

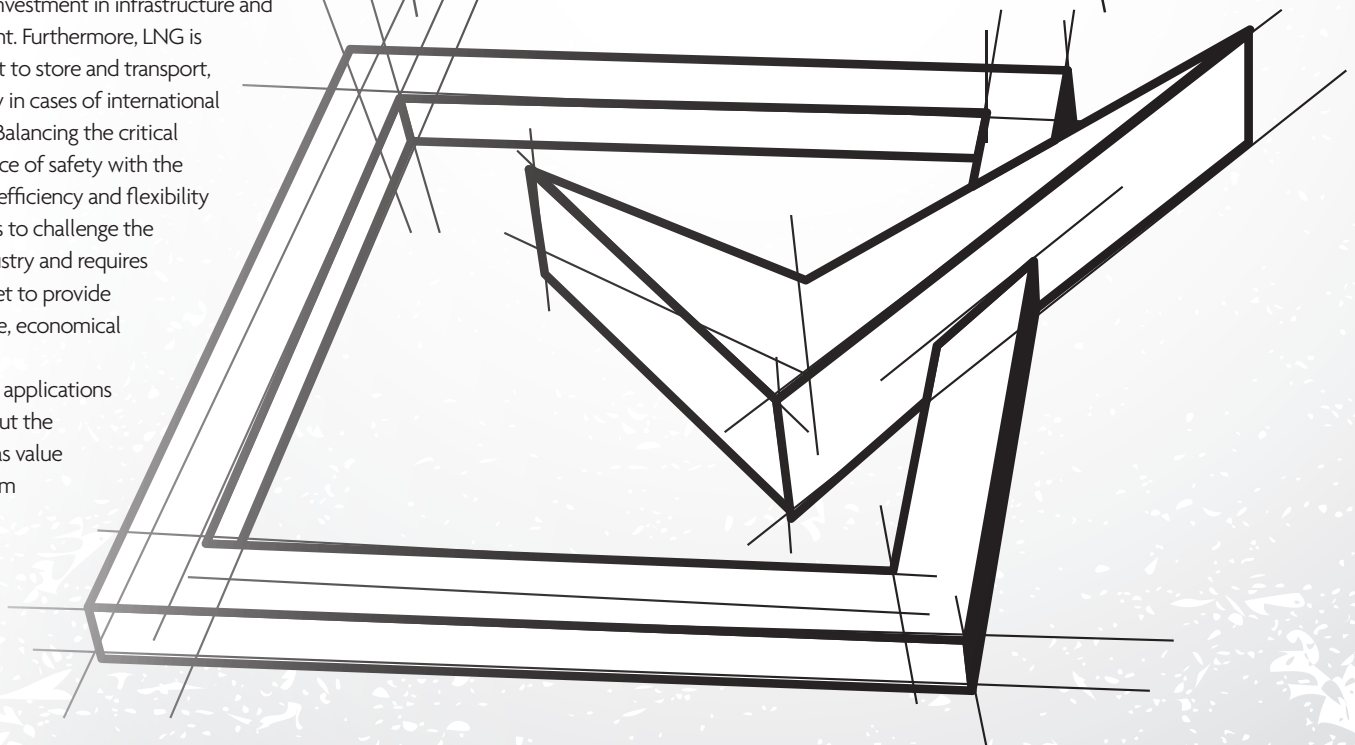
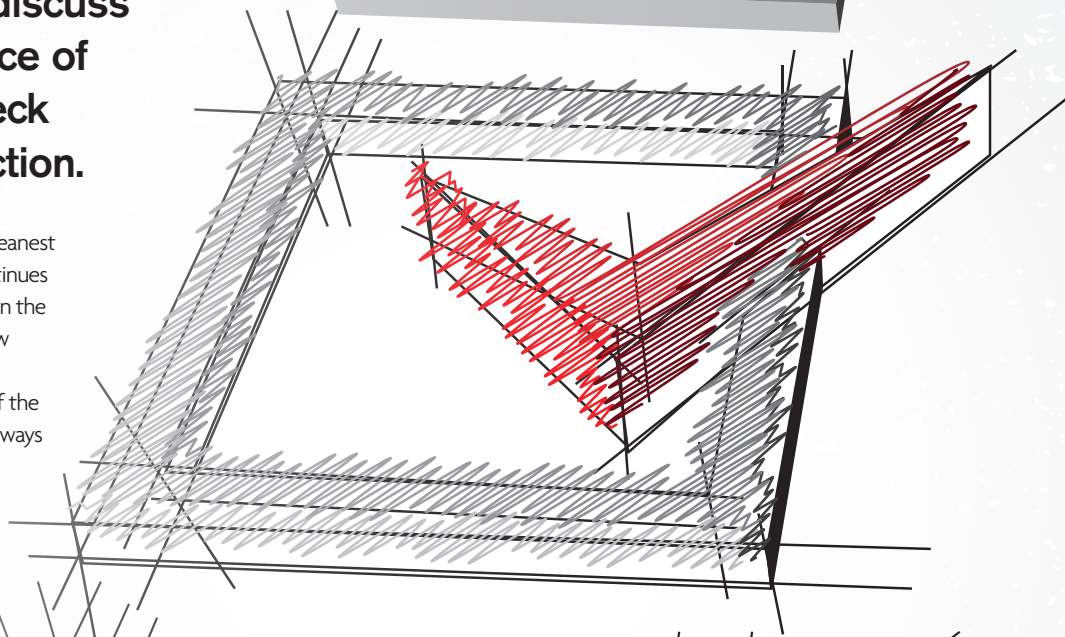
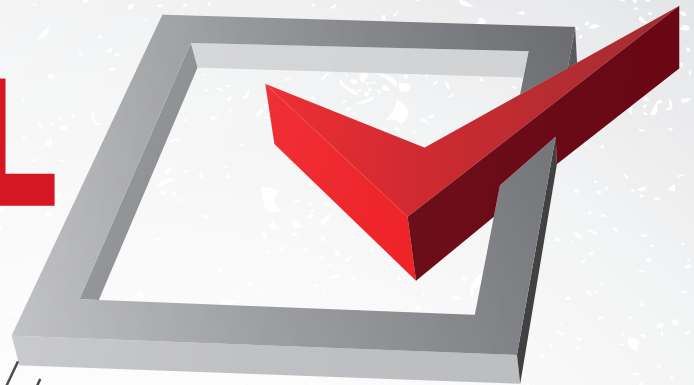
CHECK CRITICAL

Carlos E. Davila and John C. Lunde, Crane, USA, discuss the growing importance of highly engineered check valves in LNG liquefaction.

Non-toxic, non-corrosive and the cleanest burning fossil fuel, natural gas continues to grow as a viable energy source in the US and throughout the world. New markets, technologies and infrastructure development have catalysed the expansion of the natural gas industry while companies explore ways to capitalise upon the mounting opportunity.

The growing possibilities in natural gas utilisation, however, do not come without growing pains. Conversion of natural gas to LNG is costly and requires substantial upfront investment in infrastructure and equipment. Furthermore, LNG is inefficient to store and transport, especially in cases of international carriage. Balancing the critical importance of safety with the need for efficiency and flexibility continues to challenge the LNG industry and requires the market to provide innovative, economical solutions.

With applications throughout the natural gas value chain, from upstream supply to



downstream sale, valves are the critical differentiator in protecting equipment, maximising productivity and ensuring operational safety. Superior valve materials and proper valve selection are vital, especially in cryogenic applications like LNG liquefaction and gasification where temperature, pressure and environmental considerations are paramount. Check valves, like the Noz-Chek® and Duo-Chek® lines offered by Crane ChemPharma & Energy, are crucial components in the LNG value chain. They offer a solution to the destructive effects of flow reversal and provide essential protection to plant infrastructure, pipelines and turbomachinery.

This article will explore the background and challenges of the LNG industry, address the impact that check valves have on the overall production chain and explain how proper valve selection is crucial to operational safety and success.

LNG market outlook and challenges

With an increasingly dynamic landscape, heightened environmental concerns and a global emphasis on energy security, it is no great revelation that natural gas utilisation remains central to the future of the market.

According to *The World LNG Report* released by the International Gas Union (IGU) in 2011, 'in developed and emerging markets, gas is increasingly a fuel of choice to supply electricity, provide heating and cooling, and support economic growth.' The report further describes the expansion of the LNG market during the last five years, citing that 10 new countries have started to import LNG while myriad others in developing markets are expected to bring terminals onstream by the end of 2014.¹ This fact is merely one snapshot of an industry that continues to grow at a remarkable pace while global economies strive to leverage the opportunity.

Despite the potential of natural gas, however, the relatively high cost of LNG production and infrastructure development has been an obstacle to widespread commercial expansion. Critical cryogenic equipment and costly machinery and compressors are present throughout the value chain, and require not only substantial up front economic investment, but protection from flow reversal, fugitive emissions and other fluid handling concerns. With the extensive cost associated with each step of the value chain, it is especially important that the critical elements of an LNG operation are not compromised during emergency situations, sudden environmental changes, or user error. Furthermore, extreme temperature fluctuations from cryogenic to extreme heat demand that equipment be reliable in even severe conditions.

Highly engineered check valves

One of the most significant elements of LNG system design is integrating the means to protect mechanical equipment and prevent damage caused by backflow. Whether in the gas field, liquefaction plant, LNG storage tank, LNG tanker or gasification terminal, check valves are crucial in protecting the critical components throughout each step of the value chain.

Despite the crucial demands placed on check valves, their constant exposure to fluid mediums make them highly susceptible to wear and other operational challenges like sticking, jamming and wedging. The daily forces that act upon check valves are extremely harsh, and traditional check valve solutions can suffer from the heavy slamming caused by turbulence, which will compromise their reverse flow protection capabilities.

Furthermore, check valves have historically been limited by long closing distances that exacerbate the effects of water hammer and the significant pressure loss that results from the flutter of in stream components.

The ideal check valve, especially for critical applications like LNG liquefaction and gasification where extreme temperature fluctuation is a constant challenge, offers not only the fastest dynamic performance and lowest pressure drop, but is that in which the threat of catastrophic failure is mitigated by innovative engineering.

To avoid the challenges often present with basic swing check and tilting disc valves, highly engineered solutions like dual plate and nozzle check valves offer a more reliable solution to the challenges of severe service.

Dual plate check valves, like Duo-Chek high performance non-slam check valves, offer one such solution to the challenges of LNG production. Leading engineers specify the technology for natural gas processing, pipeline and LNG applications because it provides high performance backed by extensive research and testing.

Perfect for LNG applications, the wafer valve design is generally stronger, lighter, smaller, and more efficient than conventional swing check valves. To best protect the costly elements of liquefaction and regasification terminals and deliver the lowest total cost of ownership, the innovative dual plate design of the valve uses springs to increase the valve reaction and response time. This unique design greatly accelerates the valve's dynamic response time while dramatically reducing the water hammer effect for non-slam performance.

For the extreme cryogenic demands of the liquefaction process, Duo-Chek valves have been approved for subatmospheric to cryogenic temperatures -58 °F through -321 °F, although special materials of construction like low temperature alloy steels, austenitic stainless steel, aluminum bronze and Monel® are generally required.

Like engineered dual plate check valves, nozzle style valves are likewise essential in protecting the equipment throughout the natural gas and LNG value chain. Noz-Chek valves are specifically designed for fast reversing systems where backflow is a constant concern. In such critical service applications, Noz-Chek non-slam check valves minimise the damaging effects of water hammer in fluid systems, eliminate the chatter associated with conventional valves, protect rotating equipment from damage due to flow reversal, minimise pressure loss in piping systems and provide quick dynamic response to reduce reverse velocity.

When a noticeable reduction in flow occurs, the disc reacts immediately, limiting backflow and valve slamming. The spring load, low mass disc, and short displacement ensure a rapid self dampening response. For critical applications like LNG, the internal geometry can be modified to suit the service conditions. In addition, the Noz-Chek geometry was established by considering the design velocity required to stabilise the disc open against its stop even if moderate flow oscillation occurs.

Check valve sizing and selection

Because check valves require no outside stimulation to function, they represent a unique and challenging aspect of operational infrastructure. Rather than rely upon an operator or technician, check valves react to both the basic forces inside the valve as well as external forces like fluid type, temperature and selected

materials. Check valves begin closing only as forward flow decreases or reverses, so varying internal system pressures can cause check valve selection and functionality to be particularly problematic.

Unlike traditional on/off valves, check valves offer no indication of their setting or condition and are selected in accordance with a complex set of internal operating conditions. Therefore, specifying the proper check valve requires a thorough understanding of what goes on inside the valve itself as well as a profound knowledge of a system's overall internal environment.

While on/off valve selection is often influenced by a desire for the highest possible flow coefficient as determined in a 100% open position, check valve components always remain in the fluid stream, preventing the possibility of unobstructed, 100% open flow, an aspect that both complicates sizing calculations and causes harsh wear on the valve itself.

Additionally, whereas on/off valves are typically sized solely on line size, check valve sizing is based on a variety of factors, which vary by application. Valve sizing and selection should consider valve material compatibility with the fluid medium, the ANSI valve rating, application flow, design and operating conditions and the installation requirements of a particular facility. Line size, end connections, system modifications and leakage regulations are likewise essential to proper check valve selection.


Overall, the most important consideration to acknowledge when sizing a check valve, regardless of its design, is that the valve offering the longest lifetime of maintenance free service will be sized for the application, rather than the line size. This is the best way to prevent fluttering and ensure that your valve delivers consistent optimised performance.

Conclusion

As long as companies, countries and communities worldwide seek cleaner, more cost effective methods of energy production, natural gas will continue to grow as a significant energy source within the US and across the globe.

While markets, technologies and production facilities expand, investors must ensure that their investments are protected by the best, safest and most effective methods of flow control and emergency prevention. From cryogenic environments like that of LNG liquefaction to high temperature applications of LNG gasification, check valves are crucial in protecting equipment from the damaging effects of reverse flow and ensuring that safety is paramount throughout the operation.

As companies continue to invest in LNG and finance the technology and infrastructure necessary to extract and transport natural gas, the role of check valves will continue to grow. Failure to select a highly engineered check valve, like a dual plate or nozzle style valve, could jeopardise the safety of the LNG operation and put the piping, machinery and costly components at risk.

When superior valve materials and proper valve selection are vital, highly engineered check valves emerge as essential components within the LNG value chain and address the needs of natural gas producers worldwide. 

References

1. International Gas Union. (2011). *World LNG Report 2011*. Retrieved from <http://www.igu.org/gas-knowhow/publications/igu-publications/LNG%20Report%202011.pdf>; Retrieval date: November 11th, 2013.