Fact Sheet: Estimating Emissions from Oil Storage Tanks

What the Research Found

Oil storage tanks are important but highly uncertain sources of volatile organic compounds (VOC) from oil and gas production. Utah State University researchers tested two standard emission estimation methods on Uinta Basin waxy crude. They found that emission factors derived from depressurization of oil samples in the laboratory were more certain than those determined from numerical models (i.e., equation of state models). Model results were far more uncertain, above 100% in every case, so a model-derived emission factor cannot be told apart from zero.

What are Storage Tank Emission Factors?

- Volatile organic compounds (VOC) are carbon-based gases that evaporate easily. Along with nitrogen oxides (NO_x) and sunlight, they are key ingredients for the Uinta Basin's winter ozone.
- Oil reaches the surface under pressure. At an oil well, gas, water, and oil are separated while still under pressure, then the oil is transferred into a tank at near atmospheric pressure, allowing dissolved gases (flash gas) to vent into the gas phase. Flash gas is either vented to the atmosphere, burned in a combustor, or captured using a vapor recovery unit.
- An emission factor is the pounds VOC in flash gas produced per barrel of oil added to a storage tank (lb/bbl). Multiplied by oil production, it gives the annual potential tank emissions used in permitting and other regulatory processes.
- Two general methods are used to determine tank emission factors: (1) In flash liberation analysis, a laboratory depressurizes a pressurized oil sample and measures the gas released. (2) Equation of state (EOS) models use oil composition data and well site conditions to predict the amount and composition of flashed gas.

What Laboratory Results Showed

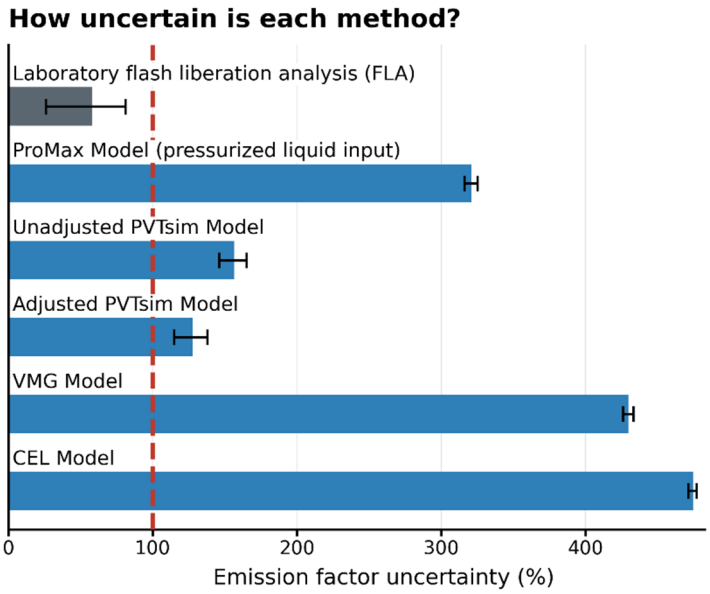
We sampled three Uinta Basin oil wells and sent replicate pressurized petroleum fluid samples to three commercial laboratories. The laboratories performed comprehensive analyses of the samples, including flash liberation analysis. We used some of the laboratory results in two EOS models at default settings.

1. **Laboratory measurements were variable.** Molecular weights, the share of heavy compounds, the gas-to-oil ratio and the VOC fraction of flash gas all differed significantly between laboratories that followed the same methods. No certified standard exists for pressurized waxy crude oil, so we can't be certain about which lab was most correct. Also, results from repeat sampling at a well over a 24-hr period were not statistically distinct.
2. **Laboratories agreed on the emission factor by compensation.** Two laboratories performed flash liberation analysis to determine emission factors. One reported heavier, more VOC-rich flash gas but a lower gas-to-oil ratio than the other, but the differences canceled when multiplied together, resulting in very similar emission factors.

3. **Repeat samples scattered widely.** Replicate analyses within a single laboratory ranged between 13% and 93% of the mean, so a single analysis may not represent a well's true factor. The gas-to-oil ratio was the most important input in determining emission factors: a one-standard-deviation change moved the factor by 22%.

Models Add More Uncertainty Than Laboratories

Model emission factors ranged from 28% to 433% of the laboratory value for the same oil, and different models disagreed with each other. The chart at right compares laboratory results with several different models. Emission factors derived from laboratory flash liberation analyses carried 26–81% uncertainty, but every model landed above 100% once its differences from the laboratory and the laboratory's own uncertainty were counted.



These uncertainties change regulatory conclusions. None of the model-derived emission factors reported in the Utah Division of Air Quality's oil and gas emissions inventory are statistically distinct from one another, and no statistically meaningful differences in emission factors by company or formation type can be distinguished, either.

What this Means for Air Quality Management

✓ **Report a range, not a point.** An emission factor without its uncertainty, and the choices behind it, conveys false precision.

✓ **For now, prefer laboratory flash analysis for waxy crude.** Laboratory flash analysis was the least uncertain method. EOS models for which the binary interaction parameters are carefully tuned may have acceptable levels of uncertainty when applied to Uinta Basin waxy crude, but such models are not yet publicly available.

Limitations

No certified standard for pressurized Uinta Basin petroleum fluid exists, so the uncertainties in this study are relative. Also, the findings are likely not applicable beyond waxy crude oils.

More Information

This work is a preprint by Utah State University's Bingham Research Center and Texas A&M University: Lyman and Dindoruk (2026), "Development of Waxy Crude Oil Storage Tank Emission Factors," https://papers.ssrn.com/sol3/papers.cfm?abstract_id=7606987. More reports and data are available at https://www.usu.edu/binghamresearch/papers-and-reports.

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