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Please fill in your manuscript title.	Carbon Capture and Storage (CCS) Well Design Using Cloud Software

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Abstract

Objectives/Scope:
To ensure safe and environmentally sound CCS Well Delivery, a detailed well design should be performed with the following criteria: 1) Dynamic thermal wellbore simulation with full capability to model liquid (Supercritical) CO2 injection. 2) Multi-string casing design with the option to add and remove fluids in any annuls. 3) Ability to simulate liquid CO2 blowout and kill operations.

This paper describes a workflow for CCS Well Design using a cloud-based software tool, named WellDesign, that has all regulatory well planning calculations in a single application and includes Open APIs to connect with third party application.

Methods, Procedures, Process:
The cloud-based software tool is built on top of an extensive library that, amongst others, contains predefined CO2 fluids, both pure and impure. The library also supports addition of custom fluid files, either by uploading an OLGA format tab file or by defining a custom fluid composition. Currently, the hydrocarbon equation of state is applied when defining a CO2 fluid in the software hydrocarbon library.

When using the thermal simulator in the tubing design module, CO2 can be selected as the applied fluid for production and injection simulations. The chained simulation functionality further allows these results to be used as the initial condition when simulating waiting or shut-in operations. The thermal simulator has full capability to model liquid CO2, including the full phase envelope of CO2 and the Joule Thompson effect from gas expansion.

Multistring analysis includes annular fluid expansion and annular pressure build up. In addition to negative fluid expansion, the software tool supports addition and removal of volume from any annulus, both before and after a thermal change.

Results, Observations, Conclusions:
Using a cloud software tool for CCS Well Design could achieve notable planning time savings. The software tool provides Intuitive & Circular workflow between different design modules.

Further CO2 modeling enhancement in the software tool is currently ongoing for the implementation of the Span & Wagner model, a full equation of state specifically for CO2, and dual phase calculations

Novel/Additive Information:
Modern Cloud-Based Applications can enable engineers, within seconds, to execute complex CCS Wells simulations.

The subject software tool utilizes networks and cloud computers for data storage and collaboration and offers a set of Application Programming Interfaces (APIs), enabling full automation, where whole or parts of the software can be operated by other computers. Software GUI can be accessed via web browser across all kinds of computers (Windows, Macs) and other smart devices (tablets, phones).

Figures:

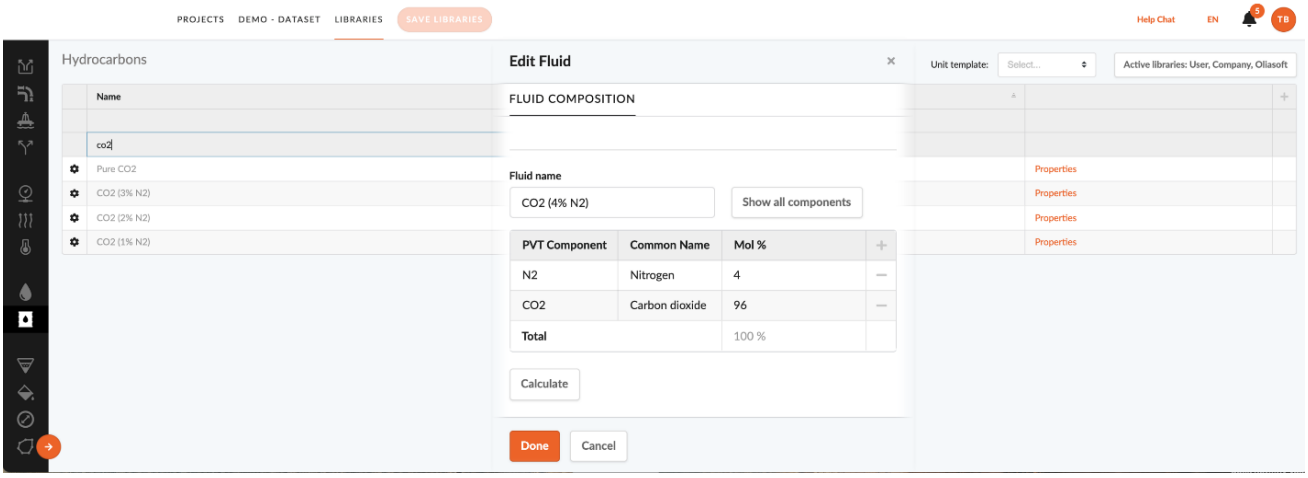

Fig.1: Definition of CO2 Fluid Composition

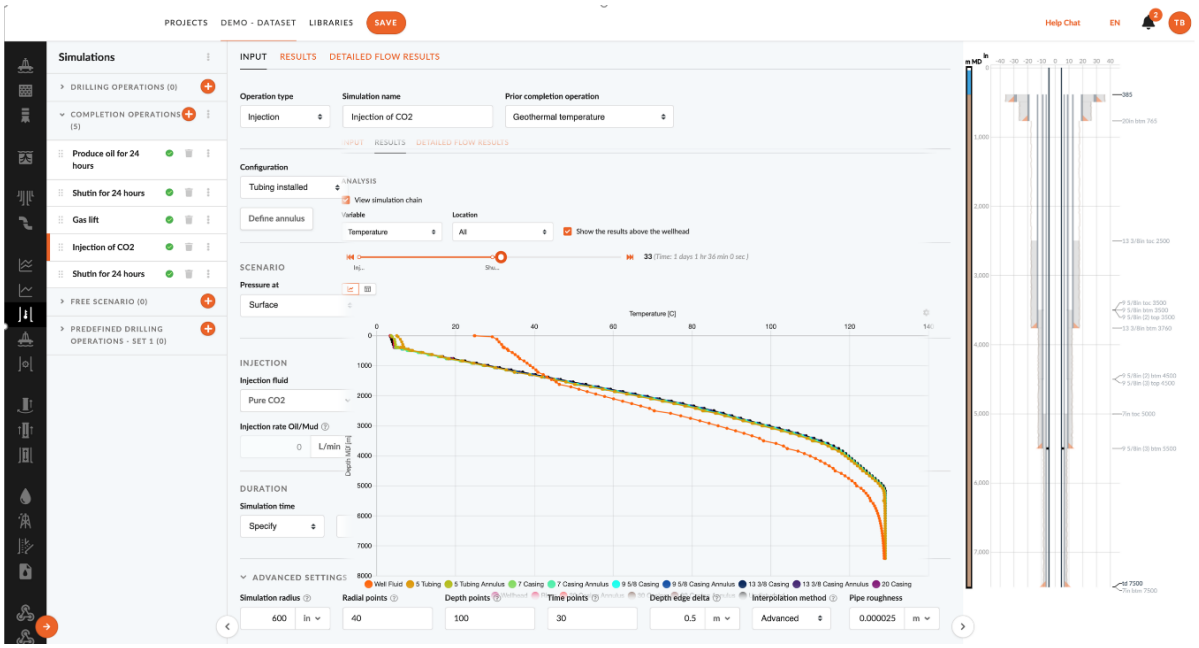

Fig.2: Example of Thermal Simulations for Liquid CO2 Injection

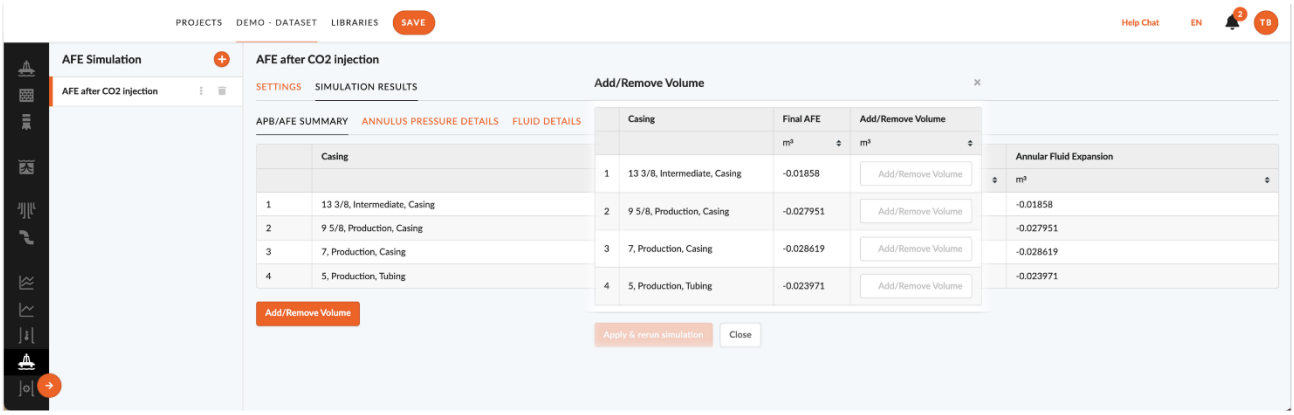

Fig.3: Example of Annular Fluid Expansion (AFE) Results after Liquid CO2 Injection