Carbon Capture and Storage Value Chain: Network Design and Operational Technologies (G571)

Tutor(s)

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Overview

This course is designed to provide awareness of the design and operation of CCS systems. Participants will gain knowledge and understanding of technical issues (flow assurance, process, safety, etc.) encountered in the design and operation of whole-chain CCS systems.

Duration and Logistics

Classroom version: A 2-day in-person classroom course. An electronic copy of the manual will be provided by the tutor at the end of the course.

Virtual version: Four 3.5-hour interactive online sessions presented over 4 days, including a mix of lectures and discussion. The course manual will be provided in digital format.

Level and Audience

Advanced. This course is suitable for all technical staff engaged in carbon capture and storage with an emphasis on the operations, facilities and engineering side of the business. Project managers and engineers will also find many aspects of the course useful.

Objectives

You will learn to:

1. Compare the primary CO2 capture technologies.
2. Review the fundamental subsurface geoscience aspects of CCS, including reservoirs, leakage and monitoring.
3. Establish how CO2 can be transported safely and efficiently via ship and pipeline.
4. Assess the thermodynamic behavior of CO2 including the impact of impurities in CO2 streams.
5. Describe the operating philosophy and modes of CO2 transport networks, both single and multiphase.
6. Outline the design specifications of CCS networks with a focus on pipelines.
7. Manage safety and technical risk, including using a consequence-based risk assessment for CCS.
8. Evaluate the thermal-hydraulic modelling of CO2 transport networks with a focus on best practices.
9. Analyze the shipping options for CO2, including port to port or port to storage.
10. Characterize CCS metering and associated technologies.

Course Content

Day 1

Introduction

How are we doing (case study: EU and UK)

- Carbon neutrality and industrial decarbonization
- CCS value chain
- Global experience in CO2 transportation in pipeline
- Global CCS outlook
- Barriers and needs of CCS

Fundamentals of carbon capture, utilization and storage

- CO2 industrial sources
- CO2 capture processes
- Hydrogen production
- Enhance oil recovery (EOR)
- Integrated capture and the Allam Cycle
- CO2 utilization
- Geological CO2 sequestration and storage – reservoirs and saline aquifers
- Leakage and monitoring (case study)

Transportation of CO2

- Ship
- Pipeline
- Equipment and topside considerations for injection of CO2 in case of ship and pipeline transport

Develop a specification

- Potential impurities
- Limits on impurities
- CO2 specification definition
- CO2 specification recommendations

Thermodynamic behavior of CO2

- Practical (re)introduction to thermodynamics and transport properties
- Modelling challenges
- Equations of state
- Impact of impurities in CO2 streams on thermodynamic properties
- Chemical reactions
- Case study: managing polar liquids – mystery project
- Thermodynamics the practical guide – review of thermodynamic property packages

Operating philosophy of CO2 transport networks

- Normal steady-state operation
- Cold temperatures
- Shutdown and cooldown

- Shut-in operation
- Restart
- Depressurization

Operating modes of CO2 transport networks

- Single phase operation – gas, liquid, dense phase and supercritical
- Multiphase operation
- Operating margins – gas and liquid phase
- Shut down
- Transition from design to operation

Requirement for dehydration

- Dehydration process option
- Water content specification

Day 2

Gorgon CCS (technical review)

- Project story
- Key challenges and lessons learnt

Designing a CCS network

- Focus on well design
- Pipeline design
- Transporting from design to operation
- Pipeline commissioning (onshore, subsea, re-used)
- Planning and concept selection
- Normal process commissioning (a typical procedure)
- Pipeline pressurization (a typical procedure)
- Digital twin (integrated modelling from source to reservoir)

The HyNet project

- Project story
- Key challenges
- Discussion
- Solutions

Quest CCS

- Shell Canada Quest CCS pilot
- Greensand

Material integrity and corrosion

- Corrosion and material selection

- Corrosion-related damage mechanisms

Safety and Risk

- Safety case
- Technical risk
- Execution risk
- Rapid gas decompression in CCS
- Modelling CO2 releases from CCS pipelines and vessels
- CCS risk register
- Consequence-based risk assessment for CCS
- Major safety risks for CCS developments

Thermal-hydraulic modelling of CO2 transportation networks

- Modelling challenges
- Review of single and multiphase flow simulators
- Current practices in modelling of CO2 transportation networks
- CO2 modelling recommendations
- Process design

Hydrogen management

- Hydrogen at scale
- Hydrogen fiscal metering – introduction
- Case study – managing H2 breakout

Shipping

- Northern Lights
- Shipping projects
- Shipping CO2
- Port to port or port to storage
- Liquefaction

Metering

- CCS metering
- Fiscal metering
- Virtual metering
- Metering technologies