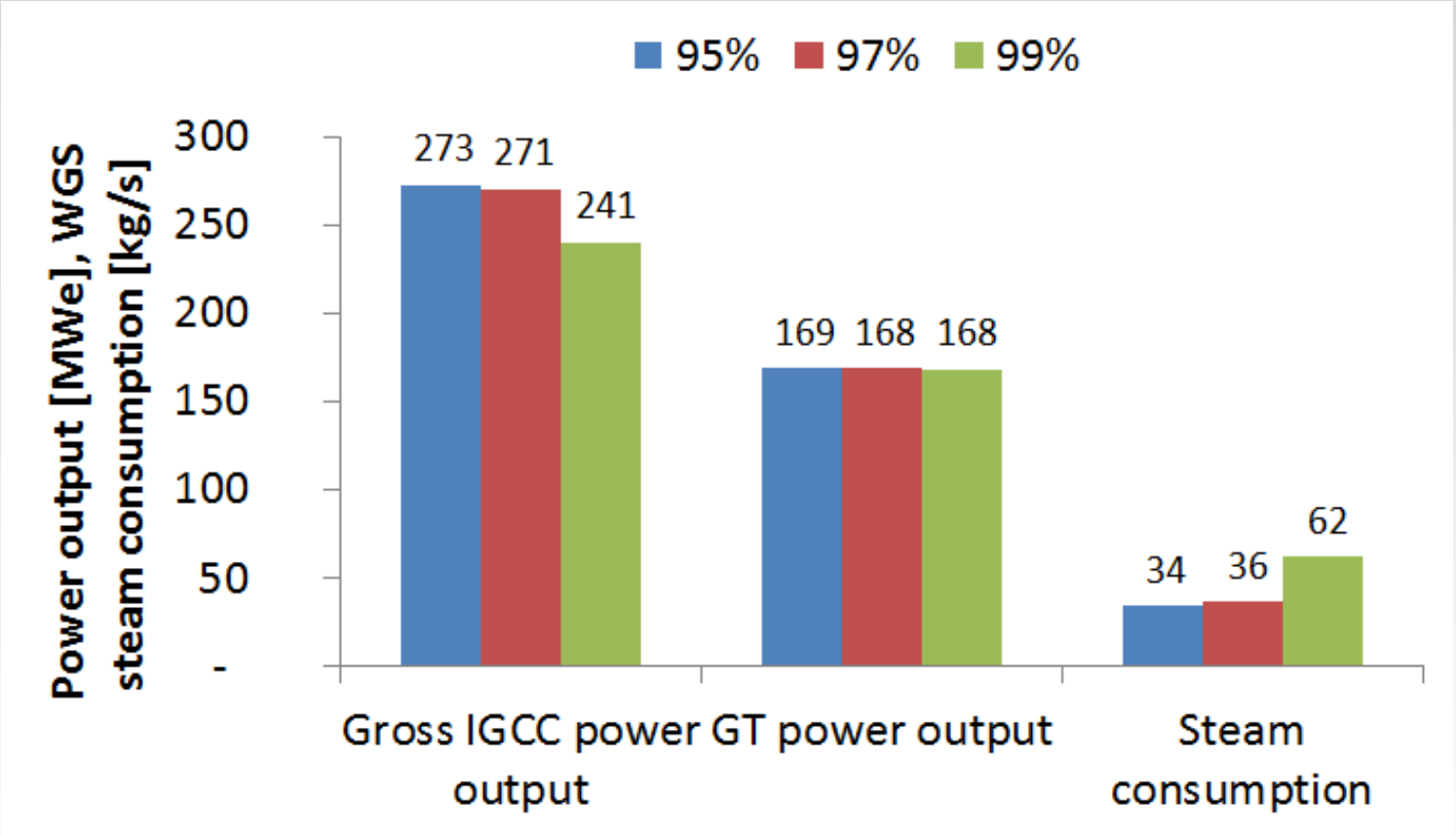


separated H_2S and CO_2 capture

WGS efficiency – H_2 rich syngas and CO_2 stream composition

Parameter	WGS – 95%	WGS - 97%	WGS- 99%
H_2 rich syngas			
CO [vol %]	2.7	1.5	0.5
CO_2 [vol %]	5.4	6.3	7.5
H_2 [vol %]	81.7	81.9	82.1
CO_2 capture			
CO [vol %]	0.05	0.03	0.0006
CO_2 [vol %]	98.3	98.5	99.2
H_2 [vol %]	0.5	0.45	0.02
MEOH [vol %]	0.5	0.35	0.04

WGS efficiency – IGCC gross power output



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)
- Comparison of same phenomenon for different solvents would be interesting

THANK YOU FOR YOU ATTENTION

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