Going with the flow

Nicola Curtis, Rotork, UK, discusses the critical pipeline safety functions provided by flow control.

Flow control is the management of liquids and gases in industrial applications, and actuators are key items of equipment that control valves at critical points within oil and gas operations. Flow control equipment is found across all three sectors/areas within oil and gas: upstream, midstream and downstream. Pipelines fall under midstream operations, moving oil and gas from one place to another. In the current energy climate, pipelines remain an essential tool of, in particular, transporting gas from North America and the Middle East to the markets that have very high demand in Europe and Asia. The demand for gas has largely returned to pre-pandemic levels and globally is predicted to continue to rise in the lead-up to 2030. Midstream infrastructure must therefore continue to provide efficient and reliable operation. This includes the actuators that can ensure safety functions and efficient flowing of oil and gas from the areas that produce it to the areas that need it.

Actuators provide automation of what would otherwise be a manual operation. They must withstand harsh environments and extreme conditions, usually requiring explosionproof and hazardous location certification. Operators choose different actuators according to different requirements, such as medium being controlled, locations, valve size, available power supply and frequency of operation. Within oil and gas, actuators can operate in such diverse applications as wellheads, tank farms, processing sites, fuel terminals, metering skids and pipelines, to name a few. They provide day-to-day flow control and safety functions. Electric

actuators are especially valuable within oil and gas operations because they do not release or vent gas emissions during their operation, aiding in attempts to reduce impacts on the environment. Fluid powered actuators, driven hydraulically, pneumatically or electro-hydraulically, are still often used within oil and gas.

Operation in remote areas and challenging environments

Flow control technology has evolved to ensure accurate, effective and reliable actuation, even in the extreme environments that pipelines often operate in. Oil and gas pipelines, by their nature, transport material across hundreds and sometimes thousands of miles. This often means they run across remote and extreme areas (including deserts, mountains, forests and frozen terrain), making them difficult to access. They operate valves on pipelines in extreme temperatures (both very hot and very cold) and coastal locations (with high possibility of corrosion), exposing them to various environmental impacts. Valve operation in extreme environments presents clear challenges and these demanding locations require flow control that offers high degrees of reliability and robustness. The challenge of remote and isolated locations in midstream oil and gas operations requires innovative engineered solutions for pipeline actuators to operate efficiently and safely. The most effective actuators in these situations must offer environmental protection of the highest degree. IQ3 electric actuators from Rotork have a double-sealed terminal compartment, preventing ingress of water and dust from the ambient environment, meeting IP66/68 standards. They can operate within an ambient temperature range of -50 to +70°C (-58 to +158°F) and for the most extreme temperatures, the IQ range (multi-turn and part-turn) is certified for operation down to -61°C for use within the Russian market. Traditionally, flow control equipment in very low temperatures were installed with heaters alongside to prevent cold and condensation affecting internal electronics. Innovative design means that some modern electric actuators can operate without this reliance on external heaters, which removes the needs to supply additional power to each actuator and reduces overall power consumption.

Figure 1. Rotork SI electro-hydraulic actuator operating on a pipeline.

Figure 2. Rotork IQ3 actuators on a pipeline in extreme conditions.

Safety concerns addressed by emergency shutdown and fail-safe functions

Especially when operating in remote (and often unmanned) locations, the ability of actuators to stop the flow of oil or gas is of paramount importance. A requirement of actuators to offer fail-safe or emergency shutdown (ESD) functionality is always requested by operators. Continued flow of oil or gas can have environmental consequences, such as impact on wildlife and nature habitats. There are also economic impacts; this can be for the operator from loss of product and damage to reputation, as well as negative effects for local economies. The gas or oil that runs through pipelines can be dangerous when not dealt with in the correct manner. Safety should be the number one consideration for pipeline operators. With effective shutdown options provided by an actuator, impacts are reduced or nullified and the process of stopping the flow of gas or oil can be safely controlled.

Electro-hydraulic actuators combine the speed and flexibility of hydraulic operation with the convenience and control benefits of an electric actuator. From a safety standpoint, they use a simple and reliable mechanical spring to provide fail-safe valve control. An actuator like Rotork's Skilmatic can fail-safe on loss of ESD signal and/or loss of power supply. It can close a valve in seconds if necessary. This can ensure the process stops in a safe operating state, avoiding safety issues and monetary consequences. In safety critical applications such as pipelines, this functionality is essential. For example, Skilmatic actuators were installed to provide ESD functionality on two newly constructed pipelines in China. These pipelines brought oil and gas into China from offshore fields in the Bay of Bengal. The actuators operate remote-operated shut-off valves (ROSoV) to isolate

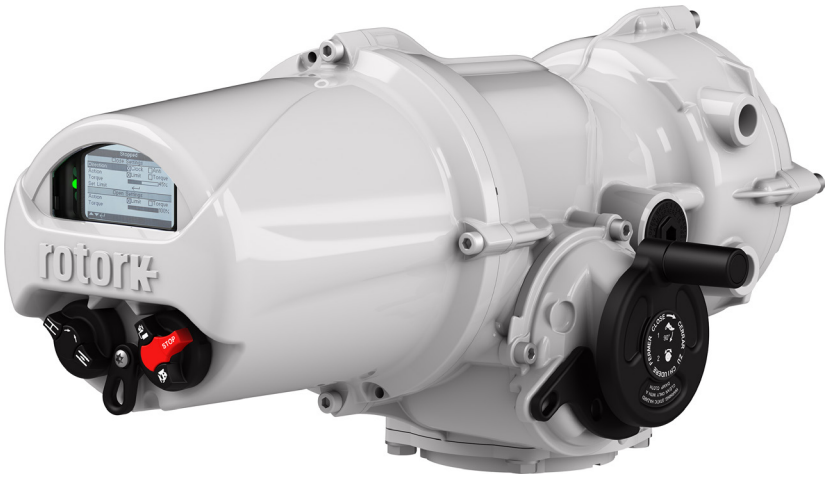

Figure 3. Rotork IQT Shutdown Battery.

sections of the pipelines in the event of an emergency. At a pipeline in southern India, Skilmatic actuators were installed to provide safety critical fail-safe duties. They were selected due to SIL3 certification requirements and their high torque output that allows them to work with large valves.

Fluid powered actuators are also often specified on pipelines because gas from the pipeline can sometimes be the only available motive power for the actuator. Actuators powered pneumatically or hydraulically often have fail-safe capability, high torque and thrust capacity and are fast acting. Spring-return pneumatic actuators provide a simple and reliable way of achieving a fail-safe action. Large actuators such as Rotork's GP range are often used in safety roles. For example, over 80 of these actuators were installed on a 1000 km Gas Authority of India Limited owned pipeline (the Kochi-Koottanad-Bangalore-Mangalore pipeline) to provide safety functionality. They control ball valves along the length of the pipeline, which carries natural gas. Fluid powered actuators are also often found within LNG applications. Actuators that convert gas into hydraulic pressure were installed on a cryogenic pipeline in northern Venezuela that transports gas and LNG between sites. These Rotork actuators provide control of ball valves along the pipeline and provide essential ESD functionality. Fluid power actuators are also found on peripheral systems, such as compressor stations that maintain a predictable pipeline flow and to preserve the pressure level in the network.

Safety control with battery options

The safety requirements for pipeline operations are clear. In the case of intermittent or unreliable power supplies, how can operators guarantee this essential safety function? The answer is battery powered flow control. Expensive external batteries can be used, but a better solution is an integral battery within an actuator. This is especially relevant in remote or unmanned sites. A solution that provides a fail-safe option and increased operational flexibility in these remote locations is Rotork's IQT part-turn Shutdown Battery. This was engineered to meet the requirement of continued operation after a power outage, if desired (until the battery charge runs out) or bringing the process to a safe stop if power cuts out. The Shutdown Battery offers the functionality of an IQT actuator, with the additional capability of fail-safe, fail-close, fail-open or stayput functions all on battery power when needed. Processes finish in a safe operating state, preventing any safety issues and avoiding monetary consequences due to loss of control after loss of power. Normal operation resumes once power is restored. An example of use would be a remote pipeline station that operates on solar energy and loses power temporarily. Operating in freezing conditions, this is the kind of engineering innovation that brings additional reliability to pipeline applications that require flow control. Because pipelines are increasingly found in these extreme or remote environments, it has been necessary for technology to swiftly evolve in this way to ensure continued effective and reliable actuation.

Pipeline monitoring

Flow control technology plays an important role in monitoring the health, efficiency and productivity of pipelines. The isolation of a break in a remote pipeline ensures a continuation of the efficiency and safety of pipeline operation.

Equipment such as an Electronic Line Break (ELB) from Rotork can be either be mounted on an actuator, or used remotely. This technology provides early detection of pipeline breaks (by continuously monitoring pipeline pressure dynamics) and initiates a movement of the actuator to a pre-defined emergency position. It quickly identifies and facilitates the isolation of a ruptured section of a pipeline, then sends data about the condition of the rest of the system. When used in conjunction with an actuator (usually fluid-powered, using pipeline gas as the motive power source), line break equipment can help to reduce damage to equipment and the environment as a result of a leak. Line break equipment overcomes operational challenges of transporting oil and gas over large distances. In the case of the ELB, detection is based on rate-of-drop (RoD) and rate-of-rise (RoR) as well as high and low-pressure limits. An example of use and benefits derived is a project where ELB units were combined with fluid power actuators on valves on a natural gas pipeline in China. The operators benefited from the ability to swiftly close the appropriate valves and isolate problems when they arise.

Conclusion

Pipelines are a key component of midstream oil and gas operations. For them to work effectively, they require flow control technology to operate valves. Actuators provide more than day-to-day control. They offer critical safety functionality and can shut down operations in an emergency. This is especially necessary in the remote and extreme landscapes pipelines often run through, which are often unmanned and inhospitable. The robust and reliable nature of the actuators on oil and gas pipelines means that operators can rely on them to provide efficient, safe and reliable flow control.