

Pressure cooker

Vapour emissions from tankers are coming increasingly under the spotlight, but a simple technical approach may be able to make a significant contribution to cutting vapour losses

The Norwegian government has already begun to regulate emissions of volatile organic compound (VOC) vapours from oil tankers operating in its waters; the European Union is also looking hard at the question. The International Association of Independent Tanker Owners (INTERTANKO) is also looking at the whole question of how crude oil behaves in the cargo tank and how this impacts on vapour losses and tank integrity. It is also becoming painfully apparent just how much of a crude oil cargo is lost to the atmosphere during transport by sea and how much money is thereby wasted.

Venting tanks

As INTERTANKO has pointed out, it is necessary to vent cargo tanks periodically during a voyage to avoid a build-up of pressure within the cargo tank, which would threaten the viability of the vessel. Common practice is to vent vapours manually through the mast riser or the pressure/vacuum (p/v) valves. Neither of these approaches is ideal; both run the risk of releasing cargo vapour to the atmosphere unnecessarily and raise safety questions. As a result of its vapour emission control study (VOCON), INTERTANKO has recommended the use of vent monitors to check on the composition of the gas being vented and record the pressure drop during the release.

An alternative approach has been promoted elsewhere. In particular, Danish venting specialist Pres-Vac Engineering A/S agrees that current practices are inappropriate but claims that a simple and automatic solution can be found by the application of modern p/v systems consisting of the latest generation of non-oscillating p/v valves. It is a fact, Pres-Vac argues, that the bulk of existing cargo tank venting systems installed in the past 25 years do not provide the level of performance reliability that will give the crew confidence that cargo tanks are being vented properly. As a result, manual venting is carried out, which inevitably results in the emission of VOCs to the atmosphere and the loss of cargo value.

Valve certification not indicative

A common misconception is that certification of p/v valves means they operate according to their rated capacity and are suitable for the application. In fact, valve certification is undertaken from a fire prevention point of view and does not necessarily indicate that the in-service venting capacity over time is sufficient to keep the tank pressure within limits needed to avoid damage to the cargo tanks. "Over- and under-pressurisation incidents can be the result of incorrectly operated isolation valves or misunderstood use of breather valves," says Eric Sørensen, managing director of Pres-Vac, "but most frequently, they occur as the result of clogged valves left unattended because of the overwhelming maintenance burden on the crew." Moreover, the new ISO standard, 15364:2000, which will be mandatory for installations on newbuildings under SOLAS as of this coming July 1 (see IMO MSC/Circ.1009), makes no progress in the design of vents, merely providing a checklist for the owner to follow when choosing the type of p/v valves to be fitted to a vessel. For instance, says Sørensen, the Danish type approval body under the EU Marine Equipment Directive, is now applying a caveat emptor clause which makes the user responsible for deciding whether or not a vent is suitable for the application at hand. "Type approval is simply a sheet of paper referring to successful fire tests, not a general endorsement for every installation," he says.

Measures to take

Pres-Vac considers that a properly designed venting system, using p/v valves of a reliable and low-maintenance design within the remit of ISO 15364, can make the practice of manual depressurisation redundant - provided that the valve design allows for a higher working pressure range within the tank without increasing operational risks. Such an approach would not only reduce the volume of cargo vented to the atmosphere - so saving both cargo value and environmental impact - but could also improve the safety of tanker operations.

Moreover, the move towards onboard vapour control could be rendered obsolete, since it would be difficult to justify the expense and safety implications of installing costly and complex equipment to collect the relatively small volume of vapours that might still be vented. Sørensen believes that an 80 to 90 per cent reduction of today's loss level could be achieved if his company's recommendations for a 'high pressure' system are followed.

There are, Pres-Vac argues, three simple and effective measures that could be taken to reduce by a significant level the volume of vapour lost from crude oil tankers during the voyage.

1. If the venting system is regarded by the crew as reliable and it can be inspected and maintained without being dismantled, then operational procedures can be revised to eliminate the need for manual depressurisation.
2. The opening and closing pressure settings of the p/v valves, along with alarms settings and inert gas replenishment level, can be increased.
3. The dynamic flow characteristics of the p/v valves can be enhanced, allowing for full venting capacity without pressure surge, meeting the 'non-oscillating' definition of CEN standard 12874.

The ideal venting system, therefore, should:

- employ individual full flow p/v valves
- be fail safe
- be able to be inspected externally
- be maintained without removal from the piping/no 'closing down' of operations
- perform according to the relevant rules and standards
- automatically maintain a cargo tank pressure under loaded conditions
- not require the fitting of additional or replacement associated equipment

The current position is that tank pressure is generally maintained between 1,000 mm water gauge (WG) and 400 mm WG during the voyage. Rather than rely on p/v valves to maintain pressure within this range, the usual procedure is that, once tank pressure reaches 1,000 mm WG, the vents or mast riser are opened manually until the pressure falls to 400 mm WG. By depressurising tanks in this simplistic way, as much as 0.25 per cent of the cargo is lost during the course of an average voyage. For the sake of illustration, this suggests that a million-barrel Suezmax tanker will lose 2,500 bbl of oil during a voyage - or about \$5,000-worth of cargo at current prices.

INTERTANKO has addressed this level of losses in its VOCON study and has recommended a more reasoned approach to depressurisation based on the vapour pressure of each cargo. This indicates that manual depressurisation should cease once the tank pressure has fallen to somewhere between 700 and 850 mm WG. In comparison, says Sørensen, the system advocated by Pres-Vac would constrain

boil-off in the span from 700 mm WG to the vent's closing pressure, for instance 1,500 mm WG.

Despite its position as a leading supplier of p/v valves, Pres-Vac states that, generally speaking, such valves cannot be trusted as failsafe. The simple reason is that such equipment is designed and built to meet standards and regulations that do not take into account actual working conditions. Type approval is granted on the basis of fire tests rather than on the valve's ability to maintain a pressure balance over time. By way of illustration, Sørensen points out that the venting capacities of old valves in for overhaul are often seen to be reduced by half or more.

The question of trust, therefore, hangs not on the valve's ability to prevent a flash-back fire but on its inability to balance the tank pressure. IMO's recent revision of SOLAS generated numerous reports of overpressurisation incidents caused by or involving non-performance of valves, so this mistrust appears well founded.

Another problem is that many existing designs are prone to failure because they are too easily clogged by cargo deposits, ice or corrosion. If this is combined with difficulties in inspecting or dismantling the valve for cleaning, then it is not surprising that the crew regard them with mistrust. Yet these valves comply with the regulatory requirements and receive type approval.

Types of valves

In light of the above, IMO has amended SOLAS to mandate the use of secondary venting systems, but this has probably had little effect. If crew do not trust one p/v valve, it is hard to see what advantage will be gained simply by adding a second. Moreover, the fact that a particular valve has received type approval does not mean it is suitable for a particular application. It is quite clear from the regulations (SOLAS, ISM Code) that it is the owner's responsibility to ensure that the valve chosen for each vessel must be appropriate for use with the type of ship and the cargoes it will carry. "This is where the new ISO standard comes into the picture as the owner's quality assessment tool," says Sørensen. "Considering this in the context of ISM Code obligations with respect to identified risk areas, the issue of mistrust would fade if a proper product review were to be made in the selection process."

There is a surprisingly wide array of valve designs available on the market, and there have been a number of changes in recent years. Full lifting valves, which offer an instant reduction of pressure, are no longer allowed since they always suffer from hammering, chattering or fluttering, which raises the danger of flash-back in high-velocity vents. Further, they feature an unacceptably low closing pressure of 500 to 600 mm WG. Controlled blow-down valves, typically magnet-controlled, also offer an instant reduction in pressure but are unsophisticated and can result in inadvertent loss of vapour pressure.

Modulating valves offer a rise in pressure above the nominal setting proportional to the vented volume. They are not subject to hammering, but users should expect a pressure increase of 15 to 25 per cent above the setting at certain points in the flow chart, namely at the normal working rate, which is typically half of the US Coast Guard VCS calculated volume. A more sophisticated version - non-hammering, weight-loaded high-velocity valves - open fully under high efflux velocity but suffer from similar pressure increases.

The newest design

The latest type of valve, non-oscillating and high-velocity, overcomes all these problems by controlling pressure surges across the flow chart and by virtue of a design featuring narrow clearances outside the pressure zone which eliminates the problem of clogging by oil splash. This is achieved through a combination of a controlled blow-down mechanism with a weight-controlled non-hammering design. Its design allows for the use of smaller diameter piping and/or higher venting rates.

Such valves can be adjusted to limit the loss of vapour from a cargo tank, on the basis of the data provided via INTERTANKO's VOCON study. In particular, the opening setting can be much higher than normal - for instance 1,800 mm WG - with a small operating margin between the valve setting and the alarm setting, say 50 to 100 mm WG, leaving the alarm setting unchanged from today's practice for newbuildings. The closing pressure can be set according to the pressure drop conditions of the vent piping; when the opening setting is 1,800 mm WG, then a suitable closing pressure would be around 1,500 mm WG. The valve would then act to maintain a relatively constant pressure of between 1,500 and 1,800 mm WG throughout the voyage.

The use of such valves will provide crew with greater dependability and will remove the need for manual depressurisation, so long as proper consideration is given to the characteristics of the cargo being carried. Pres-Vac estimates that the cost of retrofitting such equipment is in the region of \$2,500 to \$5,000 per tank; such investment will be easily recouped in higher delivered cargo volumes. For newbuildings the cost is negligible, around \$500-1,000 per tank compared to ordinary non-hammering valves.

It must be stressed, though, that the operability and performance of valves, in all cases, depends on the correct choice of valve by the owner and the optimum operation by the crew. Sørensen advises owners to "take an active role in drafting clear specifications concerning the requested procedures for inspection and overhaul on deck".

According to Pres-Vac, several owners have already decided to take up the new generation of non-oscillating, low-maintenance equipment. "One owner, Saudi Arabian Maritime Co [SAMCO], is already redesigning the venting system on its series of VLCC newbuildings with a view to monitoring and establishing the VOC loss reduction from a tailored high pressure system based on the new generation of vents," says Sørensen.

It is expected that the newbuildings will meet the forthcoming environmental requirements at an extra cost of approximately \$1,000 per tank.