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VRUs Demonstrate Economic Value

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ANDREWS, TX.–As the natural gas market continues to grow at a record-breaking pace, vapor recovery has taken on a new significance in the oil and gas industry. For decades, vapor recovery was generally utilized for large gas streams, very large storage tanks, or even environmental purposes.

Today, however, natural gas is no longer an afterthought from the production of oil. In fact, natural gas has been driving U.S. drilling activity for the past decade, providing ever-increasing revenue streams for producers. This revenue potential, coupled with a strong need to supply an energy-hungry economy, has brought vapor recovery and compression into a whole new setting.

Vapor recovery units can become a highly profitable capital expense with minimal payback time, and they are proving very effective at increasing overall operating revenues. Many producers are only now evaluating the time of return on investment, and they are finding that the majority of small- to mid-range VRUs has a payback period of less than six months.

When crude oil is brought to the surface and processed, many of the dissolved lighter hydrocarbons and water are removed through a series of high- and low-pressure separators. At this point, the crude oil is flowed to one of more than 600,000 field storage tanks in the United States. The remaining hydrocarbons in the oil are emitted as vapors into the tank, where the vapors are then vented to the atmosphere, flared or recovered by vapor recovery units.

The volume of gas vapors that emit from a storage tank depends on many factors. Crude oils with an API gravity greater than 36 degrees will flash more hydrocarbon vapors, while heavier crudes with an API gravity of less than 36 degrees will flash a smaller amount. Frequently cycled oil will also allow for a greater number of active vapors to be recovered in relation to oil that remains stagnant in storage tanks for longer periods. Ambient and operating temperatures, along with the pressure of oil coming into the tank, also affect the volume of vapors on a respective storage tank.

Vapor recovery units can recover in excess of 95 percent of the hydrocarbon emissions that accumulate in storage tanks. The gas makeup of these vapors can vary, but methane will generally be the primary component, accounting for 40-60 percent of the total gas stream. Also, since the recovered vapors contain liquids, the Btu content is much higher than pipeline gas. Therefore, recovered vapors can generally be more valuable than methane alone, with a general Btu adjustment in excess of 2.0 per cubic foot.

VRU Design And Selection

The design and selection of a proper VRU for the required application is critical, although it's often seen as much more complex than it actually is. Compressor selection for the required application is one of the most critical areas of this process. The majority of small- to mid-range applications utilizes either a rotary vane or rotary screw compressor.

Rotary vane compressors are often viewed as one of the most cost-effective compressor designs on the market. The rotary vane compressor is best utilized when moving large volumes of gas with discharge pressures below 150 psi. The rotary vane is extremely efficient at these pressures and can also handle high concentrations of hydrogen sulfide very easily. This type of compressor also allows for much lower initial cost and future maintenance.

Although somewhat less versatile than a rotary vane, a rotary screw compressor operates great in a large-volume setting with pressures below 250 psi. The rotary screw can also handle wet gas very efficiently while providing excellent temperature control for controlling the fall-out of condensate.

The Natural Gas STAR Partners is a voluntary partnership between the U.S. Environmental Protection Agency and the oil and gas industry to find and apply cost-effective ways of reducing methane emis-

TABLE 1

Potential VRU Project Financial Analysis

Capacity (Mcf/d)	Installation & Capital Cost[1]	O&M ($/Year)	Value of Gas[2]	Time to Payback	Return on Investment[3]
25	27,530	5,500	43,500	<8 mos	395%
50	35,490	6,250	78,000	<6 mos	584%
100	42,770	7,500	156,000	<4 mos	972%
200	57,330	8,750	312,000	<3 mos	1,543%
500	80,080	12,480	780,000	<2 mos	2,737%

1 = Unit cost plus estimated installation costs. Actual costs vary depending on expenses for shipping, site preparation, supplemental equipment, etc.
2 = 95% of total gas recovered at $9/Mcf x ½ capacity x 365 days.
3 = Calculated for five years.

Vapor recovery units can recover more than 95 percent of the emissions that accumulate in crude oil storage tanks. The gas makeup of the vapors varies, but methane generally accounts for 40-60 percent of the total gas stream. Also, since the recovered vapors contain liquids, the Btu content is much higher than pipeline gas, making the recovered vapors more valuable than methane alone.

sions. This organization has reported that more than 26 billion cubic feet of gas are lost every year from crude storage tanks in the United States and Alaska alone. Placing a dollar amount on those tank vapors using an average gas price of $9 an Mcf and a typical 2.5 Btu adjustment for tank vapors shows that U.S. producers are losing almost $600 billion annually by failing to recover vapors.

This lost revenue stream could be utilized in a number of ways, including piping to natural gas gathering lines for sale at a premium as high-Btu natural gas, or utilized as a fuel to reduce overall costs for a variety of on-site operations. Table 1 provides an example of an economic analysis of a potential VRU application. In general, there are five steps for assessing potential VRU applications and economics:

- Identify possible locations for VRU installation;
- Determine the volume of vapors at the installation site;
- Calculate the value of the recovered vapors;
- Determine the cost of a VRU project for the application; and
- Evaluate the project's economics.

Bakken Shale Case Study

A field application from Houston-based Murex Petroleum Corp. demonstrates the potential revenue stream generated by small- to mid-range vapor recovery units. Murex is utilizing vapor recovery technologies in developing the Bakken formation in the North Dakota portion of the Williston Basin. As a key player in this emerging play, Murex is taking advantage of the rich gas stream that flashes from the tanks of a newly completed horizontal Bakken oil well.

The Bakken interval consists of an upper and sometimes a lower oil shale with a silty dolomite squeezed in between. This formation has been tested for hydrocarbon production in different ways throughout the exploration history of the Williston Basin. Completed as a "bail out" zone to deeper dry holes, the vertical tests of the interval were largely unsuccessful, with a good well producing a total of 40,000 barrels of oil. In the early 1990s, horizontal wells were drilled into the upper shale section. For the time and price of oil, these wells were expensive and economic recoveries were poor. Currently, operators are drilling extended-reach horizontal laterals into the silty geopressured section between the upper and lower shales.

Stimulation with massive hydraulic fractures carrying 500,000-1 million pounds of sand has enhanced producing rates to attract a large array of operators. New completions can yield relatively high initial producing rates (300-500 bbl/d) with sharp hyperbolic declines. The produced oil is 42 degree light sweet crude with gas-to-oil ratios of 800-1,000 cubic feet/barrel.

Solution gas entrained in the oil stream is an obvious source of revenue where gathering infrastructure exists, but the volume of flash gas that is vented from the production facility usually goes unnoticed. PVT analysis of Bakken oil indicates 40 cubic feet of flash gas per barrel of oil that is liberated from separator pressure of 40 psi down to atmospheric pressure. A well producing 300 bbl/d would yield 12,000 cubic feet a day of tank vapors. This is the last gas to be liberated from the oil stream and contains a large amount of heavy gases.

The rich gas stream from Bakken crude has a Btu content of 1,850 MMBtu/Mcf. For a well that produces 50,000

Murex Petroleum Corp. is using vapor recovery technology in developing horizontal Bakken oil wells in the Williston Basin to capture the rich gas streams that flash from the tanks of newly completed Bakken wells. The company has additional VRU installations that recover gas vapors from sour oil wells with high H_2S content.

barrels of oil in the first year, 2 MMcf of tank vapors will be gathered. If the vapors recovered from this well receive an $8.00/MMBtu gas price with a Btu factor of 1.850, the additional revenue realized from the VRU is $29,600. This amount equals the compression equipment and installation.

For that same well with 300,000 barrels of estimated ultimate oil recovery, 12 MMcf of vapors will be gathered over the life of the well. Again, at $8.00/MMBtu, the VRU would generate $180,000 of net revenue. This gives a six-to-one return on capital over the life of the well.

Additional Benefits

Capturing a lost revenue stream is the purpose of most VRU installations. There are other benefits that can be realized from the installation. Murex Petroleum has additional VRU installations that recover vapors off sour oil wells. These vapors are high in H_2S gas, and as such, pose a significant health and safety risk to contract personnel.

The EPA regulates well sites such as these, and in some cases, mandates this type of VRU remediation. The economics of these types of installations cannot be justified on tank vapor recovery alone. The volume of vapors gathered is low enough that the economic value of the vapors would not pay for the installation of the VRU.

A solution that has been employed in an attempt to gain additional economic benefit from the compressor is to tie the casinghead into the recovery unit and pull the casing down to atmospheric pressure along with the tanks. This gives 20-30 psi of additional drawdown on the formation face, and yields sufficient volumes of oil in some wells to pay for the installation. Considering today's commodity prices, a 1 bbl/d increase in oil production can pay out the installation in 12 months.

VRUs also have a positive environmental impact by eliminating emissions of volatile organic compounds (VOCs) at the installation site. This allows for operators to reduce their emissions to below actionable levels as specified in Title V of the Clean Air Act. By capturing methane, VRUs also reduce the emissions of a potent greenhouse gas.

State and local oil and gas regulators are becoming more aggressive in regulating the venting or flaring of a commercial product. The regulations will continue to increase as the long-term economic value of natural gas increases. ❒

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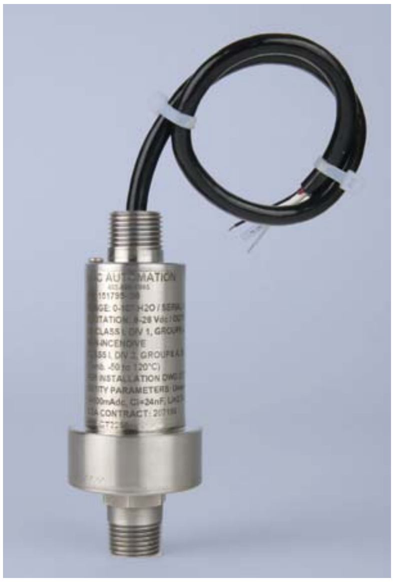

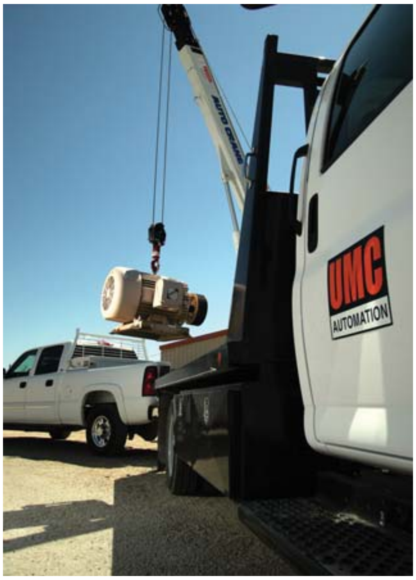

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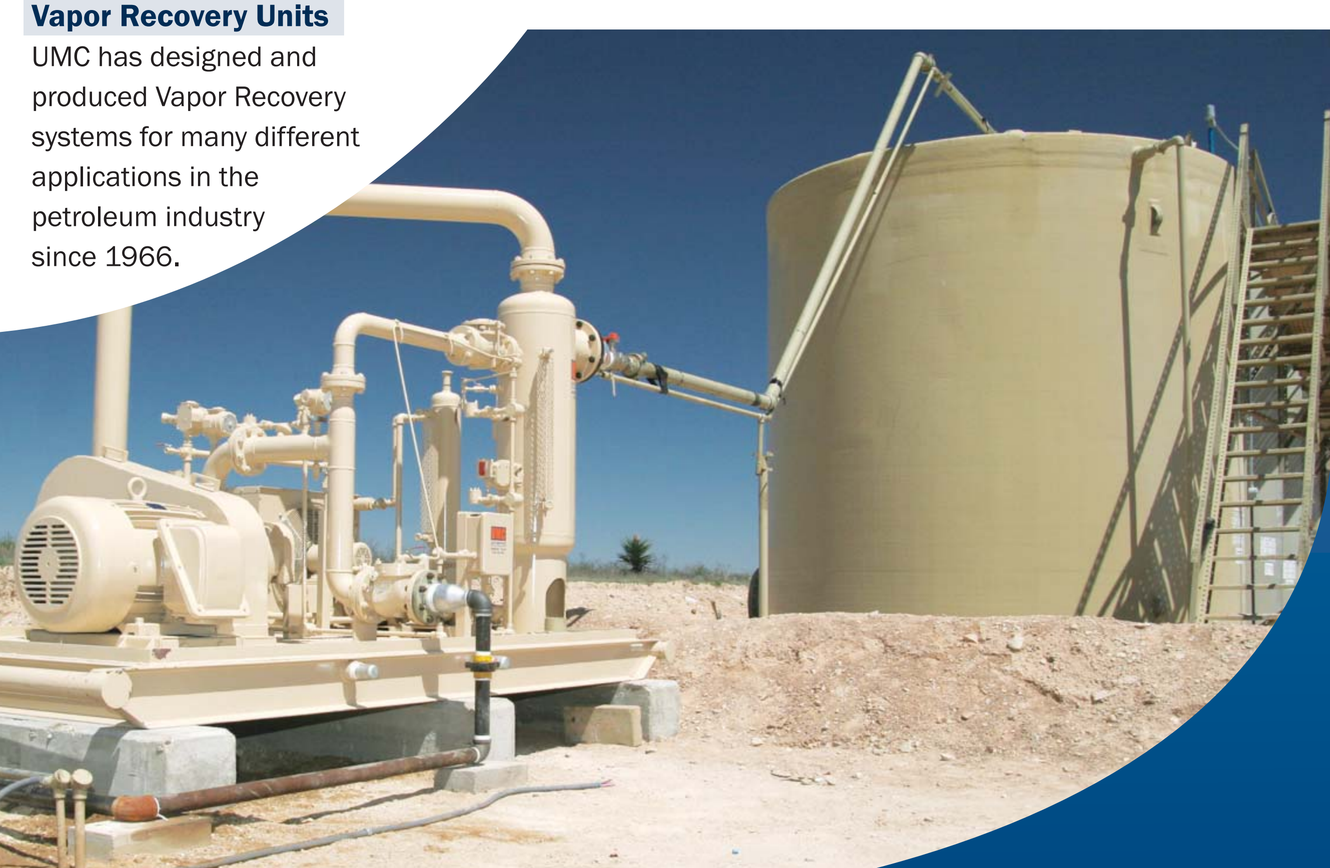

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