Authors: Seth Lyman, Huy Tran, Trevor O'Neil

Title: Characterization of emissions from oilfield engines

Utah's Uinta Basin experiences high ozone during some winters, and wintertime ozone production is driven largely by emissions or oxides of nitrogen (NOx) and organic compounds from the local oil and gas industry. The ambient atmosphere in oil and gas-producing areas of the Uinta Basin is relatively poor in NOx (mean wintertime concentrations of about 5 ppb) and relatively rich in total organics (mean wintertime concentrations of about 300 ppb). Alkenes, which are dominated by ethylene and propylene, comprise about 3% of total organics, but that number grows to about 8% in areas with intensive oil production. Ethylene and propylene are extremely reactive with respect to ozone production, so understanding their sources is important to developing an effective strategy to mitigate ozone pollution. We have shown in previous studies that alkene emissions from non-combustion sources in the Basin are very low, while it is well understood that combustion processes generate alkenes. Very few publicly-available measurements of combustion sources have ever been made in the Uinta Basin, however.

To begin to fill in this knowledge gap, we measured emissions of NO, NO_2, CO, CO_2, O_2, H_2O, CH_4, and a suite of 70 non-methane organic compounds from 36 artificial lift engines (i.e., engines that drive pumps to pull crude oil from the subsurface) in the Uinta Basin during winter 2021. Most lift engines are operated "lean," i.e., with more air than is needed for stoichiometric combustion (often 5 or more times more oxygen than needed). This results in low combustion temperatures, which leads to low NOx emissions and incomplete combustion of organics. NOx emissions from most of the engines were <0.01% of total pollutant emissions (i.e., all measured emissions except O_2 and H_2O) by weight. Uncombusted organic compound emissions, by contrast, were as much as 40% of total pollutant emissions by weight. Most engines had low emissions of alkenes, but a few exhibited concurrent high alkene and CO emissions. We aren't yet sure why some engines are high alkenes emitters and some aren't.