APES
ENERGY EVOLUTION

TECHNICAL TRAINING COURSE

5 days

Well Design and Construction for CCUS / CO_2 Injection

WHY CO_2 WELLS ARE DIFFERENT

- Below about 800 m, CO_2 is in dense phase: liquid-like density with gas-like viscosity.
- Into a depleted reservoir, CO_2 can flash in the tubing and cool sharply due to Joule-Thomson effects reaching extreme negative temperatures.
- Small amounts of impurity move the phase envelope (5% methane shifts the critical point by about 3 °C).
- Oilfield equipment is qualified for heat, not cold.
- Dry CO_2 is benign. In the presence of free water or brine backflow, it attacks steel and cement.
- Containment must hold for hundreds of years after injection stops.
- Existing wells are often in sub-optimal locations for storage and were built to older standards.
- Evolving standards, regulations and legislation.

WHO SHOULD ATTEND

- Drilling, completions and well integrity engineers moving into CCUS work
- Subsurface, production and facilities engineers who need to understand the well side
- Team leads and technical authorities reviewing CO_2 well designs

Some oil and gas well experience is assumed. No prior CCUS experience is needed.

LEARNING OUTCOMES

Over five days participants work through the full life of a CO_2 injection well, from the storage basis to final abandonment, using published project experience and hands-on exercises that run all week.

- Read a CO_2 phase diagram and predict where in the well phase changes and cooling will happen
- Turn storage-site data into well design requirements and pick a completion concept
- Identify the load cases, materials and equipment ratings specific to CO_2 service
- Specify cement and barriers that keep the caprock sealed for the long term
- Screen existing and legacy wells for reuse, remediation or abandonment
- Work within ISO, NORSOK and OEUK guidance and Malaysia's CCUS Act 2025

THE WEEK AT A GLANCE

DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
CO_2 is not natural gas	**From storage site to well concept**	**Tubulars, materials and load cases**	**Completion, cement and barriers**	**Existing wells and the end of life**
Fundamentals, phase behaviour, global/regional projects and regulation	Injectivity, caprock, sandface and phase management	Corrosion, low temperature and stress analysis	Safety-critical equipment, barriers and monitoring	Legacy wells, operations and abandonment

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Day-by-day programme

01 CO_2 is not natural gas

TOPICS

- The CCS chain, storage options and trapping mechanisms; why CCS is not reverse gas engineering
- CO_2 phase behaviour, density swings, impurities, hydrates and Joule-Thomson cooling
- Overview of relevant regional and global projects

HANDS-ON

- Phase-diagram game
- Excel: CO_2 density and phase down the well
- Team exercise: design an injector for a fictional field choosing between a new well or converting an old producer.

02 From storage site to well concept

TOPICS

- Storage capacity and plume (flood front) basics; caprock and overburden assessment
- Pressure through field life, geomechanics, thermal fracturing and maximum injection pressure
- Injectivity: PVT effects, relative permeability, halite, hydrates, fines and filtration; sandface and sand control
- Well design; managing phase in depleted fields: small-bore or tapered tubing, insert string, downhole choke, heating; minimum rate

HANDS-ON

- Software (PROSPER): injection performance and tubing size sensitivity
- Paper/Excel: completion concept selection for a depleted field
- Team exercise: continued

03 Tubulars, materials and load cases

TOPICS

- Corrosion with free water and impurities; brine backflow and crossflow during shut-ins
- Carbon steel, 13Cr, super 13Cr, duplex and nickel alloys; elastomers and rapid gas decompression; connections
- Load cases: cold injection, start-up and shut-in transients.
- Integrity versus functionality, and system versus component rating at low temperature; velocity and vibration

HANDS-ON

- Software (WellCat): tubular stress and temperature analysis
- Material selection decision tree
- Team exercise: continued

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From design to long-term integrity

04 Completion, cement and barriers

TOPICS

- Safety valve placement, testing and low-temperature limits; API 6A temperature class trees; control lines and hydraulic fluids
- Packers, annulus fluids and nitrogen cushions; downhole gauges and fibre (DTS/DAS)
- CO_2 attack on cement, placement quality, CO_2-resistant systems and lab testing of cement and caprock
- Well barrier schematics, MAASP and integrity management; monitoring, measurement and verification (MMV) from the well

HANDS-ON

- Well barrier schematic workshop
- Barrier-failure scenarios
- Team exercise: continued

05 Existing wells and the end of life

TOPICS

- Legacy wells: data forensics, plume and well interaction, FMECA risk ranking, relocation and re-entry
- Reusing producers: reuse as-is versus recompletion; existing lower completions and sand control
- Operations: first injection, start-up and shut-in procedures, well control and intervention with CO_2
- Abandonment for storage: restoring the caprock, barrier materials, length, position and verification; post-closure duties

HANDS-ON

- Legacy-well risk ranking
- Quiz: Facts vs Myths
- Team exercise: Present/defend the design

STANDARDS AND GUIDANCE USED IN THE COURSE

ISO 27914 (geological storage of CO_2), ISO 16530-1 (well integrity), NORSOK D-010 (well integrity in drilling and well operations), DNV-RP-J203 (geological storage of CO_2), OEUK Well Decommissioning for CO_2 Storage Guidelines, API 6A, US EPA Class VI rules, and Malaysia’s Carbon Capture, Utilisation and Storage Act 2025 (Act 870).

ENQUIRIES AND IN-HOUSE DELIVERY

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