Enabling Production of Remote Gas

a cross disciplinary competence building project

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Outline of presentation

- Remote gas perspectives
- Challenges
- The project
- Results
- Summary
Natural gas perspectives

- IEA, Natural Gas Market Review 2007 – Security in a globalising market to 2015:
  “Natural gas is becoming an increasingly global commodity; developments in previously separate regional gas markets can no longer be considered in isolation”

- IEA, Natural Gas Market Review 2009 – Developments in the LNG markets:
  “The 2009-13 period will see liquefaction capacity increase from 280 bcm as of end 2008 to 373 bcm by end 2010 and 410 bcm by end 2013, almost a 50% increase within five years”
Many concepts for offshore LNG, GTL and Methanol have been developed, but not implemented

- The reason for not being realized might be insufficient economical margin to bear the risk related to the following issues:
  - Technical
  - Operational
  - Safety
  - Regulations
  - The number of stake-holders involved along the gas chain

- These issues lead to the hypothesis that future floating gas conversion concepts would benefit from more compact equipment

- Further, that these challenges also requires an interdisciplinary approach
Enabling Production of Remote Gas

Objective:
Enable competitive natural gas production from remote fields by addressing critical technology barriers through a coordinated effort by industry and research institutions.

Challenges:
- Footprint
- Weight
- Robustness
- Safety
- Tilting

Floating LNG

Floating Chemical gas conversion

Whole-system Issues
- HSE
- Reliability and operability
- Power supply
- Techno-economical analysis

2005-2009
Enabling Production of Remote Gas

Whole-system issues
- Concepts and scenario implementation
- Safety, reliability and environment
- Power supply to remote gas conversion processes
- Operability and control
- Techno-economical analysis

LNG processes
- Unsteady two-phase flow in liquefaction plants for natural gas
- Design methodology for offshore LNG production processes

Chemical gas conversion processes
- Compact gas to products technology
- Synthesis gas production

- to be presented in this conference
Developing scenarios for Remote Gas production as a tool for directing multidisciplinary research

4 scenarios for Remote Gas

Recommendations:

- Floating gas conversion and production of LNG
- Mobile production / processing units
- Production / processing in arctic areas
- Sustainability of remote gas production
- Sub-sea production and gas processing
- Modular design and scalability of processes

Developing scenarios for Remote Gas production as a tool for directing multidisciplinary research

- 4 scenarios for Remote Gas
- 4 concepts for Remote gas

A common basis was provided for studies related to:

- Whole-system issues: ReMET and Pinocchio LNG
- LNG processes: Pinocchio LNG
- Chemical gas conversion processes: ReMET
Pinocchio LNG

- Modularized offshore LNG plant
- Standardized processes
- Scalable processes
- Process reuse
- Local power generation
- Zero emissions of hazardous chemicals
- Ultra-low emissions of CO₂
- Fast-track manufacturing and process installation
- Low operation costs
- Suited for remote operation
LNG process for Pinocchio LNG

- Criteria for selection of LNG process:
  - From literature
  - From description of the Pinocchio LNG concept
  - From the project partners

- Evaluation and selection of LNG process:
  - Prico (reference)
  - Tealarc
  - Expansion process

- Energy analysis
- Improved understanding of the LNG process optimization problem and formulation of restrictions
- SQP and Evolutionary search methods researched

- The impact of process design decisions on operability and control of an LNG process
Fundamental aspects of flow behavior in LNG heat exchangers

Modeling and experimental work to gain insight into fundamental phenomena occurring in heat exchangers in liquefaction plants.

- Droplet – film interaction studies carried out at relevant conditions
- Phenomena modeling for supporting future LNG heat exchanger model development

Bouncing of a 1-propanol droplet: diameter 0.23 mm impinging velocity 1.14 m/s
bouncing velocity 0.29 m/s
ReMET - Remote Methanol

Characteristics
- Associated fields of relatively small size
- Deep water (2000m+)
- Reuse of installations
- New gas conversion technology
- Modular design
- Possibility for conversion of existing ship
Methanol process for ReMET

Methane $\rightarrow$ Syngas (CO+$\text{H}_2$) $\rightarrow$ Methanol

**Syngas production by catalytic partial oxidation (CPO)**

$\text{O}_2$, CH₄ $\rightarrow$ CO,CO₂, H₂,H₂O

**O₂ storage material**

- CeO₂
- CeO₂-ZrO₂
- Perovskites

**Microstructured packed reactor for methanol synthesis**
Synthesis gas production by catalytic partial oxidation (CPO)

- Partial oxidation of CH₄ to syngas
- Oxidizing CH₄ by the framework oxygen of an reducible oxide at 500-600°C
- Cyclic process
- Regeneration by air
- No steam or pure oxygen is needed

Perovskite based materials have been studied
- Pure perovskites
- Supported perovskites

Ideal perovskite unit cell structure

La₁Sr₁₋ₓFeₓCo₁₋ₙO₃₋δ

A atoms

B atoms

Process principle

H₂

CO

H₂

O X X O X O
X O X O X O X
O X O X O X O

CH₄

Air

O X O X O X O
X O X O X O X
O X O X O X O

O X O X O X O
Summary

- 50% of stranded gas is located off-shore
- Improved gas conversion technologies gives stranded gas access to the marked remote gas
- The Remote Gas project carries out in-depth research within LNG and chemical gas conversion
- Scenarios and concepts have been developed to direct the research within common issues, LNG and chemical gas conversion

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