Tank Emissions from Controlled Tanks

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Tanks Emissions: overview

- Tanks can be a significant source of methane & VOC
 - flash emissions, working and breathing emissions, and emissions resulting from upstream problems (stuck dump valves or problems resulting from undersized separators)
- Current emissions estimate: 104 ktonne CH₄
 (crude oil tanks + condensate tanks)
- Previous estimates were ~4x higher
- Inventory calculates that 70-80% of oil and condensate are stored in controlled tanks, but ~90% of emissions are from uncontrolled tanks.
- Most new tanks (installed since August 2011) are covered by NSPS Subpart OOOO / OOOOa, requiring control if VOC PTE is over 6 tons per year

Do tank emission controls work?

- Some top-down research has indicated high emissions from VOC-heavy sources
 - Petron et al 2014: high benzene in Weld County in 2012
 - Roest and Schade 2017: high VOC emissions in Eagle Ford 2013-2015
- Consent decrees between USEPA and operators in Colorado and North Dakota, focused on high emissions from tanks with controls installed.



Causes of failure for tank control systems

- Design Flaws
 - VRUs undersized
 - Separators undersized / dumping very frequently
 - Separator dump valve leakage**
 - Liquid pooling
- Mechanical Failures
 - Thief hatch mechanical failure
 - gasket failure, weak or defective sealing mechanisms, etc.
 - Pilot flame fuel supply and igniter failures
 - Incomplete combustion
- Operational Failures / Errors
 - Thief hatches open
 - Other issues intentional bypass, flares unlit
- Leaks in the system

**2017 GHG Inventory includes a line item for Malfunctioning Separator Dump Valves, but not any of the other forms of tank control malfunction.



Estimating Emissions from tanks with malfunctioning controls

Lyon et al (2016) "Aerial Surveys of Elevated Hydrocarbon Emissions from Oil and Gas Production Sites"

- Helicopter survey of 8,000+ wellpads in Bakken, Barnett, Eagle Ford, Fayetteville, Marcellus, Power River, and Uinta basins (23 counties)
- Observed emissions from 453 tanks
- Largely qualitative (emissions observed? Y/N)
 - Lower detection limit 1-3 g/s (1.5 4 tpy)
- Most likely, many of these tanks are "uncontrolled" so we would expect to see emissions from them.
- But, did they see emissions from any tanks that should have been controlled with either a flare or VRU? If so, this would point to a malfunction. How often does this occur?

Reviewing "controlled" tanks (Method 1-Subpart W)

- Look at subset of pads from Lyon study that are 100% controlled, at sub-basin level, according to operator reports to Subpart W
- For each sub-basin (i.e. county), operators report total number of large tanks and total number of "controlled" large tanks.
- In the areas of the Lyon study, we found 14 operator-county combinations where all tanks are reported to be controlled. (Matched with pads surveyed in Lyon study based on lat/long.)
- This accounts for 538 well pads in Lyon study.

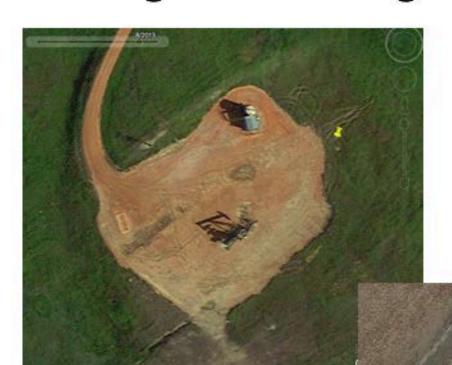


Reviewing "controlled" tanks (Method 1-Subpart W cont.)

- 538 pads measured in Lyon study that report 100% tank control to Subpart W.
 - Remove 1 pad that was fully controlled in 2014, but not in 2013, in case controls were installed halfway through 2014.
- 60 tank emissions sources at these pads
 - Adjustment to only consider wells with date of first production at least 60 days at time of Lyon survey to account for Subpart W rules
- 1,825 tanks based on Google Earth review
 - Google Earth caveats:
 - Where possible, look at Google Earth images from 2014 (year of survey), infer in cases where this is not available.
 - Not always straightforward to know which tanks for with which pads based on Google Earth alone.



Google Earth images:



1 tank, 1 well:



4 tank, 3 wells:





Reviewing "controlled" tanks (Method 1-Subpart W cont.)

- In this subset of tanks that should be 100% controlled, 3.2% are found to be venting.
- Double checks:
 - We ran these pads through E&P tanks to see if properly controlled tank emissions (assuming 95% control or similar) would still be high enough to be observed by helicopter equipment (1 g/s)—and none were.
 - Checked to see if emissions could be from "small tanks" or malfunctioning/dump valves which are reported separately in Subpart W—and none were.



Reviewing "controlled" tanks (Method 2-0000)

- Tanks on pads with first production (from first well) after OOOO effective date and at least 60 days before Lyon survey date, should be fully controlled.
 - Since the Lyon study was conducted in 2014, these were actually "Group 2" tanks with the earliest FDOP on the pad after 4/12/13.
- Due to the availability of data, we initially confine our review to pads in ND.
- 67 pads measured in Lyon study should be fully controlled under OOOO.
- 38 tank emissions sources at these pads
- 529 tanks based on Google Earth review
- In this subset of tanks that should be fully controlled,
 7.2% are found to be venting.



Findings

- These preliminary analyses find that 3-7% of these sets of tanks, which should be 100% controlled tanks, are venting significant hydrocarbons
- We plan to expand the Method 2-0000 analysis from the Bakken to other basins in the Lyon et al survey dataset.



Roughly estimating impact

- Surveys did not quantify emissions.
- As an estimate of the impact of <u>observed</u> leaks, we can estimate emissions impact if 3-7% of controlled tanks are venting <u>all</u> flash gas.
 - This may be a reasonable assumption: once a thief hatch opens or a PRV cracks, pressure in the tank is lost and essentially all vapors may take the "path of least resistance" and vent.
 - At the same time, this impact does not include smaller leaks. Some pads could vent 100% and not be detectable, and any pad can have a smaller leak not detectable from the helicopter.
 - If a pad has a stuck dump valve, or an undersized separator is not properly separating liquids, emissions can be <u>much</u> higher than flash potential emissions.
 - Surveys were from 2014, before LDAR was required by OOOOa. If pads have wells drilled after 9/2015, LDAR will be required.
- If 3-7% of "controlled" tanks are venting flash, overall tank emissions methane should be 10-20% higher (10-20 ktonne).



Questions?

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