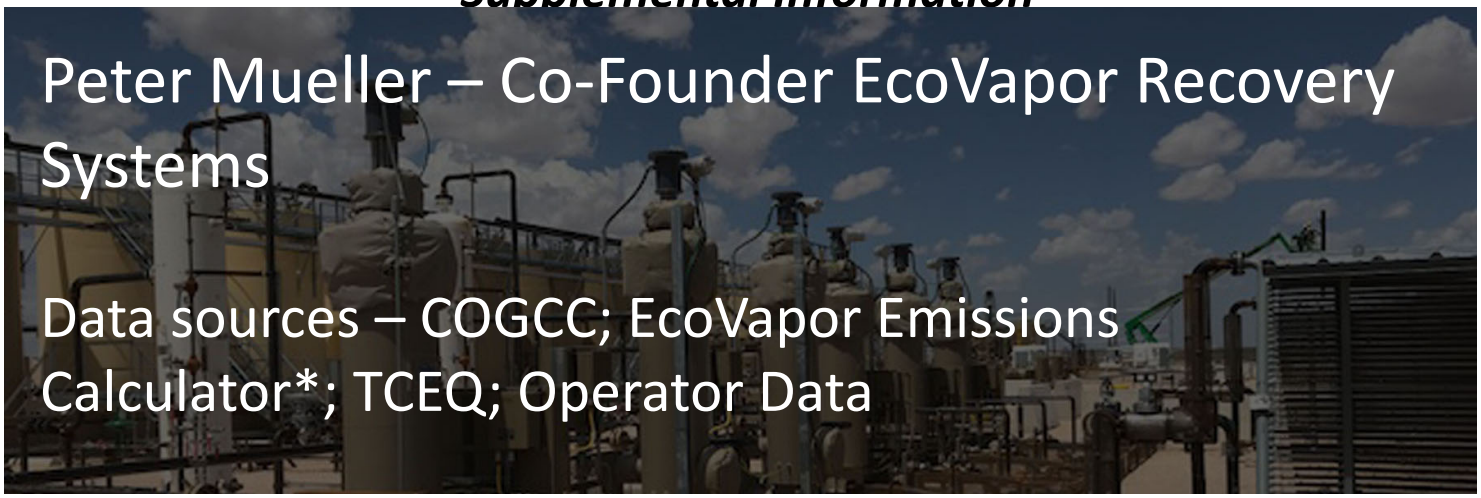
Enhanced Vapor Recovery

Supplemental Information



** Factors and calculations verified by LT Environmental*

Methane Advisory Panel -

There were three topics discussed that I wanted to follow up on.

1) **Chemistry of the oxygen removal process (patented).** This is laid out in Slide 3 and includes the reaction as well as example concentrations of the byproducts (CO2 and H2O) in the discharged gas stream. These concentrations will be further diluted when the recovered gas stream blends with the gas off the separators.
2) **Tank pressures.** The discussion concerned whether tank pressures are lower when using a VRT and VRU or when using a VRU that pulls flash gas directly off the tanks. The 4th slide shows empirical data from an installation using our integrated system that incorporated a VRU and our oxygen system on one skid. Those units also have data sensing, recording, and transmitting systems. This is an example of the worst case scenario where there is no VRT/VRU and the oil moves directly from the low pressure heater treater to the tanks. Despite not having an VRT/VRU system in place to reduce tank flash gas volumes, the EcoVapor system caused tank pressures to decline immediately after startup from over 7 oz/in2 down to 1-2 oz/in2, well below the ECB inlet opening pressure so all tank flash gas was then going to sales. Later tank pressures temporarily increased when the system was down for VRU maintenance and then declined again once the system was back on line. The system was able to reduce tank pressures and capture all the flash gas. While a VRT/VRU combination is able to capture a portion of the flash gas prior to the oil entering the tanks, our data indicates that VRTs recover approximately 2/3rds of it, leaving the rest to escape from the oil in the tanks and build pressure there. Tank pressures must then be high enough to push gas through the piping, flame arrestor, and ECB inlet valve, all of which is avoided by using a VRU to pull gas directly off the tanks.
3) **Emissions from catalyst regeneration cycles**. This has not been fully quantified. We send 3,000 to 5,000 lbs of catalyst for regeneration each year at this point. Emissions for transportation to Houston from Greeley and back are estimated at 0.71 TPY of CO2. I do not have data on the volume of natural gas used to heat the catalyst and the carbon or sulfur liberated during the process, less what emission control systems are in place. While I expect that these emissions are relatively small, I will try to quantify them.

Oxygen removal process

$$CH_4 + 2\ O_2 + \text{Heat} \Rightarrow CO_2 + 2\ H_2O$$

Relative amounts of CO2 and H20 in discharged gas:

- **CO2 = 50% of inlet O2 ppm; *@ 4000 ppm O2 => 0.2% CO2***
- **H2O = inlet O2 ppm; *@ 4000 ppm O2 => 0.4% H2O***
- ***All components remain in vapor phase; there are no emissions from an EcoVapor ZerO2 unit.***

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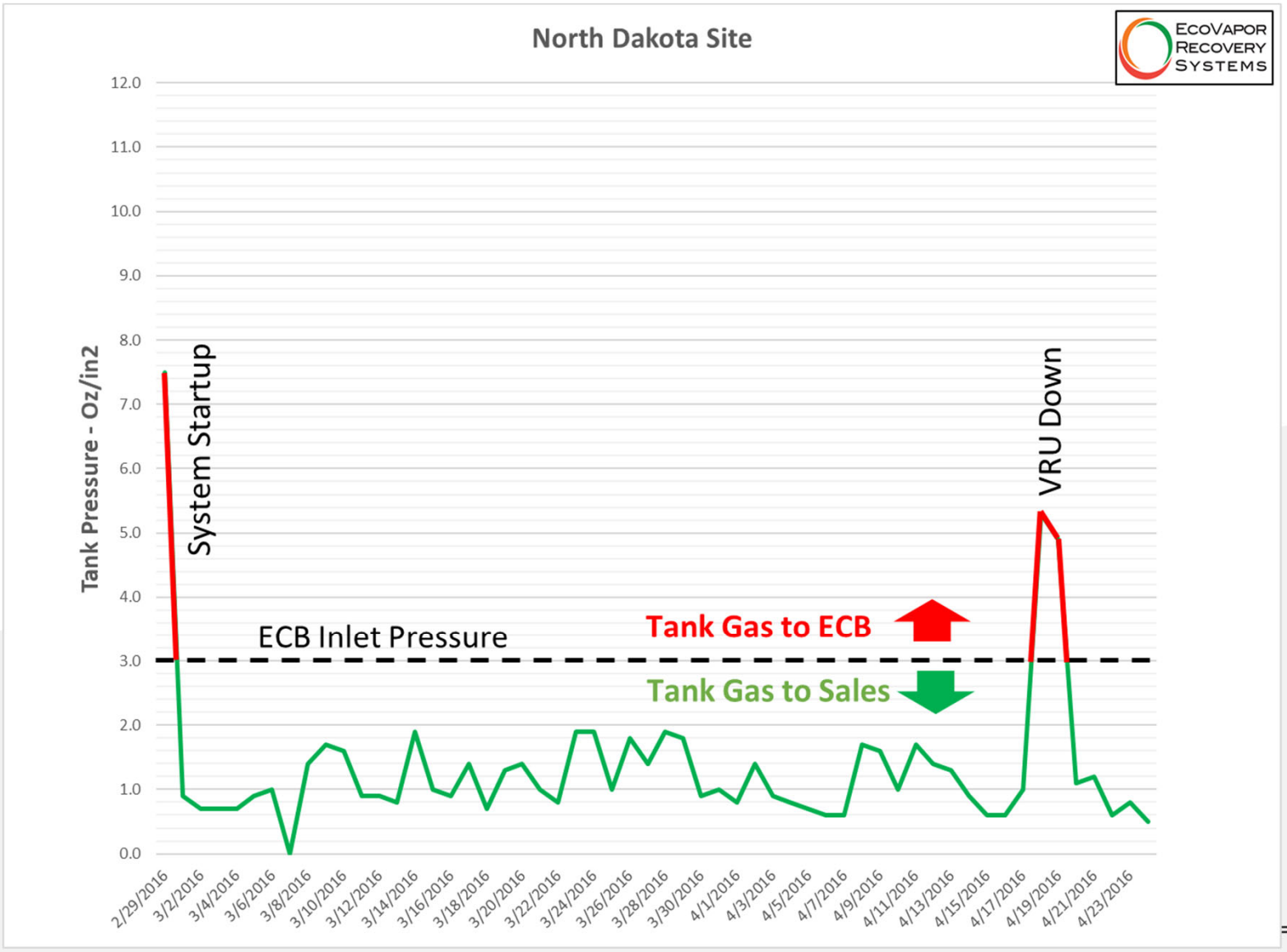
North Dakota Site
EcoVapor Recovery Systems
Tank Pressure - Oz/in2
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
System Startup
VRU Down
ECB Inlet Pressure
Tank Gas to ECB
Tank Gas to Sales
2/29/2016
3/2/2016
3/4/2016
3/6/2016
3/8/2016
3/10/2016
3/12/2016
3/14/2016
3/16/2016
3/18/2016
3/20/2016
3/22/2016
3/24/2016
3/26/2016
3/28/2016
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