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PROCESS CONTROL GOES GREEN

OIL AND NATURAL GAS OPERATORS CAN HELP REDUCE METHANE AND OTHER EMISSIONS—AND INCREASE REVENUE—BY REPLACING TRADITIONAL PNEUMATIC DEVICES WITH ENERGY-RESPONSIBLE PNEUMATIC PRESSURE AND LEVEL CONTROL DEVICES.

BY JOHN MANGAN

An estimated $20 billion or more in revenue is lost each year globally due to methane emissions. Coupled with this lost revenue, global greenhouse gas emissions (GHG), of which methane comprises a substantial portion, have been gaining ever increasing visibility from a variety of agencies, special interest groups, national and international companies, politicians and the general public. It's clear that a substantial problem exists. Many companies, however, are looking to alleviate that problem by changing their methods of operations and sharing best practices with each other.

THE METHANE FACTOR

Countless studies have analyzed the net effects greenhouse gases have on our environment and have resulted in a diverse range of views on the subject. However, one accepted fact is that methane is the most potent of the global greenhouse gas (GHG) emissions. Each year significant amounts of methane—the primary constituent of natural gas—are emitted into the atmosphere. These emissions cause concern because of the increasing negative effects on the environment as a whole, as well as the large amounts of revenue lost as a result. The importance of reducing methane emissions cannot be understated; but with innovative technology and implementation of best practices, the entire world's industries can shift toward using more environmentally responsible products for process control functions. This shift in thinking will also result in cost savings and increased revenue.

Many owners and operators at oil and gas production, processing and transmission facilities have

Methane Burning From Factory

already taken initiatives to eliminate or reduce methane emissions. One shining example, which illustrates the widespread collaboration among companies, is the EPA Natural Gas STAR program. This program is a voluntary partnership between the U.S. Environmental Protection Agency and numerous natural gas companies, which provides a way to share best practices for reducing emissions among member companies. Currently, the program includes 23 of the top 25 natural gas producing companies which constitute 62% of the production, processing, transmission and distribution of natural gas. It also constitutes 62% of the production, processing, transmission and distribution of natural gas. As Figure 1 illustrates, in the 14 years since the program was established, more than 577 billion cubic feet of methane emissions, at a value of $3.4 billion, have been eliminated through voluntary initiatives by the member companies—initiatives that have also provided these companies cost savings and increased operational efficiency.[1]

This article provides examples of opportunities to reduce methane emissions in oil and natural gas applications, and highlights the significant cost savings that can be realized by implementing available technologies in the process control market. The primary methane emissions mitigation method discussed in this article is identification and replacement of high-bleed pneumatic pressure and level control devices.

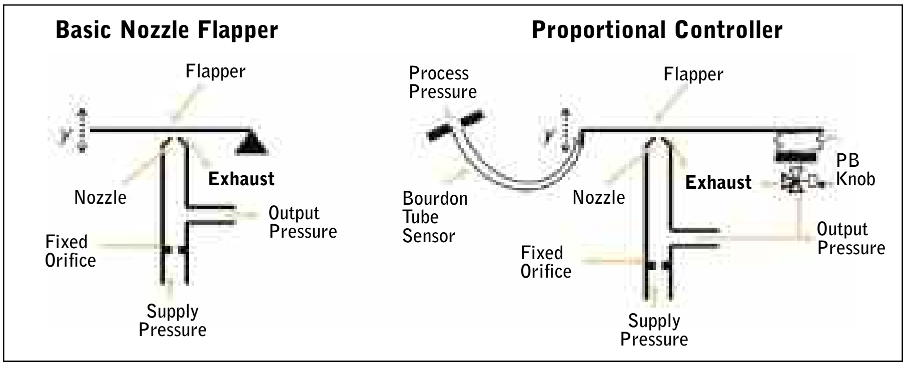


Figure 2. Design principles of pneumatic devices—basic nozzle flapper and proportional controller—are illustrated in the above diagram.

PNEUMATIC CONTROL DEVICE BASICS

Continuous bleed pneumatic controllers are used in the oil and natural gas industry to regulate level, flow-rate, temperature or pressure. Given the infrastructure for installing these devices, natural gas may be the only option for a supply medium in places where it is not possible, economical or convenient for installing compressed air systems.

Nearly all pneumatic devices use the same basic design principle, which consists of a nozzle-flapper mechanism (Figure 2, left) that executes throttling control and exhibits continuous or intermittent bleed of the supply medium. Varying the separation between the flapper and nozzle alters the resistance to gas flow. Increasing the distance between the nozzle and the flapper reduces nozzle resistance and output pressure, while decreasing the distance has the opposite effect. In most pneumatic devices that use this concept, the inherent design of the nozzle flapper mechanism is the only reason the supply medium bleeds to the atmosphere.

Controllers that use a three-way valve for proportional band control also introduce another way for supply gas to bleed to the atmosphere (Figure 2, right). Some pneumatic controllers are designed to bleed only when the unit is in transient operation, or cycling, while others bleed both during steady-state conditions and transients. The steady-state bleed tends to dominate the emissions reduction focus; however, consumption during transients should not be underestimated because of the potentially significant effect on the total amount of gas consumed by the device.

Consumption from pneumatic devices depends on many factors, including the gas supply pressure, the type of controller, the frequency of cycle or activation, the pressure of the actuator supply, the bench set and travel. Higher requirements for supply and actuator operating pressures tend to increase the pneumatic consumption because the nozzle-flap-

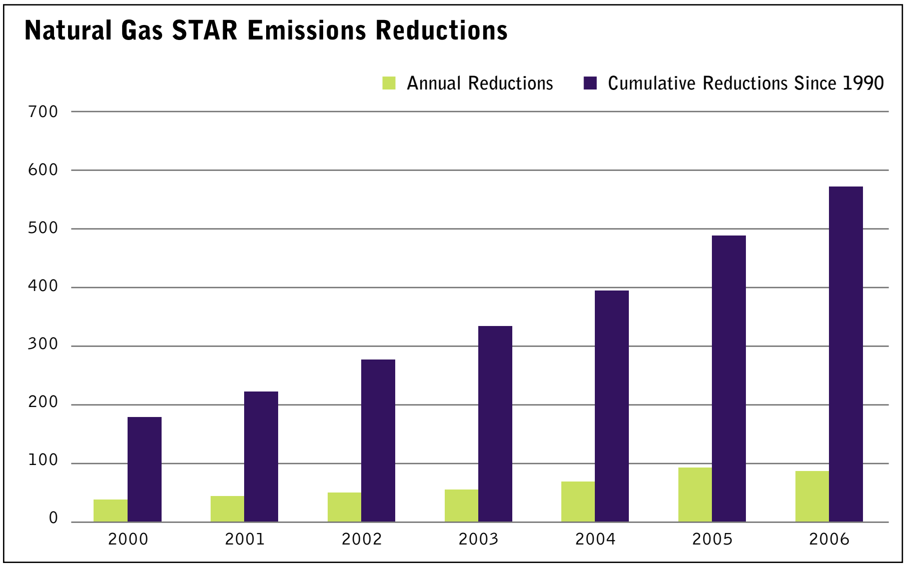


Figure 1. In the 14 years since the program was established, more than 577 billion cubic feet of methane emissions have been eliminated through voluntary initiatives by the member companies.

per design bleeds more gas at higher pressures. This is due to the presence of a higher pressure drop across the constant nozzle diameter. Frequent throttling cycles and transient controller operation also tend to result in higher bleed rates than controllers operating with less activation cycles that are primarily in steady state. Adjustments can be made to control loops where these devices are installed, including changing the proportional band settings to reduce the amount of bleed through the proportional band, three-way valve.

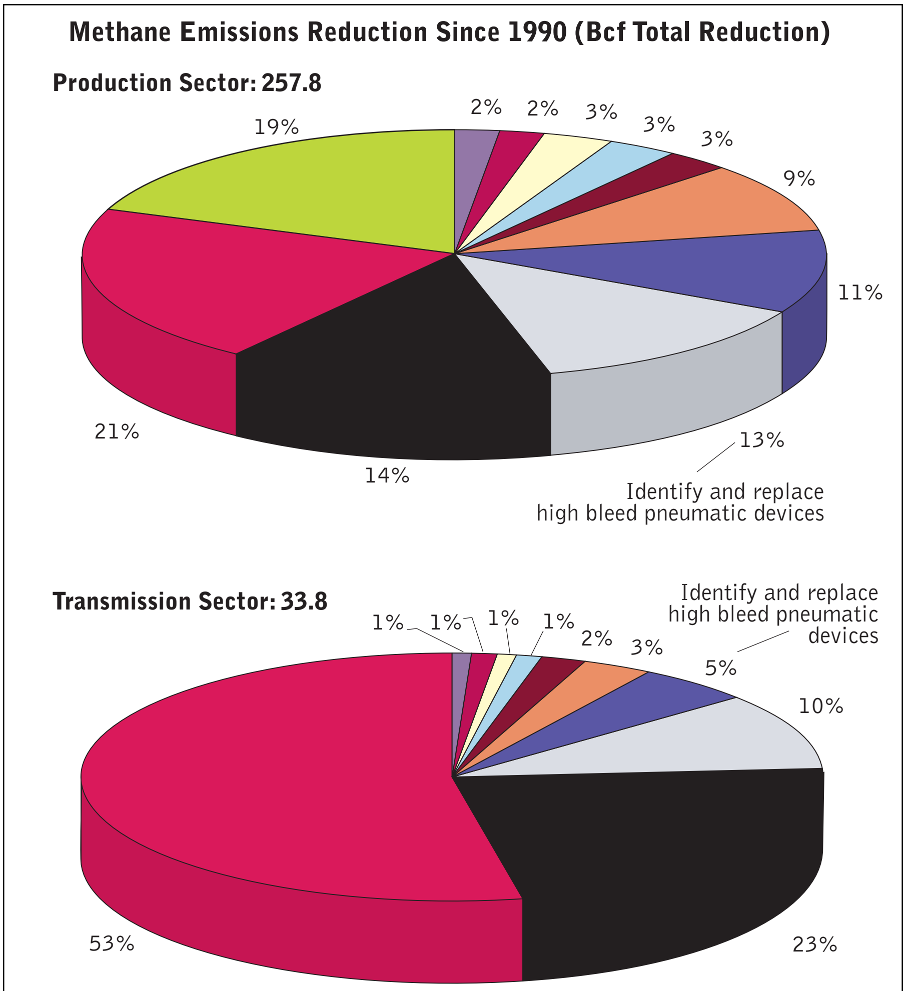
Changing actuator supply pressures and replacing springs in spring and diaphragm actuators when seat load requirements allow it, can also reduce the amount of pneumatic energy required, thus reducing consumption. High-stem packing friction can cause the actuation system to work harder than necessary, thus increasing the amount of bleed through the controlling instrument. Readjusting the packing flange nut torque value to meet the manufacturer's specifications can ensure optimal control valve assembly performance while maintaining stem seal integrity and reducing the amount of energy required to move the valve.

WHAT ABOUT RETROFIT KITS?

Sometimes, as a method of reducing consumption, users implement retrofit kits for the relay in pneumatic devices. These kits can be effective for reducing consumption through the relay component itself. However, often these modifications are performed without fully addressing how the particular relay will work with the rest of the device design. Incorrect matching of the relay can lead to performance issues, so the retrofit approach must be handled with concern for maintaining valve assembly operability and overall performance.

Many times, a retrofit kit is suitable for replacing the existing nozzle with a new design that has a smaller orifice through which the supply gas can bleed. However, there are trade-offs when using small-orifice nozzle designs. A negative side effect is the tendency for the orifice to plug, causing reduced performance or loss of process control. Another shortcoming is reduced controller response times and lack of being able to operate large actuators with high-volume requirements. In cases where fast stroke speeds are required and valve assemblies with large actuators are used, a small-orifice, low-bleed controller may not be an option. In these cases, a low-bleed device that incorporates modifications other than orifice diameter reduction should be considered, allowing a more reliable operation when complex pneumatic supply filtration can't be used. Such is the case with upstream oil and gas production and separation facilities.

Although compressed air standards have improved over the years, and air filtration of five microns is achievable, not all installations that use natural gas have systems in place to filter the pneumatic supply sufficiently to avoid operational and performance issues with pneumatic controllers that use small-orifice, low-bleed nozzles. Clearly, many options exist for reducing the amount of pneumatic consumption in a typical control loop. Many of these methods and practices have been available for some time, but it's important to consider those prod-



SOURCE: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2005, April 2007

Figures 3 (top) and 4. Since 1990, identifying and replacing high-bleed pneumatic devices accounted for 13% of total reductions in the production sector and 5% of the reductions in the transmission sector.

ucts that can significantly reduce pneumatic consumption while providing no compromise in performance or operational ability. The numerous issues to consider when evaluating options for reducing gas consumption in pneumatic devices should not deter efforts to find ways to reduce pneumatic consumption and methane emissions because such efforts can quickly pay for themselves.

ASSESSING REDUCED EMISSIONS OPPORTUNITIES

A shared best practice by EPA Natural Gas STAR partners is identifying and replacing high-bleed pneumatic devices. Use of such devices is prevalent in the oil and gas production, processing, transmission and distribution sectors. According to EPA estimates, 57 Bcf of methane emissions in 2005 were attributed to these devices in the oil and natural gas production industry, which accounts for nearly 40% of all methane emissions in the production sector. Pneumatic devices installed in gas transmission equipment make up a lower proportion of the overall methane emissions in this area of the gas industry, but still are a significant 11%, roughly 10 Bcf in 2005.[2]

Estimates are that, in the production sector, approximately 180,000 to 250,000 pneumatic devices are used for monitoring and controlling liquid levels and flows; gas levels and flows in scrubbers, separators, dehydrators; and control of pressure in flash tanks. This sector represents the largest amount of pneumatic devices and offers the most opportunity for emissions reduction.[3]

In the natural gas transmission sector, there are more than 100,000 pneumatic devices. Most natural gas compressions are done to get the gas ready for transportation from one point to another. Mature and low-pressure gas wells require compression for transporting produced gas into higher pressure pipelines or gas-gathering stations. During the natural gas production cycle, compression typically is required several times including at the wellhead itself as well as at many other facilities along the way, such as gathering and distribution stations, processing and storage facilities and in long-distance pipelines. These significant levels of compression requirements in moving natural gas translates into large numbers of pneumatic devices needed to operate isolation valves and regulate pressure and flow at compressor stations, pipelines and storage facilities. Most pneumatic devices operate isolation valves and regulate gas pressure and flow at compressor stations, pipelines and storage facilities. Metering runs at distribution and gate stations also use pneumatic devices for regulating flow and pressure.[3]

Given the high percentage of methane emissions from pneumatic devices in the natural gas industry, it is clear there is a need for emphasis on emissions reductions here. Although these devices represent the largest contribution to overall methane emissions, they also represent the highest potential for emissions reduction through increasingly available technology from control device manufacturers.

CAPITALIZING ON THE OPPORTUNITY

The potential for future methane emission mitigation is evidenced by the reductions already achieved in recent years by the natural gas industry. Since 1990, identifying and replacing high-bleed pneumatic devices accounted for 13% of total reductions in the production sector, which is equal to 33.5 Bcf, and for 5% of the reductions in the transmission sector (Figures 3 and 4). In 2006 alone, more than 3.2 Bcf of methane emissions were eliminated, equaling $22.5 million in market value at a price of $7/MCF.[1]

This practice has been gaining in popularity—proving to be an investment that results in very brief payback periods. In "Technology drives methane emissions down, profit up," *Oil and Gas Journal, Aug. 13, 2007*, Gillis, Waltzer, Heath, Ravishankar and Cormack note that typical payback periods for installing low-pneumatic consumption devices are 3 to 8 months. Costs of replacing high-pneumatic consumption pressure controllers vary by manufacturer but typically range from $700 to $3,000 per device, with incremental costs of low-bleed devices in the $150 to $250 range. Savings through reduced gas consumption pays for replacement costs in very short periods of time. Figure 5 shows typical bleed rates for a traditional pneumatic controller versus a new generation low-bleed pneumatic controller, as well as expected gas and cost savings annually through use of that low-bleed device.

The annual operational savings can be calculated using the following formula:

Difference in pneumatic consumption (scfh) × Price of Natural Gas ($/1,000scf) × 8,760 hours/year = Annual Gas Savings.[4]

For example, consider a gas separator system with pressure controllers on three separators and a filter/coalescer. Existing pneumatic pressure controllers can bleed as much as 40 scfh for this application with 35 psi supply pressure and a 6 to 30 psi output configuration. With new low-bleed models, this consumption can be reduced by a factor of nearly 10 for the same application. If the existing devices are replaced at or near the end of their economic lives, they pay for themselves in a relatively short time. At a purchase price of $1,500 and a reduction in pneumatic consumption of 36 scfh, the new low-bleed controllers pay for themselves in less than 9 months at $7.00/Mscf.

Although bleed rates from installed traditional pneumatic controllers vary depending upon the supply pressure, output range and selected proportional band, results similar to these can be achieved in most cases. Over longer periods of operation, such as a 15-year time frame, the total amount of gas savings between the high-bleed and low-bleed devices in a separator system with three pressure controllers amounts to more than 14,191 Mscf, or $99,338 at

$7.00/Mscf. This brief illustration shows the potential to reduce emissions and realize cost savings. The longer the time frame used in the assessment, the more lucrative the long-term opportunity to save substantial amounts of money over the life cycle of the device. (Find more details on shared practices at epa.gov/gasstar/techprac.htm.)

ACHIEVING FURTHER REDUCTIONS

Control valve positioners, which come in many varieties, provide another opportunity to reduce emissions through lower pneumatic consumption. For typical electro-pneumatic positioners, this can be achieved by selecting a low-bleed relay from the manufacturer. For example, using a low-bleed relay in place of the standard relay in a control valve positioner can reduce steady-state consumption from 14 scfh to approximately 2 scfh, with 20 psig supply pressure. This prevents 105 Mscf from bleeding to the atmosphere, and at $7.00/Mscf, would save $736 a year. Over a 15-year time frame, the cost savings amounts to $11,038. Although low-bleed relays sometimes cannot be used in control valve assemblies with high-volume requirements, they are a viable option in most control valve applications.

Electro-pneumatic current to pressure (I/P) transducers are another opportunity for pneumatic device use to reduce emissions and gas consumption. Many of the pneumatic transducers currently installed in the oil and gas and other industries are considered high-bleed devices, but they can be replaced by newer, improved designs that use far less pneumatic supply than their predecessors. Using a low-bleed relay or a new I/P transducer to replace an existing unit can be an inexpensive way in a process control loop on hydrocarbon separators, dehydrators and compressors to reduce bleed of natural gas or compressed air. New generation I/P transducers offer significant reduction in supply gas consumption over traditional transducers, with reductions on the order of 1/5 of the consumption of the traditional device. Besides the potential for reduced gas consumption, some new generation electro-pneumatic devices also allow safe installation in natural gas supply applications without the need for external conduit seals. Along with the obvious operational savings a low-bleed transducer can provide, there are instant savings of more than $100 per unit that normally would have been spent on external conduit seals.[5]

Annual Gas Savings in U.S. Dollars

Model	Supply Press (psig)	Air Consumption (scfm)	Equivalent Natural Gas Consumption [1](scfm)	Annual Operational Cost (US$) (Nat. Gas)	Annual Savings (US$)
Natural Gas ($US/mscf)				$7.00	
Traditional controller	20	0.3833	0.49	$1,803	
New low bleed controller	20	0.0417	0.05	$184	$1,619
Traditional controller	35	0.5500	0.71	$2,612	
New low bleed controller	35	0.0667	0.09	$331	$2,281

1. Conversion factor used: 1.29 times air volume

Figure 5. Shown above are typical bleed rates for a traditional pneumatic controller versus a new generation low-bleed pneumatic controller, as well as anticipated gas and cost savings annually through use of that low-bleed device.

LOW-EMISSIONS PACKING

While it's clear there is potential for increased revenues via replacement of existing high-bleed pneumatic devices, there are also other environmentally responsible products and best practices that can improve operational efficiency in systems that use control valves. Retrofitting existing control valves with high-quality, low-emissions packing, for example, can have a significant effect of reducing emissions of volatile or toxic process fluids. As mentioned previously, it is important to ensure that torque values on control valve packing systems are within the valve and packing manufacturers' specifications. Unfortunately, a common practice is to tighten packing systems regularly, leading to potentially very-high-stem friction values and undesirable performance. Live-loaded packing systems can reduce the need for routine confirmation of packing torque values since these systems are designed to always provide optimal packing ring load and steam seal capability. Still, periodic verification of appropriate load is encouraged.

Depending upon the specific packing system, ongoing benefits include: longer intervals between maintenance; reduced valve stem friction, which leads to improved process reliability and reduced variability; and longer life expectancy. When a control valve positioner is coupled with cycle-counting ability, maintenance personnel can track total cycles on the packing system and use historical maintenance data to predict what and when the next maintenance procedure should be. This can take some of the guesswork out of control valve packing maintenance and prevent premature replacement of packing systems, or use of packing systems beyond expected life expectancy.

THE TECHNOLOGIES ARE AVAILABLE

The opportunity for increased revenue through methane emission mitigation initiatives is significant. Many technologies are currently available that allow operators in the oil and natural gas industry to prevent further release of methane to the atmosphere while saving money by implementing environmentally responsible products. With the high number of pneumatic devices currently in operation globally and the high percentage of total methane emissions these devices contribute, identifying and replacing them presents a significant opportunity savings, which means increased amounts of gas delivered to the market. The availability of a broad range of environmentally responsible products complements the efforts of the oil and natural gas industry to continue to meet the world's energy demands in an environmentally responsible manner. **VM**

JOHN MANGAN is an engineer at Emerson Process Management, Fisher division (www.emersonprocess.com), Marshalltown, IA. Since receiving a BS in Mechanical Engineering from Iowa State University, he has been employed at Emerson evaluating process control applications in the oil and gas industry. Reach him at John.Mangan@emersonprocess.com.

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2. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2005, April 2007.
3. Options for reducing methane emissions from pneumatic devices in the natural gas industry, EPA Natural Gas STAR partners implementations workshop, October 2007, Houston, TX.
4. "Pneumatic Instrument Gas Bleed Reduction Strategy and Practical Application," by Mark Adams, Fisher Controls International, Division of Emerson Process Management, 1995.
5. Throughout this article the primary focus has been the potential cost savings and emissions reduced with regard to natural gas consumption; however, the effects of reducing consumption of compressed air can also be significant and should not be overlooked.