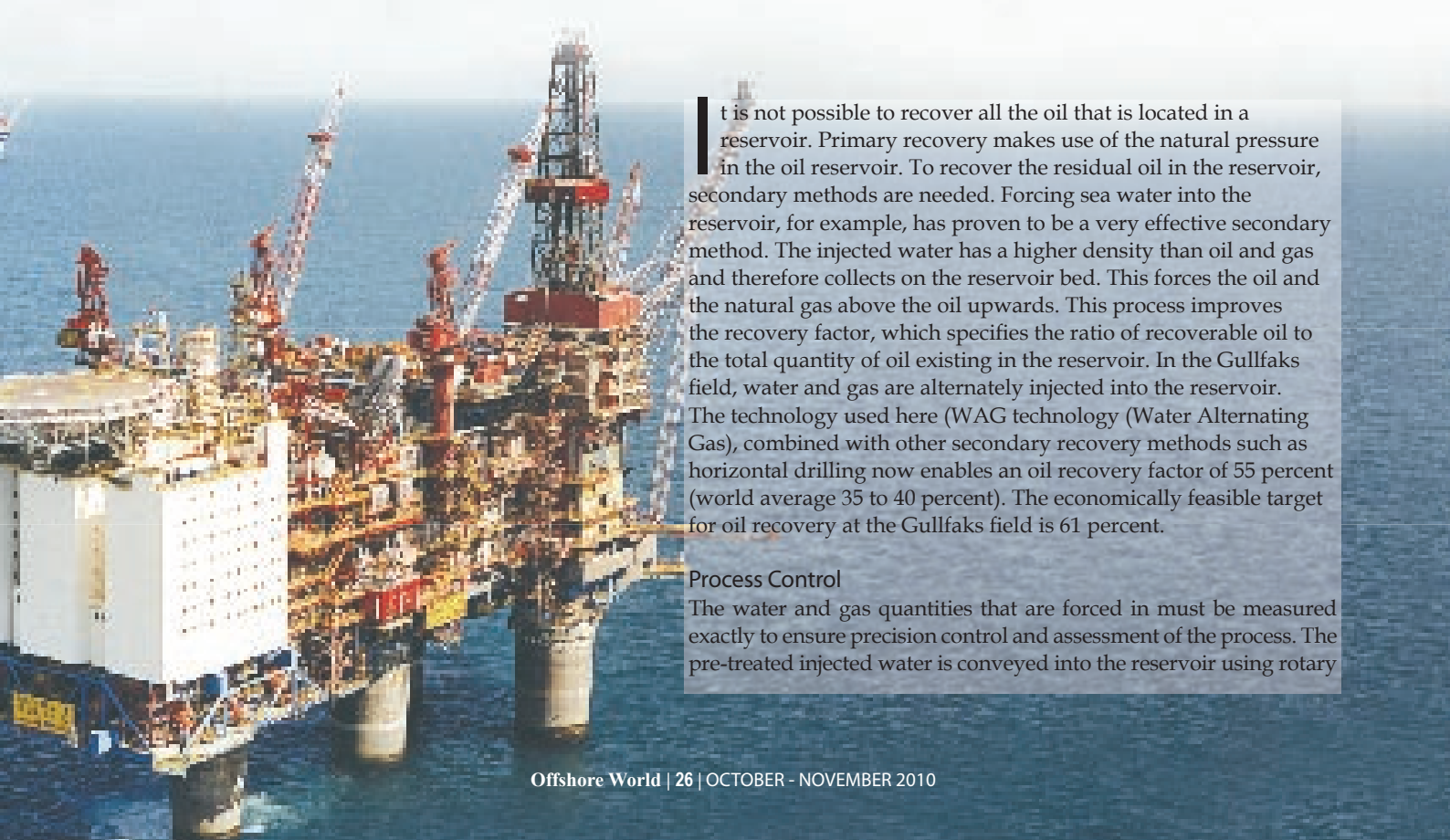


Oil Reservoir

High Precision on the High Seas Measurement of Injection Water Quantities on Gullfaks A

Dipl.-Ing. Claus Weihermueller

The Norwegian oil company Statoil is the largest oil producer on the continental coast with a payroll of more than 16,000 employees. In 1986, the Gullfaks A rig, weighing 675 000 tonnes, was the first rig in the Gullfaks field to start production. Here 280 000 barrels of oil and 11 million m³ of gas are recovered per day. The gas is conveyed through pipelines to the gas processing plant north of Stavanger, while the crude oil is loaded directly into shuttle tankers on the field. With its storage capacity of 300 000 m³ oil, Gullfaks A is a major contact and transshipment point for export.



It is not possible to recover all the oil that is located in a reservoir. Primary recovery makes use of the natural pressure in the oil reservoir. To recover the residual oil in the reservoir, secondary methods are needed. Forcing sea water into the reservoir, for example, has proven to be a very effective secondary method. The injected water has a higher density than oil and gas and therefore collects on the reservoir bed. This forces the oil and the natural gas above the oil upwards. This process improves the recovery factor, which specifies the ratio of recoverable oil to the total quantity of oil existing in the reservoir. In the Gullfaks field, water and gas are alternately injected into the reservoir. The technology used here (WAG technology (Water Alternating Gas), combined with other secondary recovery methods such as horizontal drilling now enables an oil recovery factor of 55 percent (world average 35 to 40 percent). The economically feasible target for oil recovery at the Gullfaks field is 61 percent.

Process Control

The water and gas quantities that are forced in must be measured exactly to ensure precision control and assessment of the process. The pre-treated injected water is conveyed into the reservoir using rotary



pumps and injectors. When it is necessary for the process to close one or more injectors, the flowmeters located between the pumps and the injectors will transmit an opening signal to the bypass valves, thus allowing a given amount water to flow back to the inlet side of the pump. The monitoring of the work area of the pumps by flow measurement protects the latter and therefore ensures a sustained operation. Depending on the number of open valves in the pipes leading to the injectors, it may be necessary to open the bypass valves on the pumps to secure a minimum flow. The flow speed is between 1.5 m/s and 10 m/s, depending on the mode of operation of the pumps.

Innovative Measuring Technology

The process and equipment used at Gullfaks A were gradually improved to increase the recovery factor. Until now, differential pressure probes were used for measuring the flow of sea water. In the course of the modernisation of the injectors and water treatment, the differential pressure probes were replaced by Fluxus ADM ultrasonic flow meters from Flexim. In the past, differential pressure probes repeatedly broke, so that the plant had to be shut down for repairs. Clamp-on technology has now eliminated such downtimes. Another important advantage is the great measuring dynamics of the Fluxus ADM devices which make it possible to ascertain both small and large flow quantities with a high degree of accuracy. Furthermore, the Fluxus ADM devices ensure that maintenance tasks such as recalibration of the differential pressure transmitters or cleaning the differential pressure drillings on the probes are a thing of the past. In addition, the non-invasive ultrasonic flow measurements do not cause any pressure loss and are independent of the pressure stage of the pipeline.

It is as if the probes had been specially created for this type of offshore application, for in their standard design they already consist of stainless steel and are waterproof. The values measured by Fluxus ADM are transferred to the central control station and are used for pump control and the exact balancing of injected water amounts. Thanks to the exact measurements, it is now possible to make statements about the efficiency of various actions, for example determining which of the 11 injectors has the greatest effect. The measurements enable the pumps to be safeguarded against critical operating statuses. This secures malfunction-free and sustained operation of the injection system. ■

Technical Data Measuring points

- Pipeline: DN300, stainless steel
- Flow: 0 to 4 500 m³/h
- Medium: treated sea water

Typical offshore applications for FLUXUS[®] ADM Measurement of

- Injected water
- Chemicals
- Hydraulic liquids
- Natural gas (high-pressure gas)
- Liquid gas
- Crude oil
- Reservoir water
- Methanol, glycol, etc.

Gullfaks A

Platform type	: Integrated rig for drilling, production and accommodation
Total weight	: 675 000 tonnes
Dimensions	: Total height: 270 m
Height above water	: 142 m
Narrowest width above water	: 40 m
Base: Number of supporting columns	: 4
Height	: 162 m
Water depth	: 135 m
Storage volume	: 300 000 m ³ oil
Living quarters	: 330 beds
Depth for storage	: 1 900 m
Sources	: 31 extraction probes 11 injectors
Initial operation	: 22/12/1986
Production until	: 2013/2014 (expected)



About the Author:

Dipl.-Ing. Claus Weihermueller
 Managing Director FLEXIM Asia Singapore
 e-mail: cweihermueller@flexim.com