“Wish list” of UOGD operational information for understanding emissions to air

Energy Webinar #1:

Human Exposure Research in a Cyclical Industry Part 1: Air Emissions from Unconventional Oil and Natural Gas Development

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Why a “Wish List”?

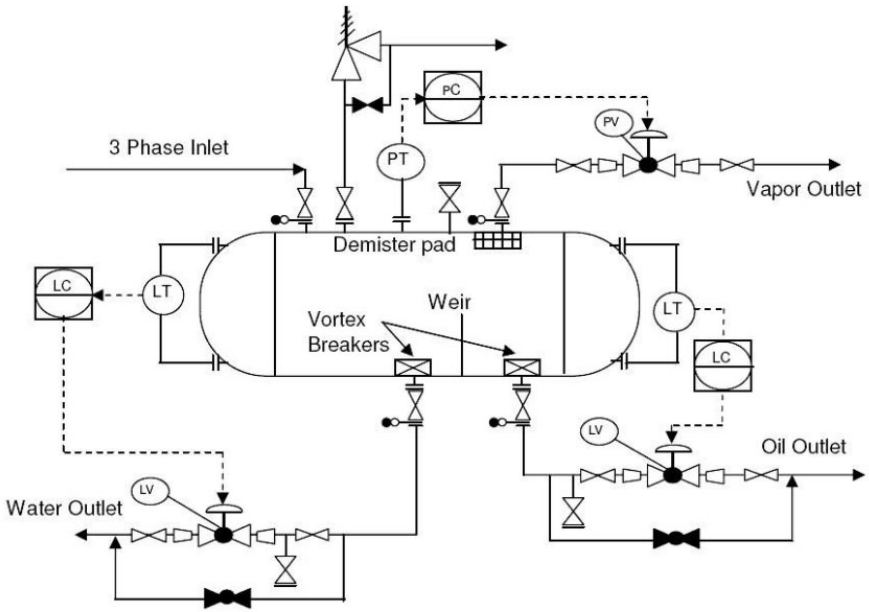
- A list of operating parameters, process equipment, maintenance practices and conditions that could be collected at measured facilities
- To transfer what is learned to the broader sector, will need to correlate to the operations and processes measured
- Operational data could assist in marrying emission measurements of specific processes to understand reasons for, and differences in, those emissions which can inform mitigation
- This is a start and ripe for dialogue ...

Phase of Development

- Drilling
- Hydraulic fracturing & completion
- Production
- Plugging and site remediation

In Preparation

1. Production history of the well(s) – oil, gas, produced water
2. Design description –
   - Facility process flow diagram (PFD)
   - Piping & instrumentation diagram (P&ID)
   - Equipment list (including pneumatic devices)
3. Routine maintenance schedule
4. OGI camera to identify source of measured emissions



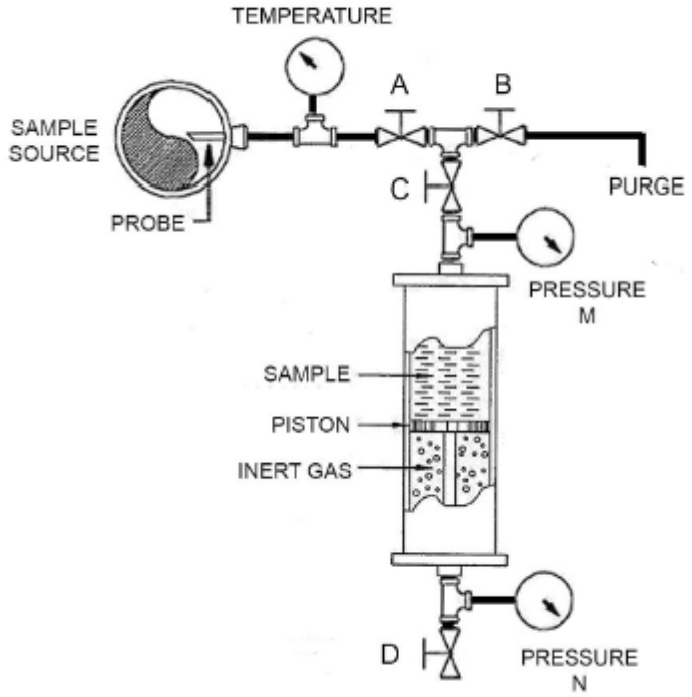
Pipeline & Wells

1. Gas gathering pipeline -
   - Typical pressure
   - Variability in pressure
   - Pigging schedule and protocol
2. Well info –
   - Type of artificial lift if used (e.g., pump jack, automatic or manual plunger lift, gas-assisted plunger lift)
   - Chemicals injected at well
   - If well maintenance/workover activities measured, provide description of purpose, equipment used, chemicals used, duration, etc.
   - If a well liquid unloading measured, provide description, duration, physical well parameters used in emission estimates for EPA's Greenhouse Gas Reporting - subpart W, frequency, etc.
3. Production occuring during measurement campaign – oil, gas, produced water

Process Samples

1. Pressurized liquid samples of oil and of produced water from pressurized separator immediately upstream of storage tanks
2. “Raw” or “field” gas sample and analysis off the separator (the gas stream used on-site for pneumatic devices, fuel gas, and reflective of fugitive leaks upstream of the tanks).
3. Stock tank oil sample - API gravity
4. Sample and analysis of the ‘waste gas’ stream routed to on-site flares or combustors; flow rate measurement.

Figure 3: Piston Cylinder Sampling Train



CARB - Regulation for the Mandatory Reporting of Greenhouse Gas Emissions Appendix B TEST PROCEDURE for Determining Annual Flash Emission Rate of Gaseous Compounds from Crude Oil, Condensate, and Produced Water

Tanks

1. Pressure and temperature of the inlet separators, VRU towers, or other intermediate pressurized separation prior to atmospheric storage tanks (using calibrated instruments)
2. Oil from the separator to the storage tank dumped in batches or continuously?
3. Temperatures of tanks (note whether read with gauges on the equipment or project-measured with their own instruments)
4. Pressure/vacuum relief settings on tanks (thief hatches, pressure relief valves)
5. Tank thief hatches – make/model and gasket type
6. Truck loading event(s) –
   - Auto-gauging or manually gauged by opening the thief hatch
   - Thief hatches open or closed during loading
   - Truck loading emissions routed to control device?

Glycol Dehydrators

1. Absorber pressure and temperature
2. Glycol pumps make/model and circulation rate
3. Flash gas separator – P and T
4. Blowcase on regenerator stream?
5. Stripper gas used?

Combustion Sources

1. Emission control flares or combustors –
   - Make/model
   - Single, dual or multiple flare tip
   - Air assist
   - Minimum and maximum rated flow & BTU/hr
   - Back-pressure on waste gas before inlet to flare/combustor
2. Other combustion equipment –
   - Tank heaters, reboilers, line heaters, heater treater, pump jack engines, VRU compressors, etc.
   - Heat rating
   - Combustion control (e.g., air-fuel ratio control)