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TURNING HETEROGENEOUS CAVERN FEATURES INTO PERFORMANCE OPTIMIZATION

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Abstract

In an underground gas storage made of caverns differing in dimensions, completion types and sizes, ages or heat exchange behaviors, operating pressure ranges and creeping rates, how to find out operational patterns leading to an optimized compromise between instantly available performance, season-wise performance profile, overall creeping minimization and WGV maximization?

The Peckensen storage, in operation since 2002 in Germany, encompasses with currently 3 caverns all heterogeneities listed here. They result either from design choices, physical observations or theoretical conclusions. Single thermodynamic models - coupled with surface, well completion and rock mechanics constraints - have indeed been developed in order to predict cavern behaviors for given withdrawal patterns and, therefore, assess their intrinsic performances. Consequently, withdrawal distribution scenarios over all 3 caverns have been simulated in order to find out, for given asset-optimizing objectives, the best possible UGS performance profile.

Doing so, single strengths of each cavern could be pointed out and quantified, as well as ways how to use them to back up weaknesses of the others, ending in an optimization exercise requiring a more complex solution than a mere, homogeneous-pressure-driven cavern pooling, as well as a time-effective thermodynamic follow-up.

Besides, this model portfolio entails a forward-looking innovation: a dual-cavern model had to be set up for one of these 3 caverns, which displays a hourglass shape and where recorded temperature profiles - pretty uncommon - could find no satisfactory match with a single-cavern model. The quality of heat exchange modeling between the two cavern halves is still "work in progress", however coping by a pressure continuum at their intersection allows for credible simulation output.

The concrete uses of these models and simulations cover a wide scope of asset optimization queries, some of them becoming decisive in a mature storage market:

- Product bundle optimization
- WGV optimization
- Performance sustain with non-seasonal products
- Intra-seasonal update of available/residual performance + forecast till end of winter
- CGV balancing optimization
- Design of plant extension and gas completions of future caverns
- Product design for upcoming WGV shares
- Facilities-linked investments/disinvestments for existing assets

Key words: Caverns for Gas Storage, Thermodynamics, Gas Simulations, Gas Storage Operations