REMEDIATION SERVICE, INT'L

Demonstration using a RSI proprietary internal combustion engine (ICE) as an air pollution control device at a natural gas production site as conducted November 11, 2008.

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ABSTRACT
Vapor control and abatement of volatile and semi-volatile organic compounds (VOC and SVOC) including (but not limited to) methane , benzene, toluene, ethyl benzene, and xylene that are produced during the operation of natural gas wells and related tank batteries is becoming mandatory for public health and safety. Abatement of these vapors, using a technology with destruction removal efficiency (DRE) of greater than 99% would be desired, while using the abatement process to convert waste gas to electricity for use on and/or off site. Combining off-gas abatement with power generation will reduce the amount of the waste gas generated, and allow for more of the resources to be sent down stream for profit as sellable gas, producing a return on investment (ROI). Achieving a ROI, while providing superior air pollution control as compared to flaring; and reduction of greenhouse gases is advantageous to all concerned.

DESCRIPTION OF EXISTING PROCESS AS WITNESSED AT THE DEMONSTRATION SITE (P&ID ATTACHED)

Vapors and liquids are delivered under pressure from production gas wells drilled to varying depths below ground surface. The liquid product produced during these operations consists primarily of “oily” water, referred to as natural gas condensate. The gas/vapor fraction also contains trace amounts of oily water as well (i.e. wet vapors), all of which are separated in a three phase separator located on site. All water and separated liquid gases collected during these operations are directed to a tank battery where they are stored for future disposal. The “wet” vapors are then “conditioned” using a glycol bath process and sent down the pipeline for further treatment and eventual sale.

The “wet” gas vapor stream treatment consists of a glycol “bath” process using Triethylene Glycol (TEG) to strip the trapped water from the “wet” gas. During the treatment process, a portion of the petroleum hydrocarbons along with the water are adsorbed into the glycol mixture. The glycol mixture is then recycled by heating it to approximately 350 degrees F , causing the dissolved VOC and SVOC in the glycol mixture to be converted to its vapor state, and then vented to atmosphere or oxidized in a flare, as is the case of the demonstration site.

In addition to the VOC/SVOC vapors from the glycol process, the tank batteries that store the produced water and petroleum liquid condensate also produce fugitive vapors that are vented to atmosphere or flared. One source of these gasses is from “flashing” operations. Flashing occurs when the petroleum gas condensate is transferred under pressure to storage tanks that are maintained at relatively atmospheric pressure. During this operation, a certain fraction of the liquid “flashes” to the vapor state. The vapor produced is then released through a controlled pressure relief valve on the tank(s), and then vented to atmosphere or treated by flare, again, as is the case at the demonstration site..

Another source of vapors is from a portion of the pressurized methane gas stream that would normally be sent down the pipeline for distribution, but instead the pressure from the gas stream is used to operate pneumatic pumps for the glycol “bath” and the separate glycol recirculation heating system used to keep lines from freezing during winter operations. Once the gas pressure is used for this purpose, the gas must be directed to the tank battery for future venting and/or abatement because the line pressure will have dropped below the delivery line pressure of the main distribution line.

At the demonstration it was noted that some of the vented gas used for the pneumatic pumps is also used to operate and heat the boilers that are part of the glycol heating and bath systems. A 125,000 BTU rated natural gas heater runs 24/7, 12 months a year to operate the glycol bath system, while a 750,000 BTU/hr burner also uses a portion of this waste gas stream to operate a heat trace system that is used during winter months. Actual energy use is dependent on ambient temperature.

ELIMINATION OF THE FLARE AND GENERATION OF ELECTRICITY BY USING RSI’S INTERNAL COMBUSTION ENGINE TECHNOLOGY (P&ID ATTACHED-PATENTS PENDING)

On November 11, 2008, FSI/RSI was invited to a gas production site to demonstrate how their internal combustion engine technology might replace certain flare processes, while producing electricity on site. The production of electricity was used to demonstrate that electric motors could replace the pneumatic pumps currently operating at the site and/or an natural gas compressor to recapture the tank battery vapors. The site where the demonstration took place was smaller in size when compared to others; however this site was chosen for ease of access and that the RSI technology being demonstrated is scalable.

There was one gas production well on this site. There were two flares being used, one was burning a steady stream of low pressure VOCs at a process rate of approximately 300,000 BTU/hr from the Glycol treatment process; and another flare that was receiving a process flow estimated to be 1,000,000 BTU/hr with bursts up to two times that amount during liquid transfer into the tanks where “flashing” occurs.

It was estimated that the pneumatic pumps (two) were using approximately 8 SCFM each (16 SCFM total) of methane gas flow to generate the necessary pressure to operate the pumps. A portion of this gas after it exited the pump motors was being used to operate the 750,000 BTU rated burner for the glycol heat trace system, and also for the 125,000 BTU rated glycol treatment system as well. The remaining portion of the vented gas was directed to a flare, via the tank battery. More gas is vented to the tank battery during the summer months than during the winter months because of less heating requirements on site.

For this particular site it is estimated that during the winter months of operation, with electricity to operate the pumps instead of the natural gas pressure and an electrical natural gas pump also operated by the engine’s generator, a minimum of 1.4 million BTU/hr of gas could be captured and redirected to sale. During the summer months, the savings would increase to approximately 1.9 million BTU/hr. This would also result in lower greenhouse gas emissions because of the elimination of the flares and the reduction of the waste gas stream being oxidized.

RSI arrived on site with its 500,000 BTU/hr rated internal combustion engine (ICE) system for demonstration purposes. For the first test, the RSI ICE system was connected to the tank battery. Using RSI's proprietary O2 air/fuel controller and emissions tracking carburetor, the system was able to extract a portion (estimated at 50%) of the steady state gas feed from the tank battery to the flare. The engine ran on 500,000 BTU/hr fuel from the flare stream with no disruption of the air fuel ratio control loop to the engine, even during "flashing" events as witnessed before and during the actual site demonstration. Although the engine was connected to an alternate fuel source (propane), practically none was used, except of initial system start-up. The RSI ICE system's generator produced 40 kW of energy during the demonstration. The energy produced was consumed by an electrical load bank connected to the system (also brought to the site by RSI).

Based on the results from the demonstration, RSI estimates that for tank battery vapor control, a 2.5 million BTU/hr RSI ICE system would have been required to handle all the gas directed to the existing tank battery flare, to include "flashing" events. The RSI system for this process stream would be designed to operate at 1,000,000 BTU/hr under normal operations, and then ramp up to 2,000,000 BTU/hr (or more as the case may be) just prior to a flashing event. to control the momentary increase in vapor emissions. Once the flash event was completed, the operating load would then be reduced back to the 1,000,000 BTU per hour rate to only consume the energy produced during the normal process flow from the tank battery. These consumption rates are approximate and can be adjusted to meet the specific site needs. We estimate that more than 100 kW of continuous electrical energy could be produced from the waste gas generated from this tank battery alone if both process gases were oxidized.

A more favorable approach (although not tested during this limited pilot study), instead of oxidizing the vapors from the tank battery, it is our intention to use the electricity produced from the ICE used to abate the glycol wash flare to operate a natural gas compressor whereas the tank battery vapors can be put back into the pipe line for sale.

Following the initial test, a second test was conducted using the same 500,000 BTU/hr rated RSI ICE system. The objective of the second test was to determine if the waste stream from the second flare on site could be used as a primary fuel source for the ICE system. The 2nd flare on site is used to abate all the BTEX and other VOCs generated from the glycol "bath" system.

The RSI ICE system was able to turn off the flare, and consume all the energy generated by the glycol process normally vented to flare. The ICE system was also generating up to 40 kW of electrical power, which a portion of the generated electricity (less than 8 kW) could be used to replace the need for the pneumatic pumps, again, allowing for a reduction of the sellable natural gas production currently being vented to the flare. Again, it is a consideration to use the remaining power to operate a natural gas compressor to capture more sellable gas from the waste steams from the tank battery. If this be the case, the existing pneumatic pumps would be left in place so that a retrofit of the system would be limited to eliminating the flares with one engine and one compressor. The gas from the pneumatic pumps would be recaptured at the tank battery, pressurized, and put into the distribution line for sale.

EQUIPMENT REQUIRED TO REMOVE FLARES AND HANDLE VAPOR STREAM 100% BY RSI ENGINES:

For this site without the concept of using a compressor to capture the tank battery vapor for resale, FSI/RSI would supply two systems. One 500,000 BTU/hr rated unit (actual usage will be site specific and automatic to fit the need) to be used for eliminating the

flare used for the waste gas stream from the glycol bath process. This engine would generate 40 kW of energy to be used to run electric motors instead of pneumatic pumps and whatever other “work” that may be available. The second unit for the tank battery would be a 2.5 million BTU/hr rated system where as it would normally operate at a rate sufficient to process the vapors coming from the tank battery (estimated at 1 million BTU/hr and automatically adjusted to actual), and then automatically ramp up to its programmed set point to handle the bursts of energy from the flashing event.
If a compressor is operated from the first unit to capture the process flow from the tank battery and direct it to distribution for resale, then the 2.5 million BTU/hr system is not required, accept perhaps for back-up/redundancy.

ESTIMATED EMISSIONS TO ATMOSPHERE PER ONE MILLION BTU/HR RATED RSI SYSTEM

VOC, CO, and NOx emissions per 1,000,000 BTU/hr (500,000 BTU/hr unit was demonstrated on site) are .12lb/hr, .63lb/hr and .42lb/hr respectively per MBTU flare gas processed. SOx was not measurable. CO2 greenhouse gas would be considerably less as compared to the existing flares on site, currently estimated at 125lbs/hr/MBTU because VOC reduction will always be greater than 99%. According to the South Coast Air Quality Management District (SCAQMD), when one pound of unburned VOC is vented to atmosphere, that would equal 21 lbs of greenhouse gas emission emitted, therefore the greater the DRE of the oxidizing device the better. Also, the reduction of oxidation in favor of recapture is quite remarkable as far as reduction of green house gases. Source testing report of a similar unit showing VOC, CO, and NOx as used for this demonstration is attached for reference.

SUMMARY

Based on the results of the two tests performed on November 11, 2008, it is estimated that providing electricity to operate electric pumps vs. pneumatic and to operate a natural gas compressor, would save approximately 1.4 million BTU/hr of energy. During the summer months, this savings would increase to approximately 1.9 million BTU/hr. Remaining electrical energy may be used for other useful purposes, such as process produced water with electro coagulation on site rather than transport off site for treatment.

Our systems are scalable to fit larger or smaller applications. Contact info@rsi-save.com or http://www.rsi-save.com .