Mid-size LNG design considerations for robust and flexible operation: Yangling LNG plant as a case study

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Yangling LNG presentation

- Owner : Shaanxi LNG Investment and Development Co LTD
- 0.5 MTPA LNG production
- Peak Shaving Plant
- Air Products AP-SMR™ Liquefaction Process
- TPFMC in charge of the

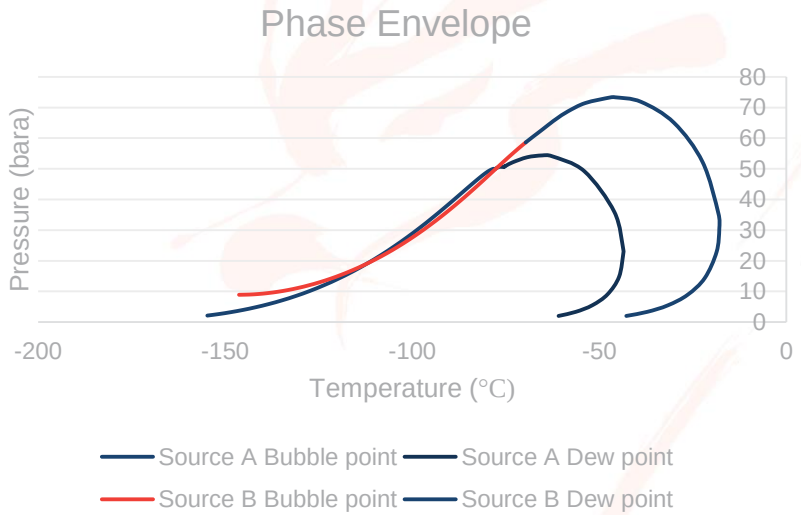
  LNG train and storage facilities
  - Successfully started up and running since 2015

Design Challenges

- Flexibility to meet big fluctuations in gas quality and quantity
- Robustness and High efficiency at varying loads
- Operational flexibility for turn up and down
- Imported power
- Imported refrigerant: no in-situ fractionation

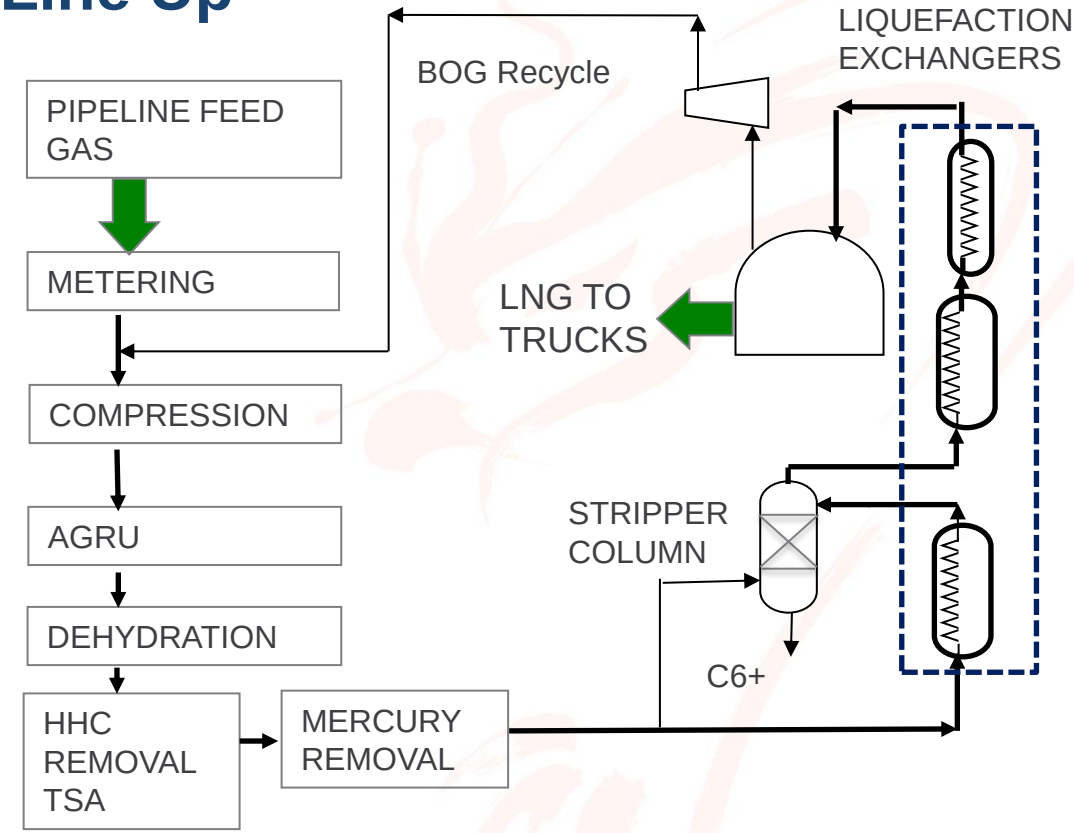
Feed Gas Quality

	Gas Source	
Feed component	A	B
Methane	95.7	92.88
Ethane	1.341	4.107
Propane	0.209	0.759
C4	0.0691	0.316
C5	0.0247	0.084
C6+	0.0124	C6+:0.089



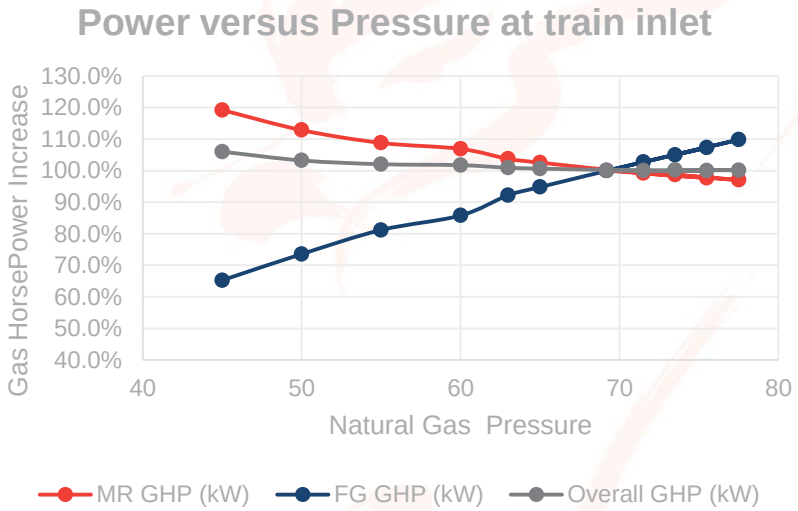
Plant Line Up

- Preteatment
- Liquefaction with AP-SMR technology
- Boil Off Gas recycled back to plant
- 2 x 25 000 m3 LNG tanks
- Additional LNG export by trucks

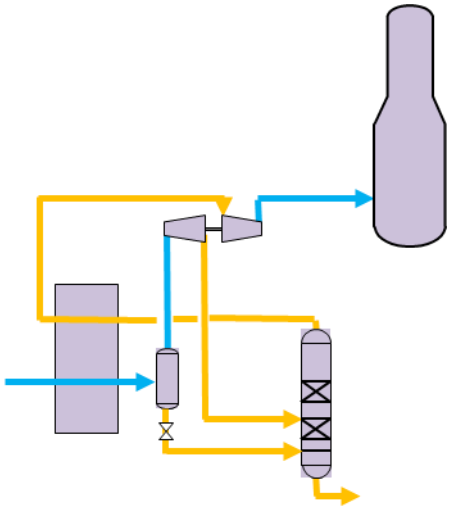


Key Parameter: Operating Pressure Pretreatment and Liquefaction

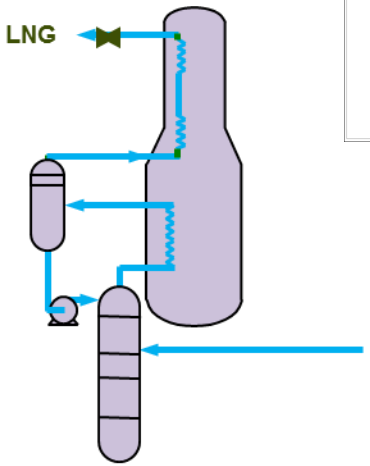
- Total Power decreases with pressure with an optimum at 77 bar
- Capital cost is reduced by optimizing the largest rotating machinery
- An increase in pressure in pre-treatment allows reduction in equipment and piping volume.
- A smaller MR compressor leads to smaller refrigerant inventory and imports vs increase in inlet compression

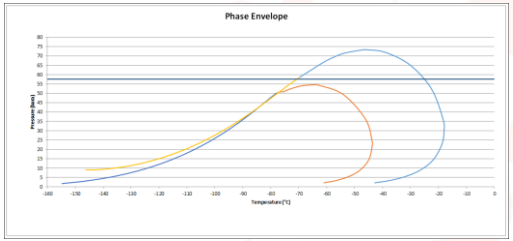


Heavy Hydrocarbon Removal
Three Routes

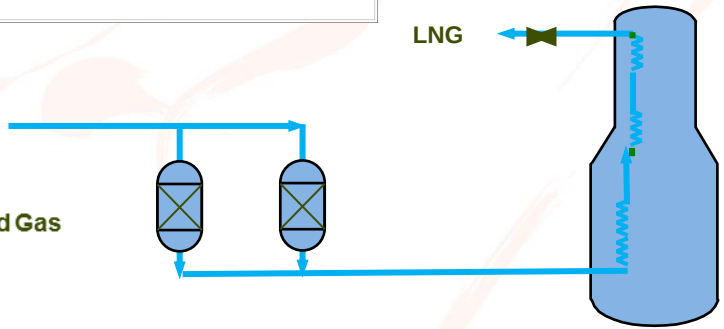


Fractionation at reduced pressure





Scrub column at high pressure

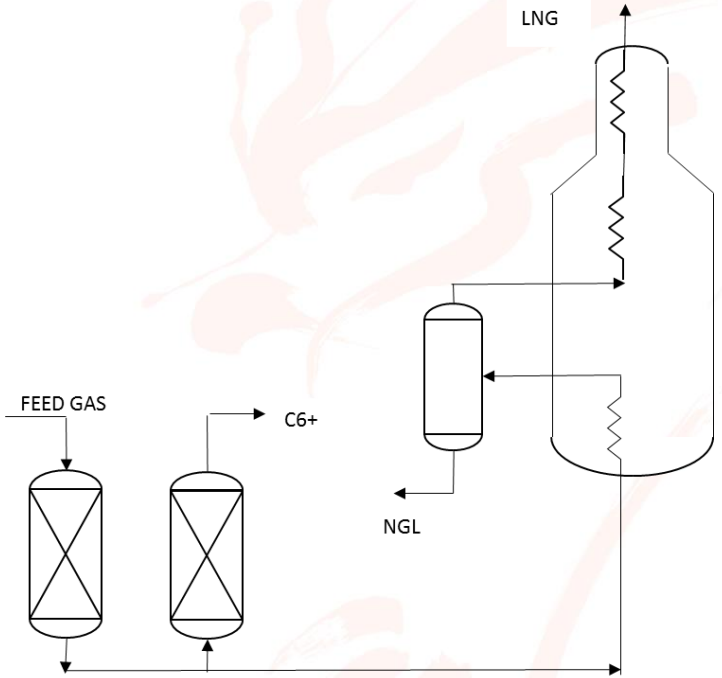


TSA (Temperature Swing Adsorption) at high pressure

Heavy Hydrocarbon Removal

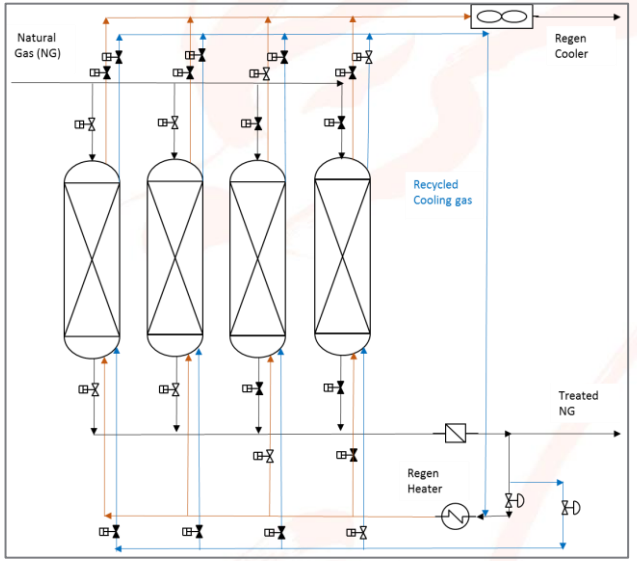
A combined solution of Temperature Swing Adsorption (TSA) and Partial condensation are selected

- Maximise liquefaction operating pressure => limit capital cost
- HHC are a byproduct
- Flexible and versatile to treat different feedstocks
- Optimise the size of each component to minimise the capital cost



HHC removal: Reuse of Cooling Gas for Heating

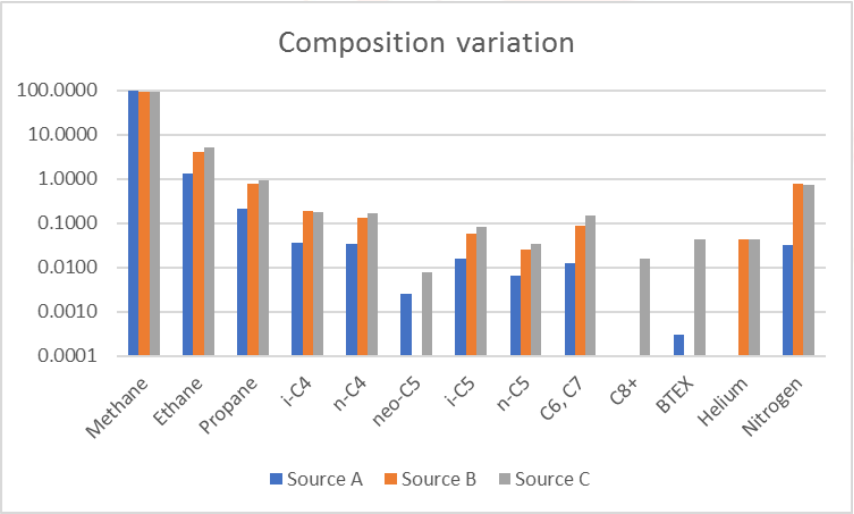
- Optimisation of the TSA beds:
- 50 % reduction in regeneration gas
- Lower risk of thermal stress by limiting temperature variations at downstream equipment at the end of cooling



Feedstock Variation: Checking for Source C

Source C was provided late in the project, after procurement of main equipment, with large BTEX and C8+ content

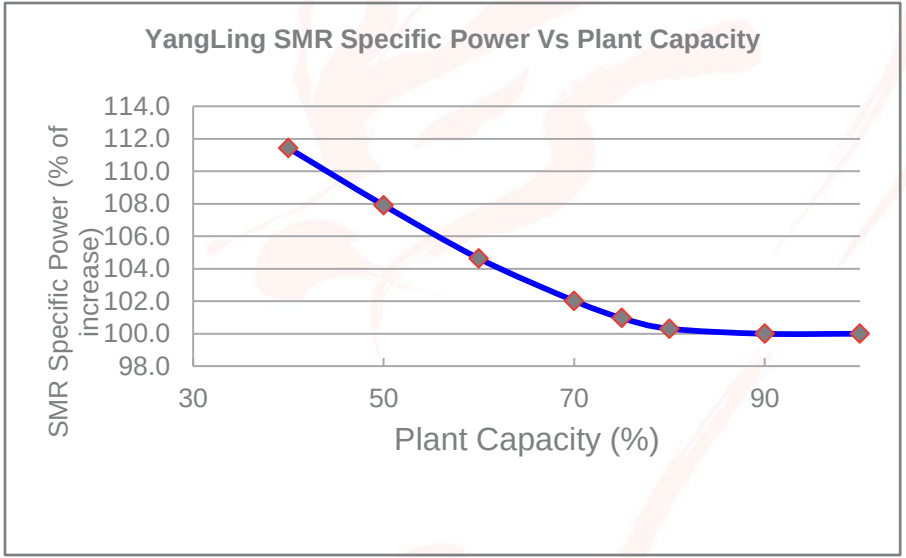
- An in-depth study assessed the impact and additional features to maintain full production
- No significant impact to overall production
- Size of the TSA beds increased



Turndown

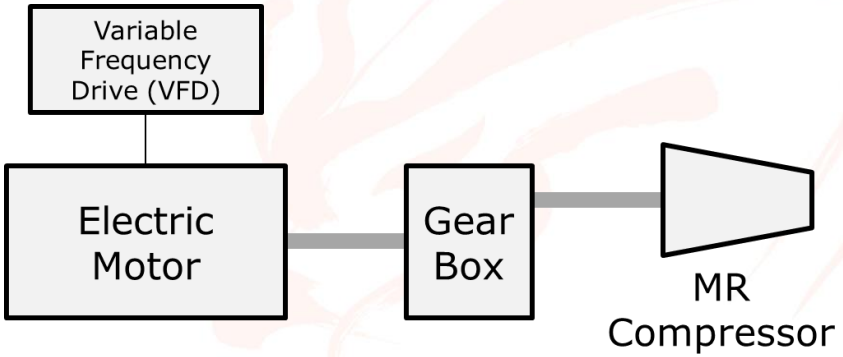
- Peakshaving plants must operate at low turndown for extended periods of time
- Yangling LNG turndown operation was checked in detail down to 40%: no opening of recycle valves observed
- Experience of stable operation below nominal turndown

Prolonged operation below 5% turndown during tank cooldown



Variable speed drive

- High Voltage Semiconductor VSI driven motor in operation
- Adjust production demand without venting costly refrigerants
- Minimize (and avoid) compressor recycling across operating window
- Ease of operation
- Restart from settle out pressure, thus avoiding venting of refrigerant
- Stable operation during hot summer days and cold winter days



Conclusions

A midscale plant brings big challenges:

- The design has to maximise profit when pipeline gas is available and at an early stage not all constraints are yet known
- Potentially wide range of fluctuations in HHC content in feed gas – needs practical solution to overcome an apparent uncertainty for the life of the plant.
- Flexibility has to be built in to anticipate modifications at minimum cost
- Experience in the unique area of mid-scale LNG plant design helps avoiding surprises

Yangling LNG Project : Thanks

Chen Fei, Air Products

Timothy Truong, Air Products

Manikandan Narayanan, TPFMC

Yangling LNG Plant Owner: Shaanxi LNG Investment and Development Co LTD

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