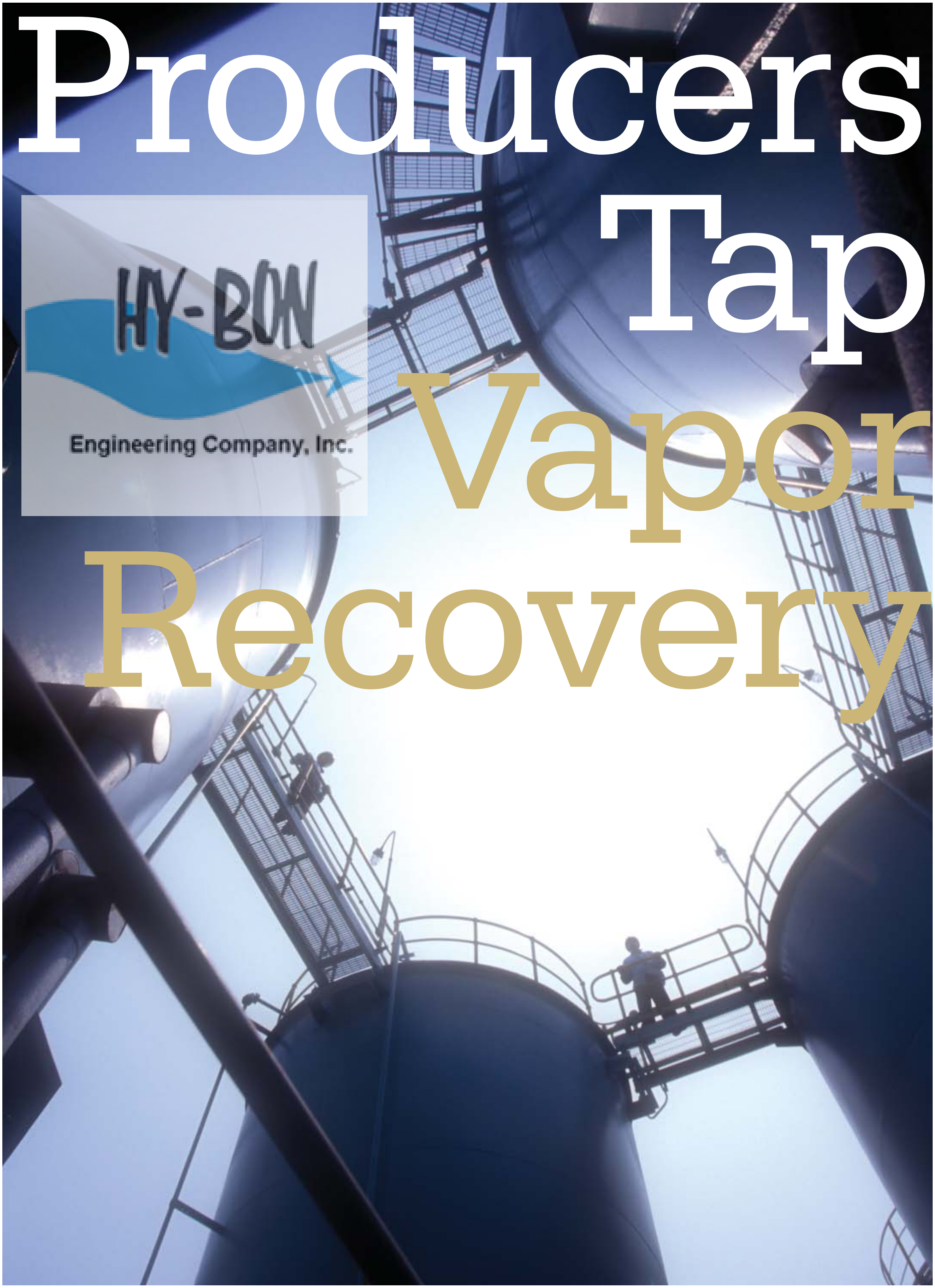
Producers Tap Vapor Recovery

HY-BON Engineering Company, Inc.



For High-Btu Gas, Additional Revenue Streams

By James Sidebottom and Larry S. Richards

MIDLAND, TX.–A trip through any producing area in North America or the world will illustrate that the majority of produced oil finds its way into bulk storage tanks at some point. What many producers do not know is that the gas that flashes off those tanks is some of the most valuable natural gas produced on the lease.

Besides being an environmental hazard and regulatory concern, these fugitive gas emissions usually average 2,500 Btu content, compared to typical pipeline gas at 1,000 Btu. On an per-million Btu contract basis, that makes this gas worth 2.5 times the value of normal produced gas. Additionally, the vapors contain varying amounts of methane, ethane, isopentane, propane and butane, which contribute to the API gravity of crude oil. Dissipation of these products to the atmosphere on a conventional tank battery means a reduction in gravity of the liquid in the tank, thereby decreasing its value.

The volume of natural gas produced depends on the volume of oil cycling through the tanks, the composition of the crude stream, the operating pressure of the separators dumping to the tank, the tank configuration, and seasonal daily temperatures. Vapor recovery units (VRUs) are designed to capture vapors and turn them into an additional income stream while minimizing regulatory and liability exposure.

Fugitive gas emissions typically average 2,500 Btu content compared to typical pipeline gas at 1,000 Btu, making the recovered gas 2.5 times more valuable on an MMBtu contract basis.

VRUs are designed to comply with EPA standards, provide additional profits to the oil producer, and eliminate the emission of stock tank vapors to the atmosphere. Today's stronger commodity prices make it even more advantageous to apply the technology. Many operators have not reviewed VRU payback economics since gas prices were in the range of $1.50 an Mcf and internal company economics were based on $0.75/Mcf gas. Technological advancements in vapor recovery, coupled with $6/Mcf gas prices, have many producers across the country scrambling to capture this unrealized revenue stream.

Straightforward Concept

The concept of vapor recovery is fairly straightforward. However, because of the extremely minute pressures involved, combined with compressing a very wet gas stream, vapor recovery is one of the most challenging and most misunderstood compression applications in the oil field. Proper compressor selection is critical, as well as several specific design elements on the skid. In addition, experienced VRU packagers can assist operators in avoiding several common installation errors that can cause headaches in the field.

In the system design, one or more tanks are manifolded to a common suction line and piped to the suction scrubber on the unit. An independent sensing line is run from the most active or farthest tank to the sensing unit on the VRU. This sensing line should be an independent connection to the tanks. The discharge piping from the VRU is connected to the gas gathering line, a meter run, or the suction of the field gas compressor. Condensates that fall out in the suction scrubber are generally piped back to the stock tanks.

The VRU is configured to stop and start automatically, depending on the pressure in the tanks. A properly designed VRU must include a bypass system that will initiate automatically and divert the discharge volume back to the suction scrubber. This process allows tank pressure to build back to the point at which compression occurs. If the pressure continues to decrease while in the bypass mode, the unit will shut down and wait in standby for the start pressure to be obtained.

Properly designed VRUs are also configured to shut down before any type of vacuum is reached to avoid pulling oxygen into the tanks, or imploding them. If air (oxygen) is pulled into the system, it is typically caused by an improperly designed package (no bypass system or improper pressure settings), improperly sealed tank hatches, or leaking relief valves. These units actuate on pressures as small as 0.5 inches of water column (0.019 psi), and most packages used in typical oil field compression are simply not able to calibrate to these minute pressures. With a correctly designed package, the addition of a properly designed gas blanketing system on the tanks can alleviate the majority of any other issues that could cause oxygen ingress.

The final critical design element is compressor selection. Either rotary screw or rotary vane compressors are strongly recommended in this application because of their ability to effectively handle wet gas. Reciprocating compressors are wonderful machines in dry gas applications, but they are not recommended for VRU service. The wet gas in this application tends to foul the valves and seats in reciprocating compressors, and condensate falls out in the crankcase and compromises the lubricating oil, resulting in component failure. Reciprocating compressors are outstanding machines in their niche, but VRU service is not that niche.

Technological Advances

Some producers have had mixed success with VRU installations during the infancy of the technology. However, several important technological advancements have been made that significantly improve the performance and reliability of VRUs.

One problematic area in the past was pressure sensors. Because of the extremely low operating pressures encountered when dealing with vapors, the early pressure-sensing devices were large and somewhat cumbersome pilot valves. These pilots typically utilized large rubber diaphragms, and weights and counterweights that responded to the fluctuations in pressures. These were essentially mechanical devices that utilized moving parts, which were subject to corrosion and fatigue.

Electronic transmitters have taken the place of pilots, and operate much more reliably at extremely low pressures. With essentially no moving parts, they are better suited for the application and require dramatically less maintenance. The accuracy of these devices is far better than pilot valves, and enables more finite control of the VRU to adapt to tank pressure fluctuations.

Vapor recovery units are designed to capture high-Btu content vapors that would otherwise be vented to the atmosphere, and turn them into a valuable revenue stream while simultaneously minimizing regulatory and liability exposures.

The compressor is a critical element in VRU system design. Rotary screw or rotary vane compressors are best suited to vapor recovery applications because of their ability to effectively handle wet gas. Shown here is a VRU installed on an offshore platform.

Another technological advancement has been the use of variable speed drives on electric-driven compressors. The new drives enable more turndown capability to respond to the daily variations in pressures in this application. The ability to slow or speed a compressor as a result of the changing conditions allows a much more flexible package. Tank volumes can change seasonally with changes in temperatures, or even daily with changes in production. Variations in pressures and volumes can even occur when the sun goes down or when a rainstorm cools the tanks. Varying the operating speed of the compressor–be it a rotary vane or a rotary screw–allows the VRU system to respond to these changes and continue to capture this valuable gas stream.

Other technological advancements range from extremely sophisticated control systems, to enhanced lubrication systems, to remote monitoring of the units using satellite communications. In addition, several niche products have been developed utilizing venturi jet designs to capture vapors utilizing either high-pressure water or high-pressure gas. The key for the operator is to determine the most cost-effective technical solution for capturing the gas stream, and then determine the level of sophistication and automation that best suits the company's budget.

Vapor Recovery Benefits

Vapor recovery technology is capable of providing three significant benefits. First, capturing vapor emissions dramatically reduces regulatory and liability exposure. Throughout the country, more regulatory agencies are responding to emissions issues with fines and other types of actions that can seriously affect a producer's profits.

Second, producers are faced with litigation in many areas rather than regulatory agency fines as a result of failing to capture vapors. These lawsuits can be dramatically more damaging than fines. In fact, producers have paid more than $300 million in lawsuit damages in the past two years alone for failing to capture fugitive emissions.

Third, at today's commodity prices, the payback economics of captured vapors are extremely compelling, with the full capital and installation costs of the units usually meeting full break-even payback in less than six months.

EQUATION 1

Economics of Vapor Recovery

$$\text{Gross revenue per year} = (Q \times P \times 365 \times B) + NGL$$

Q = Rate of vapor recovery (Mcf/d)
P = Price of natural gas
B = Btu adjustment (typically as high as 2.5)
NGL = Value of natural gas liquids

According to the Natural Gas STAR Partners, a voluntary partnership between the U.S. Environmental Protection Agency and the oil and natural gas industry, 26.6 billion cubic feet of gas is lost each year from crude oil storage tanks. That is a tremendous amount of unrealized revenue.

What are recovered vapors worth to the producer? The formula shown in Equation 1 can be used as a general rule of thumb for determining the value of vapor recovery. The most commonly forgotten factor in this formula is the value of natural gas liquids, which often can be more valuable than the commodity price of the vapors themselves. Many international operators capture this gas strictly for the condensate. In these cases, the vapors are typically used to supplement onsite fuel gas requirements.

The best way to demonstrate the potential economic value of vapor recovery, of course, is actual field results. In March 2004, two VRUs were installed in Hobbs, N.M., for a midsized independent on two stock tank batteries, each emitting 90 Mcf/d of 2,500 Btu/cubic foot tank vapors into a 45-psi sales line. Before installing the VRUs, the producer had been venting this vapor stream.

The capital expense associated with the installation was $48,000 ($24,000 for each unit, excluding operating and installation expenses). The gross monthly gas revenue after installing the VRUs at a realized gas price of $5 an Mcf (x 2.5 Btu adjustment x 90 Mcf/d x 30 days x 2 tanks) was $67,500, allowing payback of capital equipment costs in 21 days.

In another application by a large independent in North Texas in June 2004, a VRU was installed on a stock tank battery emitting 190 Mcf/d of 2,400 Btu/cubic foot tank vapors into a 50-

The combination of advancements in vapor recovery technology and strong natural gas prices are making VRU applications very economic, typically providing payback of capital equipment costs in less than six months.

psi sales line. Again, the vapors had been vented before installing the VRU. The capital expense of the VRU was $32,000, excluding operating and installation costs. In this case, the gross monthly gas revenue after installation at $5 an Mcf (x 2.4 Btu adjustment x 190 Mcf/d x 30 days) was $68,400, allowing payback in only 14 days.

Evaluating VRU Economics

The Natural Gas STAR Partners group offers excellent tools on its Web site to assist producers and engineers in evaluating the payback economics of a potential (or existing) vapor recovery project (www.ergweb.com/gasstar/analytical_tool/vaporrecovery.asp). This program allows an operator, producer or engineer to enter some basic parameters, including:

- Pressure of the vessel dumping to the tank;
- API gravity of the crude oil;
- Daily throughput in bbl/d; and
- Number of days of operation.

The program will estimate the capital equipment, operating and maintenance costs, or the user can enter his own values. The next step is to enter general economic values, with the flexibility to accept industry values or enter values based on the user company's specific conditions and contract terms. After entering these values, the program calculates evaluation criteria such as gas emission reduction, net present values, payback, and a simple return on investment, and charts the cumulative net cash flow. It must be noted that these values are based on discharge pressures of less than 50 psi, and may not always be updated by the EPA on a regular basis, so all pricing data should be confirmed with a reliable packager.

For decades, gas was seen as a nuisance, a byproduct in the production of oil. At prices of $6 an Mcf, however, that is certainly no longer the case. Flash gas from oil stock tanks may be one of the larger unrealized gas streams in the industry. Vapor recovery technology is a true win-win for producers, allowing them to capture a valuable and clean energy source (natural gas) while simultaneously improving air quality, and usually providing economic payback within less than six months.

Even so, VRUs are not a commodity. They require proper design and configuration to work properly. When evaluating a VRU project, operators should remember that success requires proper tank configuration, compressor selection and package design. However, when properly designed, VRUs provide reliable and dependable performance (averaging better than 95 percent run time) and require very little preventative maintenance. ❒

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