

Hydrocarbon Contamination of Alternative Storage Media in Converted Oil Caverns

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Abstract

The German National Petroleum Stockpiling Agency (Erdölbevorratungsverband, EBV) has a statutory duty to maintain a 90-day reserve of crude oil and petroleum products. Most of the crude oil stock of the EBV is stored in underground caverns, where most are operated by NWKG (Nord-West Kavernengesellschaft mbH).

With the consideration that the energy supply systems are to change from fossil-based fuels to renewable energies in the drive to net zero carbon emission, and that such development is continuing at pace in both Germany and across Europe, several studies have been commissioned to investigate the conversion of the existing assets, the underground caverns, to alternative storage media.

From experience of converting oil storage caverns into gas storage caverns it is well known that a residual quantity of crude oil will remain in the cavern, contaminating the natural gas. Those hydrocarbons derive from residual oil from backpockets, infiltration zones etc.

It can be assumed that the same process will happen in oil storage caverns that will be converted into storage for renewable energies, contaminating the new storage medium. This contamination may result in the fluid breaching relevant purity specification limits and/or requiring treatment equipment.

In this paper the relevant results of a study investigating hydrocarbon contamination of the following storage media are presented:

Future potential storage media

- Air (compressed air energy storage, CAES)
- Carbon dioxide (CO₂)
- Hydrogen (H₂)
- Anhydrous ammonia (NH₃)

Comparison scenario

- Natural gas

The aim of this study was to undertake a desk-based exercise using AspenTech's HYSYS software to attempt to quantify the expected level of hydrocarbon contamination, considering the first and subsequent filling and emptying cycles with the future storage media. The predicted level of hydrocarbon contamination is compared to the anticipated export purity specification limits (if relevant / applicable).

Contamination of natural gas is also considered for comparison purposes, since there have been several real-world examples where natural gas has been stored in caverns previously allocated to crude oil storage. As such, this will provide a benchmark case whereby the modelling results can be compared to previous experience and adjusted, if required and if suitable live data is made available.

Key words: Contamination Modelling, CAES, Hydrogen Storage, CO₂ Storage, NH₃ Storage