5.2.5. Vent Gas Capture (VGC) Systems	July 31, 2017

Description

Significant natural gas is vented to the atmosphere during the course of normal oil and gas operations. The capture and combustion of vented natural gas (a “VGC Project”), consisting of primarily methane, reduces greenhouse gas emissions by combusting methane and converting it to carbon dioxide, water vapour, and other combustion by-products. A portion of the vent gas may still be emitted to the atmosphere if the collection system is not 100% effective (e.g. downtime, not all sources tied in, partial collection down to low pressures etc.) or if the combustion device is not 100% effective at destructing the methane.

A typical vent gas capture project includes piping, controls, regulators and a combustion device. However, additional energy inputs may be required to boost low-pressure vent gas to high pressures to enable beneficial use (e.g. vapour recovery units).

The most common configuration of vent gas capture system that has been installed in Canada is the SlipStream® technology developed by Spartan Controls[1]. The SlipStream® technology captures vented hydrocarbons and safely redirects these gases into the air intake of a reciprocating engine in a controlled manner. The vent gas can then be used as a supplemental fuel source (the vented gas is completely destructed in the engine, while also helping to reduce the fuel usage from the primary fuel supply). The SlipStream® technology includes a valve train for process control and metering of the vent gas, and includes software and hardware to integrate the system with the facility’s control panel and shutdown systems. No incremental compression or other energy inputs are required to utilize the atmospheric pressure vent gas since the gas is input into the engine air intake, where the turbochargers operate at negative pressure and draw the gas into the engine.

Spartan Controls has also developed a version of SlipStream® that works with fired heaters (e.g. dehydrator re-boiler burners, tank heaters or line heaters). Other vendors offer variations of this type of technology to reduce vented emissions from glycol dehydration by condensing out water vapour to dry the vent gas before burning it in a fired-heater.

Other vent gas capture configurations are possible and may include vapour recovery units with small compressors to boost the pressure of the vented gas to enable productive use or sales of the gas.

Baseline:
Significant methane is vented to the atmosphere from dedicated vent lines associated with the operation of reciprocating compressors, glycol dehydrators, pneumatic instruments and pumps, and solution gas from oil/condensate production.

Pneumatic devices are not normally tied into flares for both safety and operational reasons, such as preventing backpressure on the instruments. Flaring may be the baseline for certain glycol dehydrators that are subject to benzene emission limits.

[1] http://www.spartancontrols.com/rem-technology/rem-technology-products/slipstream/

Estimating Gas Savings:
The best way to estimate potential fuel gas savings and GHG emissions is to conduct a vent gas measurement survey. This includes documenting all venting sources (compressor packing vents, pneumatic equipment etc.) and taking short duration or snap shot measurements. It is helpful to have an infrared camera (FLIR camera) on site while conducting measurements to ensure that all of the gas is being metered. For example, gas will often leak from pneumatic controller boxes when a small amount of back pressure is applied, but will not go through the meter.

Note that due to the low pressures of atmospheric vents, the captured quantity of vent gas (after installation) may not add up to the total sum of the vent gas sources identified. Low pressure gas will follow the path of least resistance, so all vent totals may not be captured.

Technology Group

Engines and Compressors – Recommended Practices

Site Applicability

Sweet natural gas production facilities that are not currently flaring the waste gas emitted from reciprocating compressor packing vents, glycol dehydrator still column vents, or other production equipment (tanks, casing etc.).

One of the key criteria is the availability of a suitable combustion device at the site to combust the captured vent gas. In many cases, this will be a reciprocating engine or a fired-heater (burner); however, the control system of the combustion device must be dynamic enough to be able to respond to the change in combustion conditions caused by the addition of a supplemental fuel source (vent gas). For example, turbo-charged engines require an air-fuel ratio (AFR) control system that will prevent over-fueling of the engine. Some original engine manufacturer AFRs can be used, but often an after-market AFR such as REMVue® will be used along with the vent gas capture system (e.g. SlipStream®). For any candidate project, it is important to assess what upgrades to the combustion device might be required, such as control systems and panels, as these costs can be significant.

It is important to assess the layout of the facility as the vent gas may need to be distributed from one process (e.g. dehydrator) to another building where the combustion device is located (e.g. compressor building). Any water content in the vent gas could present a freezing risk, so gas should be dried, heat-tracing should be added, and/or the piping should be sloped appropriately. Compressor oil in packing vent gas may need to be removed as well.

Emissions Reduction and Energy Efficiency

Measurement:
Continuous direct measurement is needed with a dedicated flow meter installed on the piping that connects the captured vent gas stream to a combustion device (e.g. engine, flare). Meters are normally tied into a Supervisory Control and Data Acquisition (SCADA) system for continuous data collection, similar to conventional gas production meters, and data is usually collected every 15 minutes and averaged daily. Meters are typically calibrated annually.

Baseline Emissions:
The baseline for a VGC project is the venting of methane to the atmosphere from dedicated vent lines associated with the previous configuration (this assumes that the waste gas stream was not previously flared). The baseline emissions can be calculated based on the metered amount of vent gas that has been captured (after installation of VGC system), the site gas composition (% methane), the density of methane, and the global warming potential of methane. Note that this is a simplification of the Alberta Offset System (AOS) Quantification Protocol for Engine Fuel Management and Vent Gas Capture, and the full calculation is available in the protocol.

A simplified formula to estimate baseline emissions:
Baseline Emissions = (Estimated Natural Gas Savings in m^3/year)*(% Methane in gas)*(Density of Methane)*(0.001 t/kg)*(GWP of Methane).[2]

Estimated GHG Emission Reductions:
GHG reductions from 104 VGC projects completed at compressor stations and gas processing plants in Alberta ranged from approximately 450 to 3,700 tCO_2e/year per project, with an average of approximately 920 tCO_2e/year per project. GHG reductions are site-specific and depend on the type of vent gas being captured and the design of the facility.

Economic Analysis

Capital Cost:	Capital costs are highly site-specific, but costs from VGC projects completed by a major producer in Alberta at 60 compressor stations ranged from $55,000 to $250,000, with an average of approximately $90,000 (per compressor). Capital costs for another VGC project completed by a major producer completing 39 retrofits, including 28 SlipStream vent gas capture systems and 11 REMVue engine fuel management systems, averaged $197,000. A third project by a major producer installed five SlipStream vent gas capture systems, averaging capital costs of $254,000. Note that capital costs may be much higher for projects that capture vented gas from multiple compressors or dehydrators and for projects that require expensive engine upgrades, such as a new control panel or the addition of an air-fuel ratio control system.
Operating Cost:	Operating Costs are minimal for vent gas capture systems, provided they do not require incremental compression (e.g. a vapour recovery unit or booster compressor is not required).
Maintenance Cost:	Maintenance costs are estimated at $500-$1,000/year for meter calibration and periodic site visits (e.g. troubleshooting units that trip offline).
Carbon Offset Credits:	The value of carbon offsets can be very significant for VGC projects and can outweigh the value of the gas savings by a significant margin using an assumed carbon offset value of $25/offset in Alberta. Based on the GHG reductions

2 Global Warming Potential of Methane is 25 currently (but subject to change), per: http://aep.alberta.ca/climate-change/guidelines-legislation/specified-gas-emitters-regulation/documents/CarbonEmissionHandbook-Mar11-2015.pdf
Density of Methane gas at 15°C and 1atmosphere is 0.6797 kg CH_4/m3, per https://encyclopedia.airliquide.com/methane

	achieved by the 104 Alberta VGC projects mentioned above (Low of 450 tCO_2e to a high of 3,700 tCO_2e and an average of about 920 tCO_2e), the value of the carbon offsets at $25/offset could be worth from $11,250/year to $92,500/year; $23,000/year on average per project.
Payback, Return on Investment and Marginal Abatement Cost:	The primary benefit of VGC projects is gas savings, and these are site-specific. Savings from 60 VGC projects completed in Alberta ranged from approximately 2.5 mcfd to 10 mcfd, with the average of about 6 mcfd. At a flat $2.50/mcf AECO gas price, these gas savings would be worth from $2,300/yr (2.5 mcfd) to $9,000/year (10 mcfd) or an average of $5,500/year (6 mcfd).

Barriers:

- Financial barriers – Small volumes and low value of recovered/conserved vent gas makes many projects uneconomic without carbon offsets. Capital costs are high when retrofitting older facilities.
- Low pressure (atmospheric pressure) of vented gas is difficult to capture/use.
- Combustion equipment, such as reciprocating engines, may require expensive modifications to be able to utilize or combust vented gas. For example, engines may require an air-fuel ratio controller or control panel upgrades, or fired heaters may need to replace the burner and control system. In addition, new combustors (e.g. flares or incinerators) may be required at sites that do not have an existing combustion source, and these devices would require a supplemental fuel gas source to burn the vented gas (e.g. pilot, purge and dilution gas).
- Vented gas is often saturated with water (e.g. glycol still column overheads) and is difficult to manage without freeze-offs in winter, and often contains other impurities (e.g. oil from compressor packing vents)
- Difficulty estimating vent gas rates due to lack of metering (e.g. compressor rod packing vents).
- Minimal capital available for energy efficiency or emission reduction projects
- Unwillingness to modify proven facility designs that are reliable.

Reliability

Vent gas capture systems are highly-reliable. They are usually designed so that if an issue arises with the vent gas capture system, it trips-offline and vents back to atmosphere by default, preventing downtime for the compressor/facility. However, this system design can lead to inefficient collection of vent gas and a lack of urgency in getting the vent gas capture unit back online. This is especially true when the system needs to be manually re-set or requires trouble shooting. Since the vent gas capture system is usually a low-priority item, it may take several weeks before a technician is able to visit the site.

Reliability may be more difficult to maintain if there are impurities in the gas stream, such as oil from packing vents or water from dehy still columns. The process is prone to upsets/significant changes in operating conditions if the combustion device (e.g. engine) is in poor condition.

Safety

The VGC system must be properly integrated with the existing site safety systems (e.g. compressor safety shut down keys) and proper training must be provided to operators. It is important to ensure that the vent gas system is always set to vent to atmosphere when the engine is not operational so that gas is never being input into the engine until after the engine has been started.

Regulatory

Operators must obtain and demonstrate compliance with relevant facilities codes and regulations.

Future Regulatory Considerations:
Both the Alberta Government[3] and the Federal Government[4] have announced their intentions to regulate methane emissions from a variety of equipment, including reciprocating compressor packing vents, dehydrators vents[5], pneumatic controllers, pneumatic pumps and production tank and casing gas venting. Draft regulations are expected in 2017 with compliance requirements by 2020-2023 timeframe. It is expected that there will be specific limits on methane venting from each of the above sources and different standards for new (greenfield) facilities and potential requirements to retrofit existing pneumatic equipment. VGC projects can be an excellent solution to meet regulatory compliance by significantly reducing or nearly eliminating methane emissions from these sources. Vent gas capture systems are a natural solution for reducing methane emissions from reciprocating compressor packing vents since the compressor engine is an ideal methane destruction device and the vented gas can displace part of the primary fuel supply.

Service Provider/More Information on This Practice

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[4] http://news.gc.ca/web/article-en.do?nid=1039219
[5] Alberta only.