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## N592: Well Engineering for CO2 Storage Applications

Instructor(s): Jonathan Bellarby

### Format and Duration

Classroom - 3 Days

Virtual - 5 Sessions

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### Summary

This course covers the design specifics of CO<sub>2</sub> injection wells. Such wells may be existing or new wells which need to be designed with the challenges of CO<sub>2</sub> injection in mind. The design includes the casing, cement, completion and all associated equipment. The challenges covered included potentially highly corrosive (to metals and cements) fluids, large temperature changes associated with potential phase changes and the long-term integrity requirements. In addition to casing design and cement design, equipment selection (such as packers with their associated elastomers) and tubular connections will be examined for their suitability for CO<sub>2</sub> injection. Legacy offset wells will be examined for potential leak paths over the long-term. Examples from existing and planned schemes will be reviewed throughout.

### Learning Outcomes

Participants will learn to:

1. Evaluate well integrity with respect to CO<sub>2</sub>.
2. Consider the challenges that CO<sub>2</sub> gas versus dense phases present and undertake PVT calculations.
3. Assess the corrosive impacts of CO<sub>2</sub> including the impact of stress corrosion at low temperatures.
4. Formulate stress calculations for the liner, production casing and tubing.
5. Analyse the issues of cement design for CO<sub>2</sub> wells, including both legacy and new well designs.
6. Examine the issues involved in repurposing existing wells with reference to existing casing designs and cement evaluation.
7. Construct risk assessments and understand monitoring technology and regulatory frameworks.

### Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussions, and case studies. Exercises include hand calculations that will be used along with a demonstration of software (Oliasoft WellDesign). This course includes e-learning elements that provide background content on Carbon Capture and Storage that serves to provide an introduction to the subject matter:

- EC003 Fundamentals of CCS
- EC005 Behaviour of CO<sub>2</sub> in Reservoirs
- EC006 Monitoring CO<sub>2</sub> Storage

### Who Should Attend

Attendees should be capable well engineers (completions or drilling) or technical specialists such as chemists, geomechanics, or material specialists.

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### Course Content

The self-paced e-learning elements of this course are

- Fundamentals of CCS
- Behaviour of CO<sub>2</sub> in Reservoirs
- Monitoring CO<sub>2</sub> Storage

### Seminar Topics

#### Topic 1

- Overview, global and subsurface perspective
- Well integrity perspective with respect to CCS - Short vs. long-term and existing vs. new design

#### Topic 2

- The volume challenge with CO<sub>2</sub> and facilities challenges, including calculations – gas vs. dense phase
- PVT Properties of CO<sub>2</sub> with phase envelope and enthalpy
- Associated thermal calculations for CCS - the potential for large cooling
- Worked Example using PVT and enthalpy calculations
- Example using demo software (Oliasoft WellDesign)

#### Topic 3

- Corrosion and material selection with specific reference to CO<sub>2</sub>
- Wet vs. dry CO<sub>2</sub>
- Stress corrosion cracking at low temperatures
- Worked example using partial pressures and corrosion experimental data
- Tubular material properties and asymmetry/ anisotropy as well as temperature dependent yield and coefficient of thermal expansion

#### Topic 4

- Working stress calculations and well design
- Formulate hand calculations and software input
- Simple hand calculations using Session 2 temperatures for the liner, production casing and tubing
- Worked Example demo using software of tubing, liner and production casing
- The specific difficulties with the VME / Design limit plot
- Well design with reference to the cap rock and cap rock fracturing and cap rock strength reduction

#### Topic 5

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- Equipment and tubular connections. CAL III and CAL IV ISO testing and connection envelopes
- Cement design for CCS – legacy vs. new well designs

### Topic 6

- Repurposing existing wells with reference to existing casing designs and cement evaluation
- Managing offset to injection legacy suspended and abandoned wells
- Example from Goldeneye
- Risk assessments, monitoring technology and regulatory framework