Solution Mining Research Institute Fall 2018 Technical Conference

Belfast, Northern Ireland, 24 - 25 September 2018

"To see or not to see, that's the question"

High Accuracy Sonar Measurements of the Oil-Brine Level in Gasoil Storage Caverns in Twente, the Netherlands

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Abstract

Since early 2016 AkzoNobel operates two gasoil storage caverns located in its Röt salt brinefield near the city of Enschede, Twente, in the east of the Netherlands. Nearly 250,000 m^3 (1.57 mln bbl) of gasoil is stored for the Netherlands Petroleum Stockpiling Agency (COVA) as part of its international obligations following from the European Union (EU) and the International Energy Agency (IEA).

Compared to other oil storage caverns all over the world, these two caverns are relatively small (approximate capacity of 150,000 m^3 (0.94 mln bbl) per cavern) and are located at relatively shallow depth (approximately 450 meters (1,500 ft)). Dutch mining regulations and the relatively shallow depth require stringent environmental protection, making these storage caverns the best guarded and safest storage caverns in the world. Double barriers, both at surface as well as deep underground and a 500 m^3 (3,100 bbl) large catchment basin sufficient to collect all oil flowing out of the well during an unwanted blowout are the clearest examples. Still, the cavern locations can be considered as the most naturally looking oil storage locations in the world. Less visible are the extensive monitoring efforts, like the double monitoring of the presence of oil in the annulus of the wells, both by pressure as by resistivity measurements.

Another peculiarity of these caverns is the fact that the cavern floor is not entirely tight. During drilling of the three wells that connect the cavern to the surface, the boreholes were drilled through the basis of the salt into the underlying claystone. This was done from an economic point of view, to be able to start the cavern development at the deepest possible place creating as large caverns as possible. But for oil storage it means that monitoring the oil and brine pressures within the cavern does not provide reliable information on its tightness and on the oil level within the cavern. Therefore another type of highly accurate oil-brine level detection was desired, with an accuracy of less than 1 cm (0.4 inch), equaling approximately 100 m^3 (630 bbl) of oil. In the project preparation phase, several ways to monitor this level have been studied, like Socon's Blanket Control System (BCS), nitrogen bubbling, optical fibers and differential pressure measurement. Unfortunately these could not provide the desired accuracy, were technically not feasible or were still in an R&D phase. Therefore, it was decided to further enhance an existing, proven technology being Socon's sonar measurement device. Following some adaptations to the tool, this device was expected to be able to detect an oil-brine interface by measuring from a fixed point (the end of the tail pipe of the brine production string) with ½ cm (0.2 inch) accuracy.

Twice during filling (to monitor the filling grade of the cavern and to prevent overfilling) and during the present storage phase since June 2015 already 20 times on a monthly basis, the oil-brine level has been measured using this tool. After having overcome some teething troubles, level measurements now are extremely accurate, showing variations in the order of several millimeters. As external influences, like temperature balancing of the stored medium, surface temperature, atmospheric pressure and tides provide variations that are expected to be in the order of millimeters as well (0.05-0.1 inch), the results are satisfactory and the level is assumed stationary. For other oil storages this method can be useful as well to periodically verify the oil level, the amount of products stored within an oil storage cavern or the cavern volume decrease due to salt creep.

Key words: The Netherlands, gasoil, storage, caverns for liquid storage, sonar, oil level, Instrumentation and Monitoring,