

VECTORS™ Demonstrates How Simulations Save Cost of Gas Storage Operations

By

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Abstract

Statoil and CARDIAC (Computer Aided Research, Development, Instrumentation And Control) have developed a simulator (named VECTORS™) suitable for optimal and safe operation of natural gas storage in caverns. The main objective of the storage plant located in a deregulated market, is to adapt to fluctuations in the consumer market for natural gas, and to take advantage of peak demands and peak prices. The operation of more caverns simultaneously requires advanced mathematical models for simulation and prediction of the conditions in the caverns and the adjacent equipment. Several operational constraints apply. There is a critical curve in a pressure and temperature diagram where hydrates may be formed. Such conditions must be avoided. There is a maximum and minimum pressure, between which the cavern pressure has to operate. There is a water vapor equilibrium curve in a pressure temperature diagram below which water condenses as fog. Finally, there are limitations to the rate of recharge and discharge of the cavern. The simulator comprises the following main simulation features:

- Prediction of pressure, temperature and water distribution in the caverns during injection, shut-in and withdrawal conditions.
- Operator's guide for inventory control.
- Simulation of gas withdrawal from clusters of caverns by flow control downstream the manifold.
- Estimation of the gas condition throughout the withdrawal system including heating and water removal requirements.

The operator's interface to such complicated control and monitoring tasks is of utmost importance. Therefore, the latest techniques in Windows based man-machine interactions have been employed. This allows the user to examine the operational conditions and thus determine the most favourable operational program to comply with the market needs.

The hard core of the program, i.e. the mathematical model for a cavern, is written in FORTRAN and interfaced with the rest of the software, which is developed in LabVIEW® 5 from National Instruments, Inc. This ensures that the software may be used, not only as a simulator, but also as a part of the real time applications for control of the caverns, together with the pipeline control systems. VECTORS™ can transfer data on-line between databases, PLC- and SCADA systems.