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VRU

Compressor Market Thriving



■ Paul Ramirez, a HY-BON technician, performs an inspection with an FLIR infrared camera, looking for leaks that are invisible to the naked eye.

Rush to comply with EPA's Quad O has industry in catch-up mode

BY NORM SHADE

The vapor recovery compressor market is currently one of the largest growth areas for gas compressors in the U.S. Many packagers and manufacturers are active in the market and several companies have made it a core part of their business.

The vapor recovery unit (VRU) boom is a result of the U.S. Environmental Protection Agency's New Source Performance Standards (NSPS) detailed in 40 CFR, Part 60, Subpart OOOO, commonly referred to as "Quad O."

These regulations went into effect in August 2012. They include a requirement to limit volatile organic compound (VOC) emissions to less than 6 tpy (5.4 T/yr) from crude oil, condensate, produced water, and other unrefined petroleum liquids storage tanks.

Operators of storage tanks found to emit more than 6 tpy (5.4 T/yr) must apply controls to reduce emissions by at least 95% or demonstrate that emissions have dropped to less than 4 tpy (3.6 T/yr) without emissions controls for 12 consecutive months.

"Although 6 tpy sounds like a lot, daily equivalents could be as low as 33 lb. [15 kg] or 1 Mcf [28 m³] of emission, 1 bbl of condensate produced, 20 bbl of oil produced or 200 bbl of water with 1% oil carryover processed," said Jeff Voorhis of HY-BON

Engineering, a long-time provider of VRU equipment.

Quad O required that VOC emissions from tanks constructed between Aug. 23, 2011 and April 12, 2013 had to be estimated by Oct. 15, 2013. Controls have to be applied to tanks found to have potential VOC emissions of 6 tpy or more to bring them into compliance by April 15, 2015. The EPA estimates that there are 20,000 affected storage tanks in this category.

The situation is more urgent for tanks coming online after April 12, 2013. They have to be in compliance

with Quad O within 60 days after start-up or April 15, 2014, whichever is later. Within 30 days of start-up, the tank emissions potential must be estimated to determine whether they are subject to the rule. If the tank's potential VOC emissions are 6 tpy or more, they must be brought into control within an additional 30 days. With strong domestic oil and rich gas drilling activity, the EPA estimates that nearly 1000 new tanks are added each month.

Several states, led by Colorado, are imposing even more stringent VOC

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■ The HY-BON standard VRU package in the foreground recovers vapors from a multiple oil storage tank battery at an Eagle Ford Shale site in south Texas.

and methane monitoring and control requirements for oil and gas infrastructure including tanks, wells, pipelines and compressor stations.

Rush to comply

Over the past three years or so, the EPA has progressed from asking producers and midstream companies to monitor VOC emissions to requiring them to recover 95% of VOC emissions if they exceed 6 tpy as found. Some companies decided to get ahead of the regulations, but many waited until the last minute in order to see exactly what the EPA and the state agencies would require.

"This has created a rush to purchase equipment," said Vickie Gage-Tims of OTA Compression LLC, another provider of VRU equipment. "Since the original compliance date of August 2012, OTA has increased its VRU production capabilities by more than 500% to accommodate demand. We have positioned OTA to play a major role in closing the industry's VRU gap."

Voorhis said, "Over 90% of the tanks we measure are over 6 tpy. The tanks are chosen by the client or measurement. Most companies don't know that they have a problem, and the vast majority of the world's petroleum storage tanks have not been direct measured."

HY-BON and OTA said that they provide services that ensure that clients have identified their affected facilities and have reliable data and properly sized equipment to achieve compliance ahead of deadlines.

Control options

Capture is the only way to reduce emissions because liquids in tanks constantly emit vapors, and they must be vented when they build to a certain level. Historically, those vapors went into the atmosphere or were flared.

There are several options for reducing the VOC emissions from tanks. The simplest approach is simply to flare the gas. However, flaring calls public attention to the emissions coming off the tanks, and although the products of combustion are well within compliance with environmental regulations,



■ This OTA 24NG VRU is designed for locations without access to electricity. The package includes OTA's KS40 reciprocating compressor driven by a 23.5 hp (17.5 kW) Kubota gas engine and is equipped with a Murphy Centurion control panel.

there may be objectionable smoke, odor or other issues when flares are not properly applied and maintained.

A vapor combustion unit (VCU) often is a better alternative to flaring. Connecting the tank vents to an enclosed

VCU can typically provide more than 99% reduction in emissions compared to venting the gas directly to the atmosphere. The VCU burner design and enclosed combustion keep the flame out of sight and eliminate many of the objectionable aspects of flaring. Most VCUs have modern ignition systems and safety features, including insulation for safe external surface temperatures, and proper sizing for the required volumes.

"Enclosed VCUs are a good solution for reducing tank emissions when vapor recovery is not economically viable, or as a back-up for a VRU," Voorhis said. "For green production, the installation should include VCUs or emergency flares for when VRUs are down."

VCUs and flares consume the hydrocarbons from the tanks and no revenue is gained from them. Use of a vapor recovery tower (VRT) is an efficient way to reduce tank emissions and capture more liquid product for sales.

The VRT is a tall pressure vessel that is installed between the production separator and the liquid storage tanks. It creates a closed system operating at around 1 psig (0.07 bar) that retains the liquid for typically about 30 minutes and collects the flash gas from the liquid without the potential for vapor leakage from open or leaking hatches or vents.

A VRT may reduce storage tank emissions to less than 6 tpy, exempting the tank battery from Quad O reporting requirements. In most installations, the



■ Vilter's standard VRU package features twin 15 hp (11.2 kW) hermetically sealed Copeland scroll compressors with VFD.



■ This HY-BON standard oil flooded screw compressor VRU package collects vapors from a tank battery in the Permian Basin in West Texas.

enue of more than US\$200,000 that resulted in an 180% return on investment and multiple intangible benefits. “This equipment can pay off in a matter of months, and then you’ve got another revenue stream,” Gage-Tims said. “So, while this first appears as something that you’re being forced to do and is costing more money, it’s dawning on a lot of people that this is lost profit being recovered.”

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flash gas from the liquids in the VRT flows to a VRU for compression into a sales gas line.

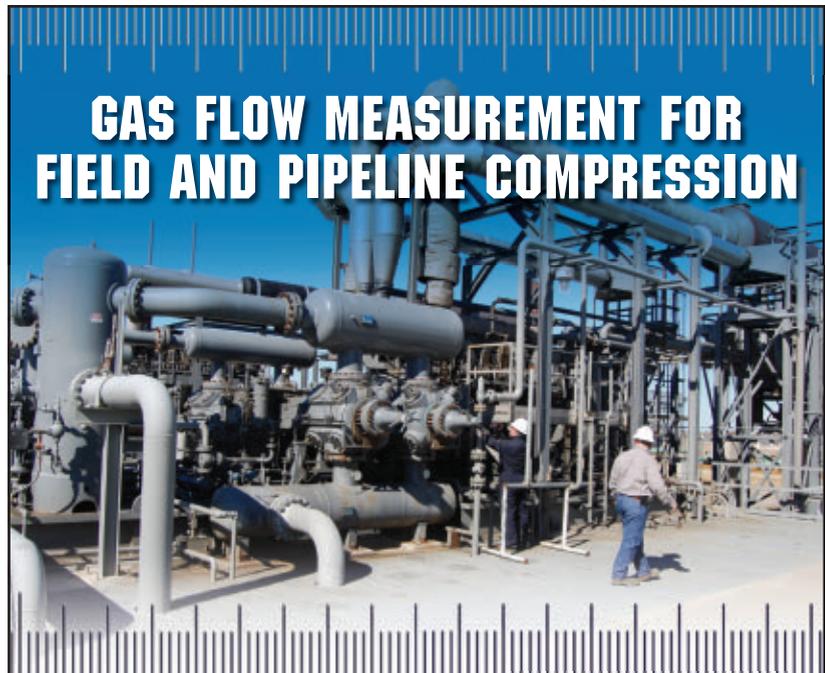
VRUs are commonly used without VRTs, connecting directly to the storage tank vents with a proper control system that keeps the tank pressure within preset ranges slightly above atmospheric pressure to maintain a blanket of gas on the tank liquid to prevent oxygen entry.

Of course, use of a VRU is only possible when there is a relatively low-pressure sales line to receive the gas from the VRU. Typically, there are sales lines available. However, some fields, such as in the Bakken Shale area of North Dakota, often lack infrastructure. In those cases, flares or VCUs are the only options, and a valuable hydrocarbon resource is wasted.

VRUs are usually compressors, but there are other technologies in use, such as slipstream or eductor systems. When the EPA began proposing VOC regulations, they contended that VRUs would pay for themselves in revenue gains. A 2007 EPA Natural Gas Star workshop presented case studies by Anadarko and Occidental that showed payback time of just a few months.

“If the volume of vented gas is above 15 Mcfd [425 m³/d] — or about 90 tpy [81.6 T/yr] of VOC emissions — and a gas sales line is available, then a VRU has the potential to be profitable,” Voorhis said. “Why burn it when you can make money?”

OTA cited an example of a VRU that services four wells with a common tank battery recovering 48 Mcfd (1.36 x 10³ m³/d) of 1704 Btu (429 Kcal) vapor providing incremental annual rev-



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■ HY-BON builds, repairs and packages rotary vane, reciprocating and screw compressor VRU packages. Low-maintenance, standard units are staged and ready for immediate delivery for new tank vapor recovery applications.

She added that VRUs are particularly profitable in an oil-rich area like the Permian Basin of West Texas, because the VOCs there are richer in profitable natural gas liquids (NGLs). In a dry-gas region the VOCs are likely to be mostly methane, which currently sells for much less.

Not only does the value of the recovered gas depend on the hydrocarbon content of gas, but also it depends on how the recovered gas is used. If it is used on-site as fuel, it is valued in terms of fuel that is replaced. If it is fed into a natural gas pipeline, its value is measured by the higher price for the rich (higher energy content) gas delivered to the gas processing plant and the value of natural gas liquids and methane that can be separated.

Devon Energy reported that it has turned Quad O compliance into a moneymaking proposition in its Cana Woodford Shale operations in western Oklahoma. Devon uses VRUs to compress gas so that it can be fed into a pipeline and sold. This is gas that would be burned or was previously allowed to vent.

When possible, Devon connects four well pads to a single tank battery equipped with a VRU system. Devon officials said that 99.86% of the emissions from its Cana Woodford storage tanks are being captured since adding VRUs.

Assessments

Testing is the first step in assessing whether vapor emissions from a tank exceed the 6 tpy limit. Although infrared imaging of plumes coming from tanks is a good indicator that emissions are escaping to the atmosphere, it is not a quantitative measurement. An ultrasonic, thermal mass flow or other accurate flow meter must be used to quantify the leakage. Before measurements are made, it's important to look for and fix any leaks in tanks and piping.

"If there are leaks in the plumbing, an accurate test cannot be achieved," Gage-Tims said. "Furthermore, it is not uncommon for Texas Commission on Environmental Quality (TCEQ) regional air inspectors to get involved on vapor tests. If they notice significant leaks, they have the authority to stop the testing until vapors can be shown to be coming from the single emission point where the measurements are being captured."

Off-gassing from liquids increases as the ambient temperature rises, and also changes with production flow rates, so it is important to define an appropriate measurement test time period.

"It follows that winter emissions would be lower than summer emissions when using a direct measurement method," Gage-Tims said. "TCEQ's latest revision of the Air Permit Reference Guide 5942 states that direct measurements should not occur in the winter or early

spring, and some regional offices are not allowing them during these periods. Therefore, alternatives to direct measurement must be utilized. Simulation testing is often the best alternative, especially considering that the 30-day compliance period may fall in cold winter seasons."

HY-BON offers an identify, quantify, rectify (IQR) direct measurement service to provide an accurate rendering of vented gas off of storage tank facilities. The service begins with an optical gas imaging (OGI) survey that identifies component leaks, followed by a comprehensive inspection of thief hatches and vent valves. This insures the integrity of the measurement and identifies tank battery maintenance opportunities.

High-quality custody transfer-type meters are used for a 24-hour measurement of the "off gas" from a storage tank facility. If all tanks share a common vent manifold, a single test may be adequate. However, if vents are separate, then each tank vent line requires a separate measurement test.

Gas samples are taken inside the top of the storage tank at atmospheric pressure. An accurate extended gas analysis through C10+ is used in the calculation of VOC tpy, which determines the applicability of the Quad O regulation. The data is delivered in a full report that captures all pertinent details for reporting purposes and identifies opportuni-

ties for economical application of vapor recovery equipment.

"HY-BON can provide a complete offering of solutions designed to address the EPA Quad O regulations while potentially returning profits to the bottom line," Voorhis said.

Gage-Tims said, "OTA provides both direct measurement or simulation testing and allows the client to decide which method to perform. Both are approved methodologies by the EPA and state departments of environmental quality to calculate the potential to emit. By actually metering the real-time flow of vapors for 24 hours, OTA is able to see the peaks and valleys of the emission volume. This permits sizing the control device to effectively handle the dynamic nature of the produced liquids."

Simulation involves the extraction of oil and/or water straight from the final separator for analysis. Tank emissions are then estimated using software that simulates working, breathing, and flash (WBF) losses from storage vessels.

Whether determined from direct measurement or simulation, the results can be used to select an appropriate VRU or other emissions control option that best fits the required operating parameters for compliance and economic return.

VRU providers

Most North American compressor packagers have supplied VRUs at some point, but several companies make it a core business.

Midland, Texas-based HY-BON claims to have coined the term "VRU" in 1952 when the company's founder designed a small compressor package specifically to capture natural gas emissions with high levels of hydrogen sulfide from oilfield storage tanks. It has focused its business on vapor recovery ever since.

HY-BON said that, with units operating in over 30 countries, it has more VRU installations than any other company. Its units range from small tabletop packages for minute gas streams

to much larger packages for higher flow rates.

A typical HY-BON standard VRU includes an ASME 125 psig (8.6 bar) MAWP suction scrubber, an oil flooded screw compressor designed for wet gas service, a weatherproof electric motor with starter and VFD, a Class I, Div. II, Group D PLC control panel with standard built-in safety shutdowns, an automatic recycle for capacity control, an oilfield-type skid and a heat exchanger for compressor oil cooling.

Typical units cover suction pressure ranges from 0 to 15 psig (0 to 1.03 bar) and discharge pressures from 30 to 175 psig (2.07 to 12.07 bar). Packages with small reciprocating compressors and EPA-certified natural gas engine drivers are also available for special applications.

"The selection of compressor and driver is an engineering question that depends on gas analysis, flow volume and pressure. HY-BON offers a 'Total Solutions Approach' in vent gas

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■ This standard zero-emissions GTO-20E package is OTA Compression's top-selling VRU. It features the company's proprietary KS40 reciprocating compressor driven by a 20 hp (14.9 kW) electric motor equipped with a VFD.

management," Voorhis said. "Our experience and engineering capability allow us to provide the best fit for any specific situation, whether that is a standard or custom VRU, a VCU, a VRT or systems incorporating all these technologies."

HY-BON builds, repairs and packages rotary vane, reciprocating and screw compressor VRU packages. Standard units are stocked for immediate delivery for new tank vapor recovery applications.

Jordan Technologies of Louisville, Kentucky, has been in the VRU and VCU manufacturing and service business since 1980.

Other companies that have made the VRU niche a significant part of their business include, but are certainly not limited to, Compressco, Flogistix, Kingsly Compression, OTA Compression, S&R Compression, Tescorp, and UMC Automation & Compression.

Several companies — OTA, for one — began focusing on the fledgling vapor recovery market during the 2009 to 2010 downturn, when low natural gas prices drastically reduced the demand for wellhead gas compression equipment.

Irving, Texas-based OTA offers several standard and customizable compressor packages to choose from based on the specific application and the required performance, including natural gas engine or Class 1, Div. 2 electric motor driven packages.

OTA said the GTO-20E is their top selling VRU. It is a 20 hp (14.9 kW) electric package that utilizes OTA's proprietary KS40 reciprocating compressor that was designed specifically for vapor recovery applications. The package is equipped with a VFD and is capable of holding ounces of pressure on tanks to maximize the capture of emitted vapors. Depending on the application, the GTO-20E package can handle discharge pressure up to 150 psig (10.3 bar) and exceed 200 Mcfd (5.7×10^3 m³/d) in vapor recovery throughput.

The KS40 is a horizontally opposed, four-cylinder compressor, which OTA said is designed for a low initial cost, flexibility, ease of service and low maintenance. Specifications list flows up to 250 Mcfd (7.1×10^3 m³/d) and pressure ratios up to 15.0 with a speed range of 900 to 1800 rpm and a power rating of up to 40 hp (29.8 kW).

The KS40 has no piston rods or packing, eliminating leakage paths and maintenance. The patented horizontally opposed heads allow the compressor to evacuate liquids during operation and standby modes.

The GTO-20E package is a closed-loop compressor system that prevents the introduction of oxygen into the process whether running or in standby. Replacement parts can be found at most auto parts retailers.

This low-cost VRU package has a red and green light "tattletale" system to make it easy for operators to notice when an issue that needs to be addressed. These lights are attached to timers that allow operators to keep track of unit runtime and downtime hours to facilitate the operational reporting that is required through the new performance standard regulations.

One of the newest entrants in the VRU market is Vilter Manufacturing LLC, a unit of Emerson Climate Technologies. Tom Hoopes, director of hydrocarbon industry, said, "Emerson views the VRU as integral to the overall well pad automation program with significant benefits to the operator. The solution is pretty exciting on several levels."

The Vilter VRU features twin 15 hp (11.2 kW) hermetically sealed Copeland scroll compressors with VFD.

"These units provide extremely efficient operation and no VOC emissions," Hoopes said. Requiring only 1.5 gpm (5.7 L/min) of oil, the packages include a lube oil stabilizer vessel that maintains oil viscosity, while keeping oil carryover to less than 1 ppm.

"Vilter VRUs are very low dBA, require minimal maintenance, meet Class 1, Div 2, are light weight and capable of discharge pressures to 175 psig [12.1 bar] at 0 psig [0 bar] suction."

The standard Emerson ROC 800 series controller stores data that can infer the amount of recovered vapor and be monitored remotely. Vilter said that, depending on gas composition and energy content, with a 25 Mcfd (7.08×10^2 m³/d) vapor recovery rate, the payback time is about nine months. [CT2](#)