Vapor Recovery Technology

Practical Applications & Case Studies

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VAPOR RECOVERY SYSTEMS
VAPOR RECOVERY

Over 26.6 Billion cubic feet of natural gas escapes from oil field stock tanks in the United States every year.
This flare in Venezuela was causing a variety of health and environmental concerns. Over 85 MMCFD of 2700 BTU tank vapors are now being captured in Eastern Venezuela that were previously flared.
ONE INCH SENSING LINE
May be flexible PVC, fiberglass or steel, taped or banded to suction line.
CAUTION: Sensing line must be independent of suction line.

SUCTION LINE
Steel or Fiberglass

PRESSURE / VACUUM RELIEF

STOCK TANK

DRIP POT ON V.R. SENSING PANEL

SCRUBBER DRAIN PUMP

V. R. UNIT SCRUBBER

BUTTERFLY OR GATE VALVE

NOTEs
All lines must be horizontal, or sloped down to V.R.U. suction as shown.
Scrubber fluid is piped back to tanks or to waste.
The system must be closed — no air entry.
Standard Vapor Recovery Unit

- Crude Oil Stock Tank(s)
- Vent Line
- Back Pressure Valve
- Suction Line
- Scrubber
- Suction Line
- Condensate Transfer Pump
- Electric Driven Rotary Compressor
- Electric Control Panel
- Bypass Valve
- Gas Sales Meter Run
- Check Valve
- Gas
- Sales
- Return
- Liquid Transfer Pump
Benefits of Vapor Recovery Units

- Capture up to 95 percent of hydrocarbon vapors that accumulate in tanks
- Recovered vapors have much higher Btu content than pipeline quality natural gas
- Recovered condensate can be extracted or sent back to the tanks to increase api gravity of the crude
- Major reduction in regulatory & liability exposure
CASE STUDIES
$5.00 x 1.13 x 1000 MSCFD = $5650

$5.00 x 0 MSCFD = $0

$5.00 x 0 MSCFD = $0

$5.00 x 0 MSCFD = $0

TOTAL GAS SALES = $5650

NOTE: Price based upon $5.00/MMBTU
THE SOLUTION

A system was designed to allow the customer to capture the vented gas from all phases of his separation process. A multi-stage unit was designed and built that took the gas from the tank vapors at atmospheric pressure, gathered the vent gas from the other separators and delivered the stream to the sales line at 500 psig.
**Crude Oil Analysis**

**600 PSIG SEPARATION**
At 500 psig separation pressure the gas has a BTU content of 1131 BTU/cu. ft.
At 80 psig separation pressure the gas has reached a BTU value of 1401 BTU/ cu. ft.

80 PSIG SEPARATION
At 25 psig separation, the gas stream is at its richest point yet, with a BTU value of 1588 BTU/cu. ft.
This gas stream reaches its most valuable point during storage in the oil tank. This gas has a BTU value of 2514 BTU/ cu. Ft. Obviously, this gas is worth capturing!
Annual Revenue Increase: $890,280

PLUS the value of the captured condensates (not metered by the operator)

NOTE: Price based upon $5.00/MMBTU
Producing Well

Glycol Unit

1000 MSCFD
800 psi
1000 BTU/cu.ft.

Gas Sales

Gross Sales Per Day

$5.00 x 1000 MSCFD = $5000

Flared

60 MSCFD
100 psi
1200 BTU/cu.ft.

Flared

90 MSCFD
0 psi
2000 BTU/cu.ft.

Flared

Gross Sales Per Day

$5.00 x 0 MSCFD = $0

TOTAL GAS SALES = $5000

Price Based upon $5.00/MMBTU
Heater Producing Well

1000 MSCFD 800 psi 1000 BTU/cu.ft.
60 MSCFD 100 psi 1200 BTU/cu.ft.

Glycol Unit Gas
Sales

$5.00 x 1000 MSCFD = $5000
$5.00 x 1.2 x 60 MSCFD = $360
$5.00 x 2.0 x 90 MSCFD = $900

TOTAL GAS SALES = $6260

Price Based upon $5.00/MMBTU

Gross Sales Per Day

Gas Booster

Recovered

60 MSCFD
100 psi
1200 BTU/cu.ft.

90 MSCFD
0 psi
2000 BTU/cu.ft.

VRU

$5.00 x 2.0 x 90 MSCFD = $900

Annual Revenue Increase:
$453,600

MONTHLY GAS SALES INCREASE = $37,800

Recoverable
Case Study – Chevron

Chevron installed eight VRUs at crude oil stock tanks in 1996

<table>
<thead>
<tr>
<th>Methane Loss Reduction (Mcf/unit/yr)</th>
<th>Approximate Savings per Unit$^1$</th>
<th>Total Savings</th>
<th>Total Capital and Installation Costs</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,900</td>
<td>$43,800</td>
<td>$350,400</td>
<td>$240,000</td>
<td>&lt;1 yr</td>
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</tbody>
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$^1$ Assumes a $2 per Mcf gas price; excludes value of recovered NGLs. Refer to the Lessons Learned for more information.

Source: Natural Gas Star Partners
Case Study

Mid Size Independent in Hobbs, NM area March ‘04

Installation of 2 VRU’s on 2 stock tank batteries, each emitting approximately 90 MSCFD of 2500 btu tank vapors / 45 psig sales line

Previous gas sales revenue: $0 (venting)

Monthly gas revenue: $5 X 2.5 X 90 MSCFD X 30 days x 2 tanks = $ 67,500

Capital expense: $24,000 X 2 units = $48,000

Payback: 21 DAYS
Case Study

Large Independent in North Texas June ‘04
Installation of 1 VRU on a stock tank battery emitting approximately 190 MSCFD of 2400 btu tank vapors / 50 psig sales line

Previous gas sales revenue: $0 (venting)

Monthly gas revenue: $5 \times 2.4 \times 190 \text{ MSCFD} \times 30 \text{ days} = $ 68,400

Capital expense: $32,000

Payback: 14 DAYS
CO$_2$ Recapture

Pulling stock tank vapors for a Major in Snyder, Texas. Flooded screw compressor for volumes to 1.5 MMSCFD. Pressure to 250 psig.
Other Costs to Consider

- Regulatory Liability Exposure
- Public Relations Exposure
  - Positive or Negative
- Litigation Exposure

Producing a clean energy source (natural gas) and simultaneously improving air quality in the community – with an economic payback of usually less than 3 months
So why aren’t more companies taking advantage of this technology to generate revenue?
- Considered an “Environmental Issue”

- Haven’t run the economics since gas was $1.50 / mcf and internal afe’s based on $.75 gas.

- Few companies actually meter the volume of captured gas or condensate

- Because “the field guys” don’t like them
So Why Does the Field Push Back?

“Our bonuses are based on oil increases, not gas”

“They are not high on the radar screen – not on the morning report or monthly report”

“The air permits ask if there is a vru on location, it doesn’t ask if there is a working vru on location”

“It broke down a year ago and nobody started screaming about it”

“It’s just another piece of equipment to take care of – and we don’t get any credit if it captures a lot of gas”

“They let oxygen into the lines, and the pipeline company will shut us off”

“They are a pain in the ass, I had a little Quincy once and I was replacing valves every other week”
VRUs are not a COMMODITY

Proper Tank Configuration +
Proper Compressor Selection +
Proper Package Design +
Minimal Preventive Maintenance =
Success
Vapor Recovery

Properly designed vapor recovery units average between 95% and 97% Run Time consistently – and DO NOT allow oxygen into the pipeline.

Electric drive vapor recovery units require very minimal (but necessary) preventive maintenance.

Units require pressure sensors and transmitters, sophisticated control systems, a bypass system, the correct compressor style (compatible with wet gas streams) and the proper tank configuration in order to operate effectively.
EXAMPLES OF APPLICATIONS
VAPOR RECOVERY

Dual VRU bound for Venezuela... one of 17 units capturing gas currently for Petroleos de Venezuela. Flooded screw compressor for volumes to 5.0 MMSCFD; up to 200 psig.
At this installation, three dual compressor packages were set in tandem to move 15 MMSCFD of 2500-2600 BTU/cu ft. tank vapors.
Two large rotary screw VRU systems manufactured in 2003 for ENI – designed to move 1.4 MMcfd of gas at pressures to 230 psig.
A 2004 installation for Amerada Hess for service in Algeria. This unit is a dual rotary vane system capable of moving 4MMCFD at pressures from 0 to 40 psig.
OFFSHORE VRUs - Examples

A rotary vane compressor package on an El Paso platform handles 500 MSCFD from 0 to 55 psig.

A high-spec offshore screw compressor VRU package designed for Kerr-McGee (Gulf region) handles 600 MSCFD to 120 psig.

A 2004 installation for Hunt will move 300 MSCFD at a discharge pressure of 70 psig.
Technological Advancements

Low Pressure Gas Management Systems
Sensing Technology

Pressure sensing can be achieved with diaphragm actuated mechanical device / set pressures achieved by manually setting counter weights in conjunction with proximity switch.

High sensitivity electronic transmitters are now commercially viable for low pressure applications. Transmitters are highly accurate to extremely minute pressures – and do not require a highly trained technician to calibrate.
Advancements in lubrication systems monitoring and control have dramatically increased bearing life.

Lubrication requirements are precisely monitored and detailed reporting capabilities are easily downloaded into handheld “palm” devices or directly into Excel format.
Control Systems

PLC driven auto ignition for natural gas drive engines reduce compressor downtime and pumper requirements.
HY-BON ENGINEERING COMPANY, INC.

Setting a New Standard!!