US EPA ARCHIVE DOCUMENT

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

SOUTHERN RESEARCH INSTITUTE

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**Hydrocarbon Vapor Recovery Device**
APPLICATION:	**Oil and Natural Gas Industry**
TECHNOLOGY NAME:	**Environmental Vapor Recovery Unit (EVRU™)**
COMPANY:	**COMM Engineering, USA**
ADDRESS:	**PO Box 53463, 201 Rue de Jean, Suite 220** **Lafayette, LA 70508 USA** **Mark Goodyear, President** **Telephone: 337/237-4373 Fax: 337/234-1805**
E-MAIL:	**mark@commengineering.com**

The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the purchase, design, distribution, financing, permitting, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups that consist of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests, collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated, and that the results are defensible.

The Greenhouse Gas Technology Center (GHG Center), one of six verification organizations under the ETV program, is operated by Southern Research Institute, in cooperation with EPA's National Risk Management Research Laboratory. The GHG Center has recently evaluated the performance of the Environmental Vapor Recovery Unit (EVRU™). This verification statement provides a summary of the test results for the EVRU, which is offered by COMM Engineering, USA of Lafayette, Louisiana.

US EPA ARCHIVE DOCUMENT

TECHNOLOGY DESCRIPTION

There are an estimated 252,000 natural gas production wells and 575,000 crude oil wells in the United States. Most of these operations employ condensate storage tanks which produce large volumes of low-pressure hydrocarbon vapors emanating from flash gas losses and working losses due to condensate transfer activities. EPA estimates that more than 30 billion cubic feet of methane (CH_4) is vented annually from such tanks, making them the most significant source of CH_4 emissions from the oil/gas production sector. The vent gas also contains hazardous air pollutants (HAPs), which must be controlled at many large facilities.

The EVRU is a non-mechanical eductor or jet pump that recovers vent gas by using a high-pressure motive gas to entrain hydrocarbon vapors emanating from condensate storage tanks. The combined discharge gas stream exits at an intermediate pressure, which can be used on site as fuel, or re-pressurized with a booster compressor and injected into a natural gas transmission line for sale. It is a closed loop system designed to reduce or eliminate emissions of greenhouse gases [CH_4 and carbon dioxide (CO_2)], volatile organic compounds (VOCs), HAPs, and other constituents present in vent gas.

The EVRU operates on the venturi principle as its core element. Motive gas is supplied from the facility's existing high-pressure natural gas pipeline. A pneumatically operated pressure sensor continuously monitors the motive gas pressure, and manipulates a flow control valve and regulator to ensure the gas is flowing at the design pressure (850 psig for this verification). The motive gas flows through a venturi orifice situated in a mixing chamber and creates a differential pressure within the EVRU jet pump. The mixing chamber contains a port which allows low-pressure vent gas (0.1 to 0.3 psig) to be drawn into the chamber due to the partial vacuum (0 to -0.5 psig) created by the motive gas as it expands through the eductor nozzle. The low-pressure vent gas drawn into the eductor mixing chamber combines with the motive gas, and exits the eductor discharge line.

The recovered gas is most often discharged into the low-pressure inlet side of a booster compressor which compresses the gas to meet high-pressure natural gas pipeline specifications. The EVRU contains flow safety valves, flow control mechanisms, pressure sensing devices, and temperature sensing devices which allow the system to operate under varying vent gas flow rates, and prevent backflow into the tanks. An oxygen alarm shuts down the system when vent gas concentrations exceed 2.5 percent oxygen.

Depending on the volume of low-pressure gas to be recovered, multiple eductor jet pumps may be installed in the EVRU system. When connected in series, the discharge line is connected to the inlet line of each succeeding jet pump prior to discharge to a booster compressor. When connected in parallel, several different sized jet pumps or combinations are brought online depending on the available flow of low-pressure gas. This parallel system was employed at the test site.

VERIFICATION DESCRIPTION

Verification of the EVRU was conducted at the TotalFinaELf (TFE) - El Ebanito site located approximately 30 miles northwest of McAllen, Texas. The site is an exploration and production (E & P) facility that manages separation of natural gas and condensate product, gas compression, and gas dehydration from wells located within a 5-mile radius. In a typical year, daily condensate production ranges from 900 to 1,200 barrels per day.

Prior to using the EVRU, the TFE site employed a conventional vapor recovery unit (VRU) to recover vent gas from five fixed roof condensate tanks and two gun barrel tanks. In the conventional VRU system, hydrocarbon vapors are drawn out of the tanks under low pressure, and are first piped to a separator to collect any liquids that condense. The liquids are then recycled back to the storage tanks, and the vapors are drawn into a booster compressor which provides a low-pressure suction for the VRU system. The vapors are routed to a pipeline for sale. The TFE test site experienced recurring mechanical failures in the VRU system, which

US EPA ARCHIVE DOCUMENT

resulted in periodic downtimes, lost product, increased operation and maintenance requirements, and higher emissions. The TFE operators have reported that the operational availability of the conventional VRU system ranged between 85 and 90 percent. During downtimes, the vapors from the storage tanks were vented directly to the atmosphere. For these reasons, the site elected to replace the existing system with the EVRU.

The EVRU system installed at the test site contained two eductors which were oriented in a parallel configuration. The total gas recovery capacity of the EVRU system is 300 thousand standard cubic feet per day (Mscfd) or 208 standard cubic feet per minute (scfm). The primary eductor, with a capacity of 200 Mscfd (139 scfm), operated continuously to maintain tank pressures below 0.20 psig. A secondary eductor, with a capacity of 100 Mscfd (69 scfm), became operational only when the tank pressure increased above 0.20 psig (e.g., a new inventory of condensate is brought in). The system is designed such that the primary eductor continues to operate after the secondary eductor starts running. The secondary eductor turns off automatically when the tank pressure drops below 0.10 psig, and the primary eductor continues to operate.

The eductors are controlled by a Programmable Logic Controller (PLC), which continuously monitors critical operating parameters such as tank pressure, motive gas pressure, and oxygen levels. In the event the EVRU is unable to remove enough vent gas to maintain the required tank pressure and the pressure begins to build up, some of the vent gas will escape through the pressure relief valves (PRVs) to the atmosphere. The design pressure of the EVRU motive gas was 850 psig, and the design motive-to-vent gas ratio was 5.2 scfm/scfm or 2.8 lb/lb. The EVRU discharge gas pressure was targeted to be about 40 psia.

Verification testing of the COMM EVRU occurred between June 23 and July 1, 2002, approximately 1 month after the system was operating continuously, unattended. The GHG Center installed a mass flow meter in the motive gas line and a turbine flow meter in the discharge gas line to continuously record 1-minute average flow rates for a period of 8 days. The difference between the discharge gas flow rate and motive gas flow rate represented the EVRU vent gas recovery rate. The GHG Center also obtained gas samples from the vent and discharge gas streams to determine the concentrations of CH_4, other C+ compounds, HAPs, and the gas heating value. The following verification parameters are quantified:

- Vent Gas Recovery Rate (Mscfd) and Motive Gas Requirements – Daily average vent gas recovery rates and the overall average vent gas recovery rate are reported for the verification period. Motive-to-vent gas ratios are also reported for the test period.
- Annual Vent Gas Savings and Operational Availability – The vent gas recovery rates verified above were extrapolated to estimate annual vent gas savings for the host site. This was done by comparing EVRU gas recoveries to estimated gas recoveries that could occur if two alternative approaches were used to manage the waste gas: (1) venting the gas directly to the atmosphere, and (2) using a conventional VRU that achieves an operational availability of 90 percent. The second baseline scenario mirrors that which was previously used at the host site, and both scenarios assume that the EVRU's operational availability during its first 6 months of operation persist throughout the year. The EVRU availability assumed is reasonable because the unit contains no motor and has very few moving parts.
- Emission Reductions (MMscfy) – The annual vent gas savings verified above were multiplied by the measured CH_4 and HAP concentrations to estimate emission reductions for the same two baseline scenarios described above.
- Value of Gas Recovered ($/yr) – A natural gas sales price of $2.85/MMBtu, as reported by TFE, is used to estimate the cash value of the recovered vent gas based on measured vent gas heat contents.
- Total Installed Cost ($) and Payback Period (yr) – Capital, installation, and total cost of the EVRU system installed at the test site are reported. Using the total installed cost, payback periods for both scenarios outlined above are reported.

US EPA ARCHIVE DOCUMENT

VERIFICATION OF PERFORMANCE

Vent Gas Recovery Rate and Motive Gas Requirements

- Daily average vent gas recovery rate ranged between 121 and 223 Mscfd, and the overall average vent gas recovery rate was 175 ± 25 Mscfd.

During the first 3 days of verification testing, motive gas pressure was not maintained at the 850 psig design pressure by the pressure regulator which was installed with the EVRU. As a result of consistently higher motive gas pressures (+900 psig) during this period, the motive-to-vent gas ratio was 6.7 scfm/scfm, significantly higher than the design ratio of 5.2 scfm/scfm. COMM replaced the motive gas pressure controller with a Proportional Plus Reset Controller by Fisher to better control the motive gas pressure. This unit contained two capillaries which sensed the high pressure supply side and motive gas pressure, and continuously adjusted the regulator to maintain the required 850 psig operating pressure. The following performance results occurred after replacing the regulator.

- The motive-to-vent gas ratio decreased to 3.2 scfm/scfm with the primary eductor operating and 3.5 scfm/scfm with both eductors operating. These ratios are lower than the 5.2 scfm/scfm design value, and demonstrate that the system is capable of recovering vent gas with lower motive gas volumes.
- Based on 1-minute measurements data, the EVRU recovered between 140 and 200 Mscfd vent gas with the primary eductor operating, and between 200 and 260 Mscfd with both eductors operating. These recovery capacities are consistent with EVRU design values.
- Proper control of the motive gas pressure is essential to optimizing the performance of the EVRU.

Annual Gas Savings and Operational Availability

- During the test period, the total downtime related to the replacement of the motive gas pressure regulator was 4.3 hours. The EVRU experienced no other downtimes during the 8 days of testing. Since then, just over five months have elapsed. According to the TFE operators, the system has been running maintenance free with no downtimes. Using this information, the operational availability of the EVRU is calculated to be 99.91 percent. To estimate annual gas savings, it is assumed that the EVRU's operational availability continues at this level throughout the year.
- For a baseline practice in which the vented gas is emitted directly to the atmosphere, it is estimated that 63.9 million standard cubic feet per year (MMscfy) of vent gas can be saved with the EVRU.
- For a baseline practice in which a conventional VRU is used, annual gas savings are estimated to be 6.4 MMscfy. For sites whose conventional VRU availability is higher than the 90 percent value reported by the TFE host site and used here, replacement with the EVRU may not produce additional gas savings. If the availability of existing VRU matches that of the EVRU (99.91 percent), no additional savings will occur.

Emission Reductions

- The higher and lower heating value of the recovered vent gas was 2089 Btu/ft^3 and 1919 Btu/ft^3, respectively. Methane represented over 50 percent (by volume), followed by non-methane hydrocarbons which represented over 47 percent of the gas constituents. HAP species, which include benzene, toluene, ethylbenzene, xylenes, n-Hexane, and C9 napthalenes, represented about 2.4 percent.

US EPA ARCHIVE DOCUMENT

- Using vent gas compositional data, annual CH_4 emission reductions are estimated to be 32.1 MMscfy or 678 tons per year (Tpy), and HAP reductions are estimated to be 1.5 MMscfy or 176 Tpy for a baseline practice that vents the gas directly to the atmosphere.
- For the test site, whose conventional VRU was down 876 hours/year, the use of the EVRU will eliminate those emissions previously vented to the atmosphere during VRU downtime. Annual methane and HAP emission reductions are estimated to be 67.8 Tpy and 17.6 Tpy, respectively. The reader is advised that for those oil/gas processing facilities that employ conventional VRUs with little to no downtime, additional emission reductions will not occur with the use of the EVRU.

Value of Gas Recovered

- The value of 63.9 MMscfy vent gas recovered is estimated to be $349,318/year.

Total Installed Cost

- The total cost of the system installed at the TFE site was $107,958.
- The EVRU has operated at the host site maintenance free for about 6 months. Given this, a simple payback period of 0.3 years is estimated for a site without a currently installed VRU. If an existing VRU is on site, payback period would be much longer, and would need to account for potential maintenance expenses for the VRU (e.g., labor, equipment replacement costs).

Original signed by:

E. Timothy Oppelt
Director
National Risk Management Research Laboratory
Office of Research and Development

Original signed by:

Stephen D. Piccot
Director
Greenhouse Gas Technology Center
Southern Research Institute

Notice: GHG Center verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. The EPA and Southern Research Institute make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate at the levels verified. The end user is solely responsible for complying with any and all applicable Federal, State, and Local requirements. Mention of commercial product names does not imply endorsement or recommendation.

US EPA ARCHIVE DOCUMENT