Examples on offshore CO_2-EOR development supported by CLIMIT program in Norway

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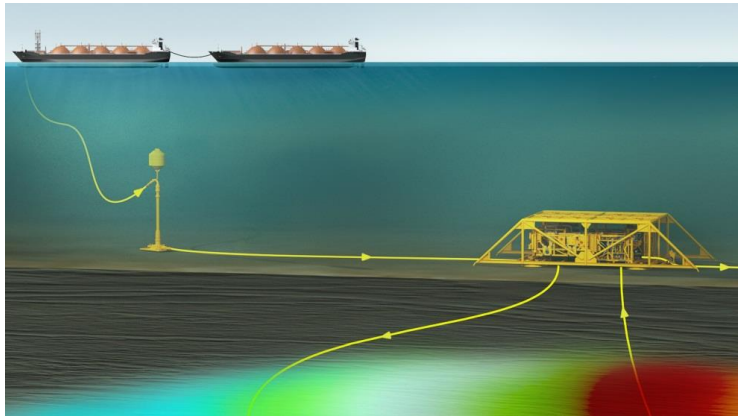
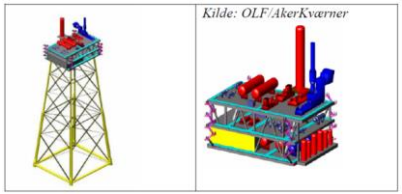
Norway: Offshore CO_2 EOR Challenges - Mitigations

- No CO2 supply
  - **Pipeline**
  - **Ship supply**
- Space limitations on platforms
  - **Subsea installation**
- Weight limitations
  - **Subsea installation**
- Corrosion issues
  - **13% Cr needed – standard for subsea wells**
- High cost when modifications done topsides
  - **Short/no downtime with subsea installation**
- HSE concern by sudden topside release
  - **No issue subsea**





Akersolution CO_2-EOR concept

Separation & CO_2 return subsea

Project history:
Feasibility; 2013—16

- De-risking and qualification of technology components

2016→

- Focus on compressors and membranes

Project objective

The objective is to assess the technical and economic feasibility of a CO2 separation and reinjection system from a CO2 flooded oil reservoir; minimizing the need for topside modifications. The development of a robust subsea CO2EOR system will be based on the proven technology of the Åsgard Subsea Compression system.

Potential

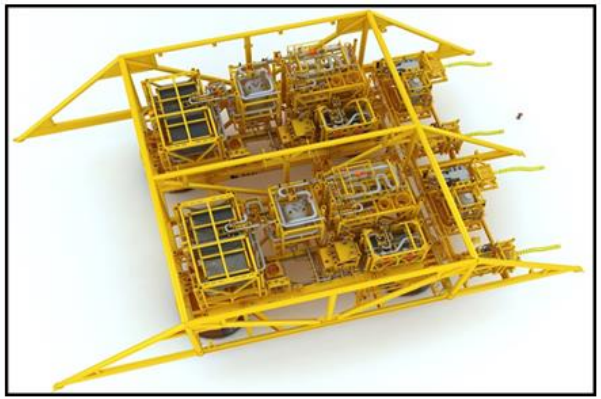
Presenting an economically and technically viable subsea solution for treatment of CO2 rich well stream. The concept can enable deployment of an offshore CO2 EOR re-injection system as a value-creating supplement to permanent CO2 storage.

Innovation

Further development of subsea compression technology for the application with a gas mixture of hydrocarbon and CO2.

Two important subsea building blocks

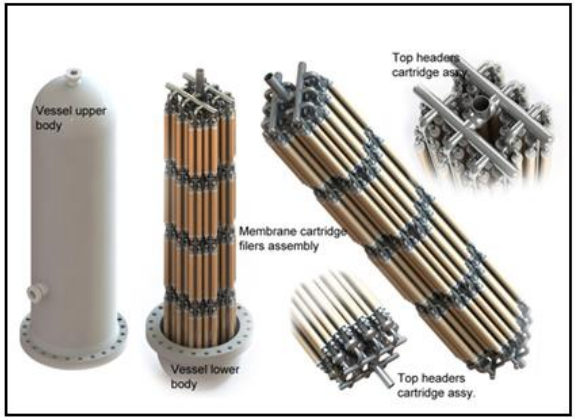
Compression System



2010 – 2015 Åsgard:

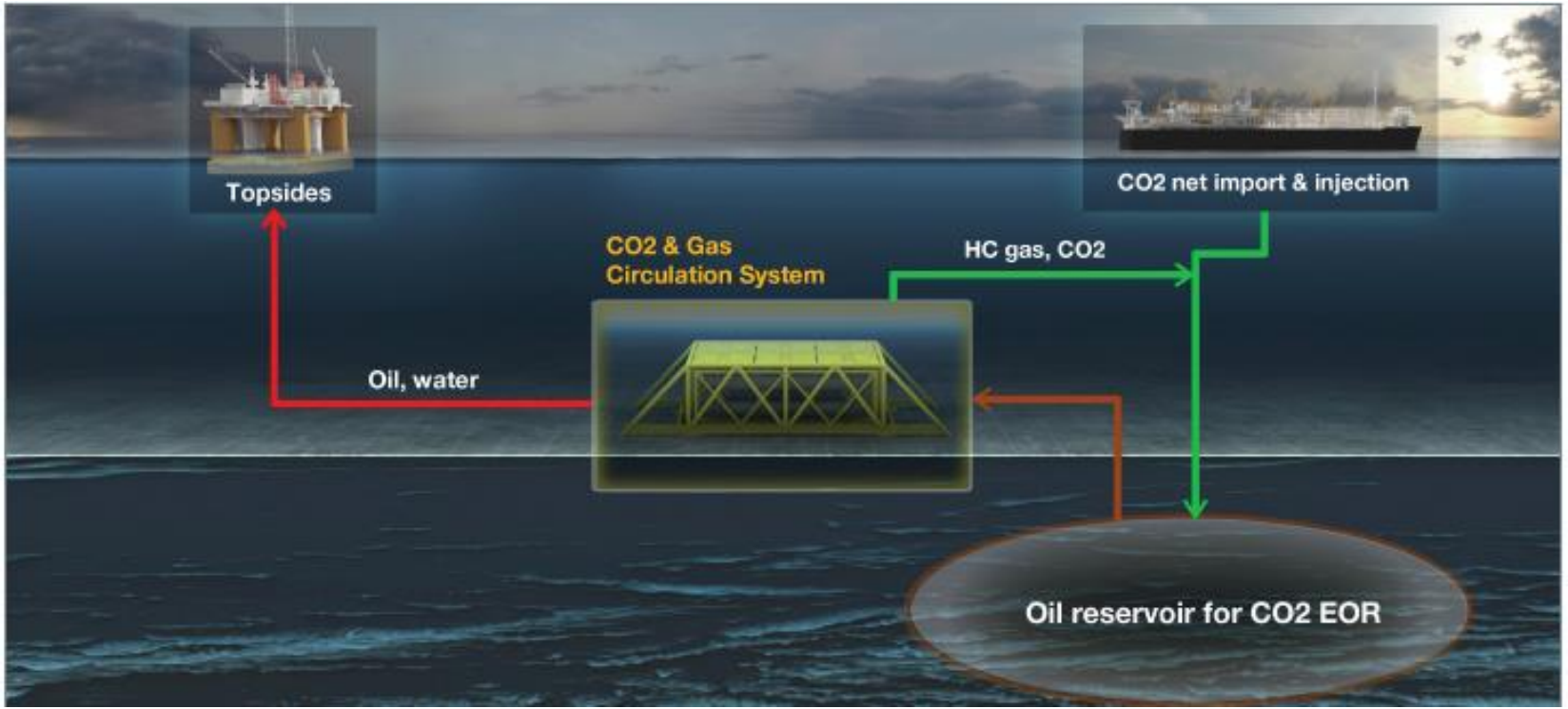
- 21 MSm^3/d flow rate
- 2 x 11.5 MW compressor power
- 300 m water depth
- 40 km step-out distance
- Topside Variable Speed Drives, Circuit breakers and UPS
- Delivered by Aker Solutions

Compact membrane packing



- Onshore stacking not feasible subsea
- Compact packing arrangement developed by AKSO

AkerSolution concept for subsea CO2-EOR

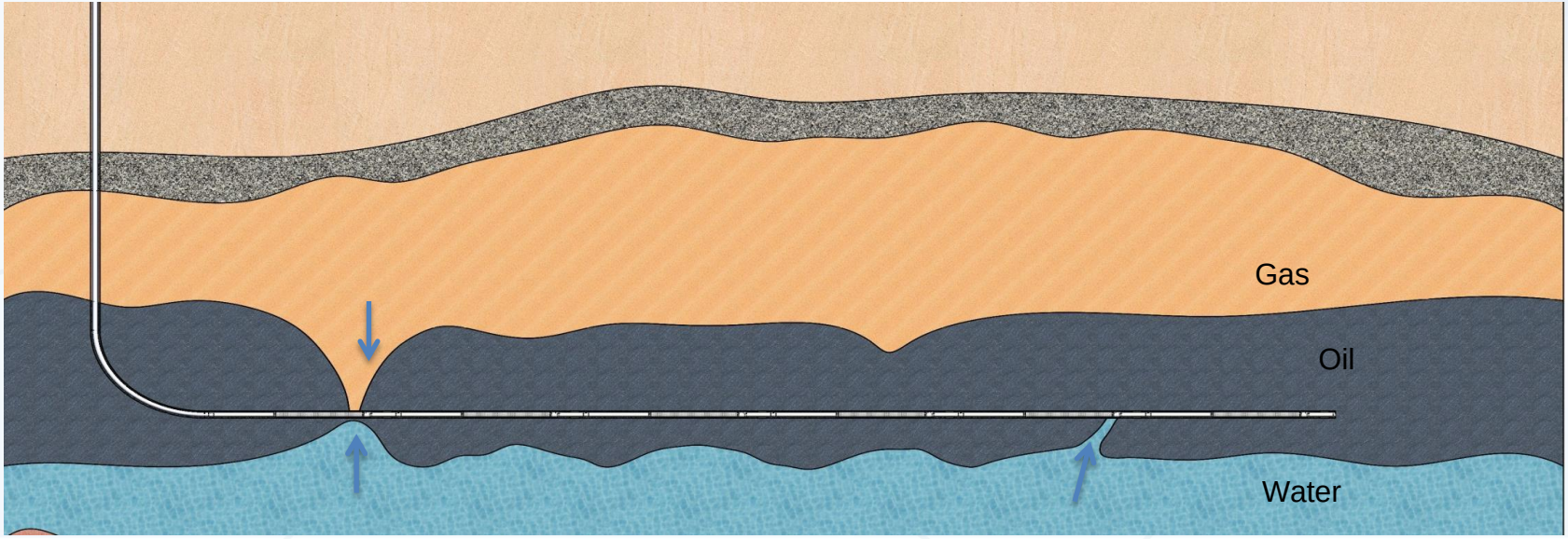


INFLOWCONTROL

- Technology for
  - «autonomous inflow control» valves in oilproducers
- In an oilproducer well:
  - Shut off sections with breaktrough of gas, water or CO2
- Commercial for normal petroleum producers
- Tested in 2016 for CO_2-EOR at Weyburn field in Canada

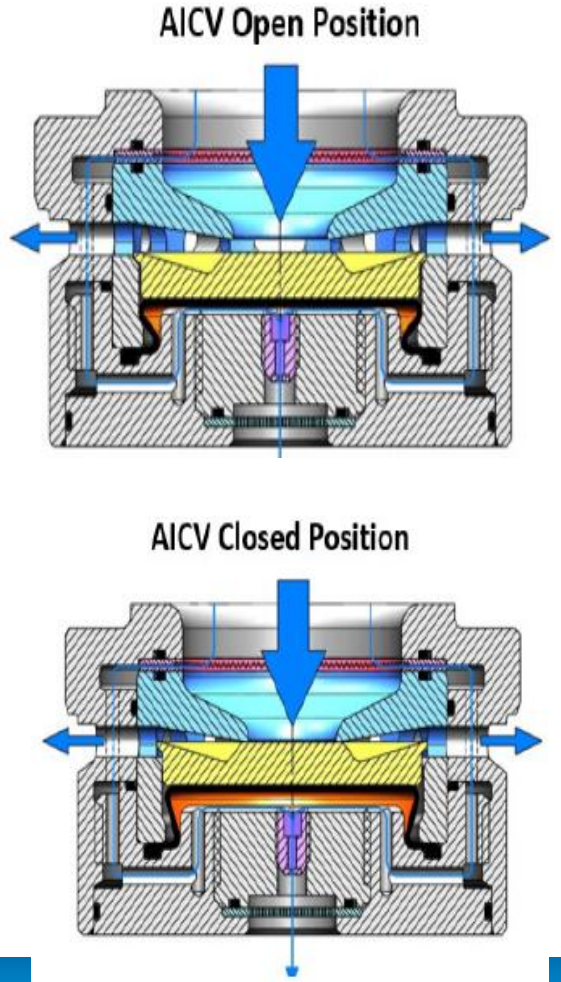
The Motivation

- Long horizontal wells to ensure maximum reservoir contact
- Non-uniform well drainage creates gas/water breakthrough
- Conventional ICD can delay the breakthrough problem, but:
  - The solution is to stop the gas/steam/water locally and completely



InFlowControl
Description of AICV Technology

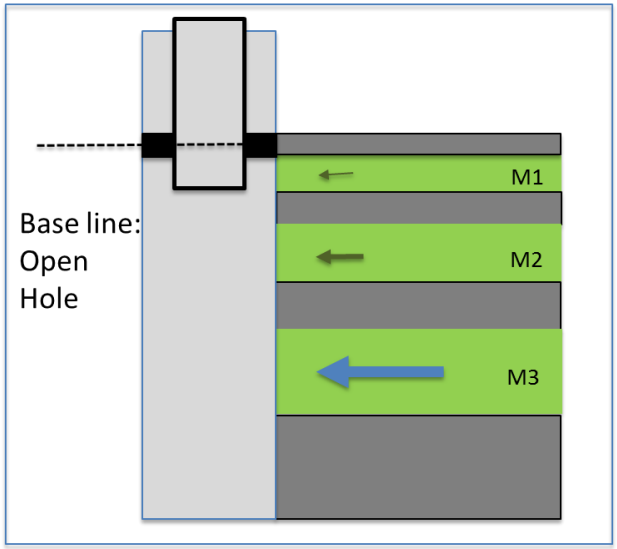
- Autonomous ICD (AICV)
  - AICV distinguishes between fluids based on viscosity.
  - The AICV chokes back zones with pure water or CO_2
  - Thus AICV well will increase DrawDown and redistrubate production to oil zones along the well
  - AICV is reversible; it will re-open when it senses oil again.

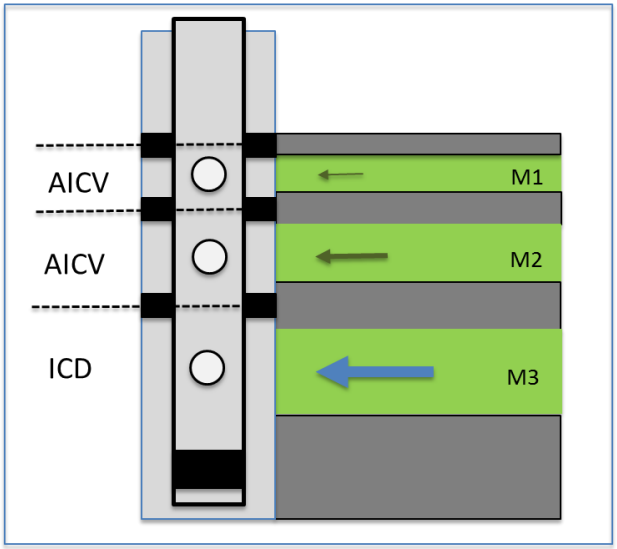


Tester at Weyburn field in 2016;
Combined AICV and ICD Results (Weyburn)

- Base line: Open hole
- Oil rate 5 bbl/day
- Oil cut: 0,4 %

- Combined mode
- Oil rate 54 bbl/day
- Oil cut: 2,1 %






Thank you!