Smart technology for CO$_2$ handling subsea

Pål Helge Nøkleby
Aker Solutions

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Presented by
Lars Ingolf Eide
Main Challenges to offshore CO2 EOR

- CO₂ supply chain not established
  - limited availability of CO₂
  - forecasted need for large volumes
- Facilities and wells are not corrosion resistant
- Limited weight and space available for topside separation on most platforms
- Extremely costly retrofits and additional installations
- Loss of production due to shut down in retrofit period
Subsea CO$_2$ processing

• Rarely described in literature

• System would
  – Be designed to ensure that the oil and gas to processing facilities contains a limited amount of CO$_2$, reducing or removing the need for retrofitting for a corrosive environment
  – Reduce the need for space and weight topsides

• Space for some utilities will be needed (supply of power, MEG/methanol etc.) unless they are supplied from shore or another facility.
Available Subsea Processing Building Blocks

- Subsea multiphase cooler
- Subsea gas compressor
- Subsea gas/liquid separator
- Subsea liquid/liquid separator
- Subsea de-sanding equipment
- Subsea produced water de-oiling equipment
- Liquid pump
- Multiphase pump
- Subsea control systems
- Subsea power solutions
Subsea CO$_2$ Processing

Main functions of a typical processing concept for CO$_2$-EOR. (Courtesy Aker Solutions)
Subsea CO₂ Processing

- Subsea systems are modularized to enable easier installation and retrieval operations
- Compact equipment is mandatory to minimize module size and weight in order to open up for more flexibility with regard to vessel selection
- Several subsea processing projects have been installed and are in operation for various applications
- No systems have yet been installed for subsea CO₂ handling
Aspects of the CO\textsubscript{2} Subsea Technology Concept

- Potential mitigation of several previous challenges
- Small subsea facilities serving segments in large reservoir
- Facilities available for injection of CO\textsubscript{2} for permanent storage
- Retrievable modules
  - limited operational time and reuse
New Concept: Zero-emission Offshore Power

Reduce Offshore Emissions + Produce CO₂ for EOR – locally

- Use “short travelled” local gas
  - Associated gas in oil-fields
  - Stranded gas in gas-fields

- Produce zero-emission power
  - Offshore electrification
  - Sell excessive power to grid

- Use CO₂ & Heat for added value
  - Hot and liquid CO₂ and H₂O
  - CO₂ is “short travelled” for EOR
  - After use, permanent storage

(Courtesy Aker Solutions)
Novelty: **Pressurized Oxyfuel = Big Savings**

- 70% saving on CAPEX ➔ economically viable offshore
- 80% reduction in size ➔ suitable for subsea application
- Scope for further reduction by going for unconventional boilers

(Courtesy Mitsubishi Hitachi Power Systems Europe)
Oxyfuel: enabler for offshore CO\textsubscript{2} EOR

- Oxy-fuel combustion burns hydrocarbon gas in pure oxygen instead of air
- Will normally require a high degree of exhaust gas recirculation
- Can tolerate high amounts of CO\textsubscript{2} and other contaminants in the feed gas; thus well-suited for:
  - Enhanced gas recovery (EGR) and EOR – it can take all the back-produced CO\textsubscript{2} in with the feed gas thus eliminating the need for additional CO\textsubscript{2} separation
  - CO\textsubscript{2} rich gas fields – it could enable economic developments by producing electricity

(Asgard Subsea Compressor Station: Operational since September 2015)

New concept “cousin” of Åsgard Subsea Compressor Station: I.e., most building blocks field proven

(Courtesy Aker Solutions)
Conclusions

- New and emerging subsea technologies can enable technically and economically feasible concepts for offshore CO2 EOR
- Utilizing such established infrastructure could also enable permanent storage of CO2 in depleted offshore oilfields - post the commercial EOR period
Thank you for the attention!

For detailed questions and more information, please contact

Pål Helge Nøkleby, Aker Solutions

paal-helge.nokleby@akersolutions.com