Title: Low NO_X and High Organics Emissions from Oilfield Engines

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WHY THIS STUDY WAS NEEDED

- Emissions inventories mostly use manufacturer specifications and engineering equations for emissions from pumpjack engines, rather than actual measurements.
- The U.S. EPA database of speciation profiles contains only one profile for natural gas-fueled pumpjack engines—derived from a handful of engines in California in 1985.
- Comprehensive characterization of emissions from pumpjack engines will help scientists, regulators, and industry understand how the engines influence air quality and climate.

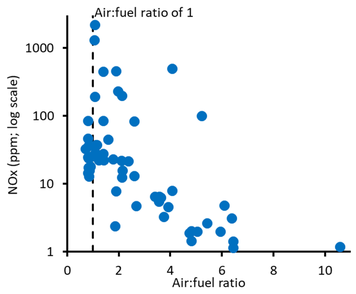
HOW WE DID IT

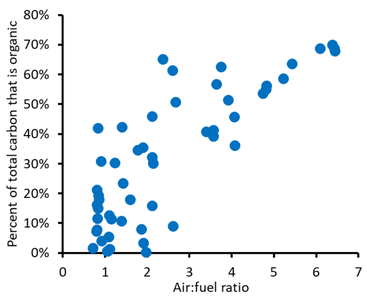
- Ecom J2KN to measure O_2, CO, CO_2, NO, NO_2
- LGR FGGA to measure CH_4
- Whole-air canister samples to measure 53 hydrocarbons, 3 alcohols
- DNPH cartridges to measure 13 carbonyls
- Heated, filtered line to transfer sample gas, avoid condensation
- Pitot tube to measure exhaust velocity
- 58 engines in Utah's Uinta Basin: Ajax E-42, E-565, DP-60, and DP-80; Arrow C-101, C-106, and L-795; and GM Vortec 4.3L

AIR:FUEL RATIO IS KEY

- An air:fuel ratio (lambda) of 1 is the exact proportion of air and fuel needed for stoichiometric combustion. >1 (lean-burning) is too much air, <1 (rich-burning) is too much fuel.

A high air:fuel ratio leads to cooler engine conditions, which creates less NO_X and leads to more fuel passing through the engine uncombusted. Most engines in this study had high air:fuel ratios, usually leading to low NO_X and much of the carbon in the organic form (i.e., not combusted to CO or CO_2) in the exhaust gas.





Oilfield **pumpjack engines** emit **much less NO_X** and **more organics** than previously assumed.

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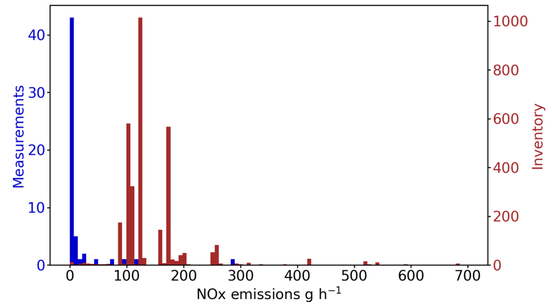
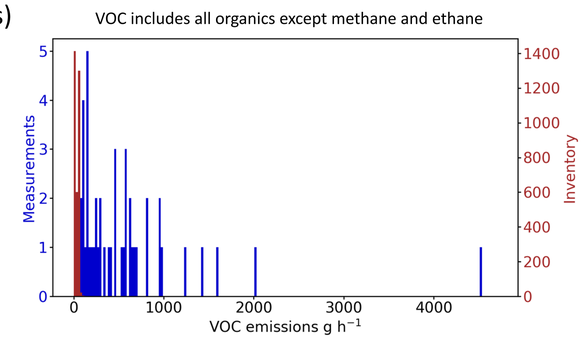
MEASURED NO_X IS MUCH LOWER THAN INVENTORY

- The histogram shows the distribution of measured NO_X emissions versus values listed in the official inventory for the same region. Average of measurements was 9% of inventory (median was 2%)



MEASURED ORGANICS ARE MUCH HIGHER THAN INVENTORY

- The histogram shows the distribution of measured VOC emissions versus values listed in the official inventory for the same region. Average of measurements was 15 times inventory (median was 10 times)



WHY MEASUREMENTS AND INVENTORY ARE SO DIFFERENT

- Many engines had an extremely high air:fuel ratio (i.e., they were extremely lean-burning), perhaps higher than assumed in the inventory, leading to less NO_X and more organics.
- Most engines operate at far less than maximum load . Inventories usually assume maximum load. A separate study found that NO_X emissions decrease exponentially with decrease in load.

IMPROVED ORGANIC COMPOUND COMPOSITION DATA

- Measured composition differs from fuel gas used by the engines and from available composition data in the EPA SPECIATE database.