

# Swirl pool

**VAPOUR CONTROL** Led by regulatory requirements, Norway continues to push the limits of onboard VOC recovery techniques. Teekay's latest step will see it adopting an innovative absorption technology for its shuttle tankers, reports *Brian Warshaw*.

After almost two years of testing, Teekay Shipping has announced that it is going to equip its next four shuttle tankers with the Compact Volatile Organic Compounds (CVOC) vapour recovery system manufactured by Norwegian company GBA Marine AS. The CVOC systems will be installed on the shuttle tankers currently being constructed at the Samsung Heavy Industries shipyard in Geoje, South Korea. The vessels, which are due to start rolling out from 2010, will join Teekay's existing fleet of 38 shuttle tankers, 18 of which operate volatile organic compound (VOC) vapour recovery systems.

It was during a scheduled drydocking in May 2007 that Teekay installed the first unit on its Aframax shuttle tanker *Navion Hispania*, but the development of the CVOC began long before then. Dr Rune Gammelsæter, GBA's research and development manager, explains that "the absorption of VOC gases in crude oil is a well known and proven technique that has resulted in several different solutions being developed, going back to at least the early fifties. The specific idea for this system was to reduce the size of the absorption components and, by that, tailor the system into any crude oil tanker without interfering with any of the existing systems onboard.

"Several of the staff at GBA had been directly involved in VOC recovery issues since the middle of the 1990s but it was not until early 2004 that we joined forces and developed the concept on paper," he continues. "It was only after some 1,100 advanced parametric studies using computational fluid dynamic (CFD) models, together with thermodynamic calculations, that the first laboratory model was ready in early 2005 for air and water testing.

"The key to the CVOC system is the patented swirl absorber," he says. "The rest of the system comprises an electrically driven crude oil pump, valves and piping, with a touch-screen computer-based control and operations system. Oil is drawn from the bottom of the cargo tank by the pump, and passes through the swirl absorber before being returned at low level to the tank. As the oil flows through the swirl

absorber, it creates a large area of contact into which the inert gas is absorbed, drawn from the main distribution line by using an advanced patented ejector design. The inert gas includes VOC from the top of the cargo tank. Through absorbing the gas back into the oil phase, the pressure in the tank decreases."

## Tested for pressure

In trials, the CVOC system was brought into operation when the pressure in the cargo tank reached 1,800 mmWG and closed down when it fell to 1,600 mmWG, but this range can be varied as needed according to the volatility of the oil. As the vessel approaches the receiving terminal, the pressure set point can be adjusted from the control system to reduce the pressure to a level acceptable for dipping the tanks.

Results from *Navion Hispania* showed that full vapour recovery was achieved during the four-day voyage from the Gullfaks offshore loading platform to the receiving terminal, with 100 per cent repeatability. During a typical voyage, the Norwegian Marine Technology Research Institute (Marintek) reported, "The GBA Marine absorber was started eight hours into the loaded voyage and ran for most of the remaining voyage. There was no emission of gas from the cargo tanks to the atmosphere after this absorber was started for the first time." Previous measurements by Marintek had determined that the Gullfaks crude oil would emit 44 tonnes of VOC to the atmosphere without vapour recovery facilities during the voyage.

Although no measurements of VOC generation were taken during the loading process, it is commonly accepted by the oil industry to range between 100 and 300 tonnes of VOC from an Aframax vessel. With the CVOC system running it was observed that a significant impact was made in reducing the releases.

To estimate the physical properties and liquid-vapour phase equilibrium of VOC under varying conditions, GBA undertook a large number of theoretical calculations using a combination of the Aspen HYSYS® thermodynamic process modeling and Ansys Fluent CFD calculations. The results indicated

emissions reductions in the order of 30 to 70 per cent and, based on previous comparisons between calculation and measurement on several fields, GBA is confident that its computer simulations give a fairly accurate prediction when the full crude oil analysis is available.

For safety reasons all oil containing components are installed in the lower part of the pump room, which is equipped with gas detection systems, level switches, and closed drain systems. Gammelsæter says that the CVOC system has received approval from Det Norske Veritas for pressure integrity and operational safety.

*Navion Hispania* is equipped with a Hamworthy Gas Systems VOC recovery unit operating on the principle of liquefaction. The recovered hydrocarbon condensate is stored while awaiting discharge to shore and the gaseous methane is used as a fuel to generate the electrical power to operate the system.

## Tailored to fit

In common with six other systems of this type installed on Teekay vessels operating in Norwegian waters, modifications have been made to the equipment, including new process internals.

The four new CVOC systems that GBA is supplying to Teekay will be used in conjunction with Knutsen OAS Shipping's KVOC system, thereby ensuring that the vessels meet the Norwegian requirement for all loading offshore, irrespective of the oil composition. This is the first time that Knutsen has sold to an outside company, having previously been installed only on its own vessels. Overall VOC recovery from Norway's offshore production is to be available 95 per cent of the time, and must capture at least 78 per cent of the emissions.

There is a growing interest in the recovery of VOC emissions during marine transportation, as demonstrated by the support being given by Norway's VOC Industry Cooperation (VOCIC) committee, which comprises all 23 companies performing offshore loading of crude oil on the Norwegian Continental Shelf, to Teekay's decision to take the two system approach.