COLD COMFORT

Paul Shillito, Oliver Valves, UK, discusses the importance of valve reliability in LNG processes.

In many countries around the world, LNG is playing an increasingly important role in supplying energy needs. This rapid growth has inevitably led to public concerns over the safety of what is still seen by many as a new way of transporting energy. This is particularly the case in North America, where communities and environmentalists have voiced strong opposition to new permits for LNG terminals being granted.

In fact, the LNG industry's safety record for transportation is enviable; LNG tankers have clocked up more than a million sailing miles without a single major incident. Sadly, accidents have been known to occur at processing sites, and while these are infrequent in comparison to other areas of the energy industry, the scale of these incidents can be large.

However, the industry is well aware of the risks and safety remains the number one concern. Arguably there is nowhere this is more important than at onshore terminals, where large volumes of LNG are processed in close proximity to a significant amount of infrastructure investment and sometimes in the vicinity of residential areas.

To keep the risks to a minimum, LNG companies have invested heavily in ensuring that facilities are as robust as possible, with the fuel always stored in double walled and fully bunded tanks.

Ensuring that the right valves are used is an equally important aspect of the safety provisions for the LNG supply chain. For inline repairs or emergency maintenance to be carried out on any piping system containing volatile and potentially highly flammable substances, it is essential that the valves used to isolate the sections being worked on provide a guaranteed and long-lasting 100% tight shut off.

Of course, the valves used in LNG processes need to function at very low temperatures, and the development of technology in this area has been rapid, with most leading valve manufacturers offering cryogenic solutions.

LNG processes are among the most demanding applications for low temperature valves, as they require very large volumes of cryogenic medium to be carried. Because of this, it is vital to specify the most efficient type of valve available.

Figure 1. 4 in. full bore cryogenic Twinsafe valve.

For this reason, the units most commonly selected are ball valves. The advantage of this type of valve over alternatives such as butterfly or gate valves, is that when the valve is open there is almost no change in the diameter of the pipe, and the unit therefore presents no resistance to the flow of material. This means there is virtually no loss of pressure, increasing the efficiency of the system and bringing commercial advantages.

Full bore ball valves also have further benefits. In cryogenic processes, there is a risk of hydrate crystals forming in the pipeline. In the case of traditional valves, where the gate sits in the stream of fluid even when the valve is open, the crystals can impede the closure of the valve creating a serious potential hazard.

Another concern is cavitation or flashing within the flow of liquid. This occurs when the liquid speeds up as it flows through the bottleneck caused by the valve. This increased flow velocity results in a decrease in pressure and this can cause the fluid to temporarily vapourise, with bubbles of gas appearing in the liquid.

This is a concern, as the turbulence in the flow created by the effect can increase wear on the valve, significantly reducing its lifespan.

Specific requirements

The fundamental design of a ball valve is always the same, whether it is designed to function at cryogenic temperatures or at 300 °C. It features a metal sphere with a bore hole at the same diameter as the pipeline and this ball is either trunnion mounted; suspended on two cannon-style metal protrusions, or 'floating', supported by just one metal stem.

The sphere sits tightly against two specially shaped rings in both the upstream and downstream directions and these are called seats. The seats form a tight seal against the surface of the ball, preventing any medium escaping into the cavity that surrounds the ball.

When the valve is operated, the ball rotates through a quarter turn. In the open position, the bore hole is in line with the pipeline and, when the valve is closed, the cavity is perpendicular to the direction of flow.

Cryogenic valves

So what are the major distinctions between a standard ball valve and one designed to function at cryogenic temperatures?

Probably the main difference is the need for an extended bonnet; the part of the valve construction containing the rod that actuates the ball valves. This is necessary both in order to allow access to the handle when ice begins to collect around the valve, and also to allow the handle to be at a far higher temperature than the rest of the valve, reducing the risk to operators of injury through contact with very cold surfaces.

Low temperatures also require different materials to be used inside the valve. Carbon steel - a material commonly used in the manufacture of standard ball valves, cannot be used in cryogenic valves because the material becomes very brittle at low temperatures. Instead, other stainless steel alloys tend to be used.

The material from which the seats of the valve are constructed is equally important, as the contraction and expansion caused by such extremes of temperature can cause some materials to develop cracks, creating potential leak paths. Soft materials such as polytetrafluoroethylene (PTFE), polyether ether ketone (PEEK), and polychlorotrifluoroethylene (PCTFE or KelF) are commonly used, as their slight pliability allows them to maintain a 100% tight seal despite such radical changes in temperature.

Testing

The crucial role that valves play in controlling LNG flow - especially in providing shut-off in emergency scenarios - means it is critical that they function as intended throughout their entire lifespan and it is up to valve manufacturers to provide this guarantee. The only way to be completely sure of this once the valve is in place is to carry out rigorous tests on the unit prior to installation.

Today's computerised test rigs constantly and accurately measure the pressure across the valve while cycling the temperature down to the required value, and repeatedly actuating the valve over a period of several hours.

It is only by applying this test to every unit leaving the production line that manufacturers and end users can be completely confident that the valve is fit for purpose.

Double block and bleed

In upstream oil and gas operations, an additional layer of safety is provided by ensuring that all isolate valves are double block and bleed systems; two separately operated valves with a bleed valve between them. These systems have also been adopted in many areas of downstream processing, as engineers begin to realise the safety benefits.

Conventionally, in order to achieve a double block and bleed system, two standard isolation ball valves would be installed, along with a separate facility for bleeding the pipework in-between.

However, space is often of the essence where any processing system is to be upgraded, and this approach, requiring an additional valve unit to be installed as well as a T-section to allow the intervening pipework to be bled, more than doubles the dimensions of the installation compared with a single valve.

This significant size increase can often make the installation unfeasible, especially where multiple valves along the line need to be replaced.

Another issue is that increasing the number of components in a system increases the number of potential leak paths. Of course, along much of the LNG supply chain, the fuel is stored at close to atmospheric pressure, reducing the risk of leaks forming. However, during the regasification process, the pressure of the medium dramatically increases and minimising potential leak paths at this stage is crucial.

Figure 2. CGI model of a larger bore cryogenic Twinsafe valve.

In oil and gas extraction operations, these issues of space saving and leak paths have been overcome by the development of the single-unit double block and bleed valve and this technology is now available to the LNG market.

Oliver Valves has recently pioneered the first single-unit double block and bleed valve tested to function at cryogenic temperatures, with the aim of encouraging LNG companies to adopt the systems in order to increase flow control safety.

Incorporating the three valves into a single housing increases the safety of the system by removing connections between separate units, resulting in fewer potential leak paths.

The volume of the cavity between the valves is also significantly reduced, allowing operators to evacuate the space and establish safe isolation more quickly, a major benefit in emergency scenarios. The reduction in volume of the material removed from the valve also means less waste, reduced handling, lower costs and easier disposal.

Another key advantage of the Twinsafe design is that the whole system has the same face-to-face length as a standard single isolate valve, as specified in ASME B16.10.

Not only does this mean the unit can easily be installed into an existing system without any re-working of the surrounding pipes, but also that the space required for a double block and bleed configuration is reduced by more than half, freeing up space for other equipment.

Driving change

Arguably the most powerful driver of change in bringing in enhanced safety measures to industrial processes is, sadly, when high profile accidents occur.

This was the case with the introduction of double block and bleed valves in oil extraction processes - they became mandatory for all isolation valves used on British drilling operations following the Cullen Report into the Piper Alpha disaster of 1988, an oil rig explosion in which 167 people were killed.

Since then, other parts of the oil and gas supply chain have benefitted from this development, and double block and bleed systems are now commonly used in refineries and other processing environments. The technology is now available to the LNG sector, and it is down to the valve manufacturing industry to demonstrate the benefits of upgrading cryogenic pipeline systems.

Ultimately, for a growing industry that is currently under such scrutiny from the public, no safety enhancing technology can afford to be overlooked. **LNG**