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Quantification of Fugitive Methane Emissions with Spatially Correlated Measurements Collected with Novel Plume Camera

Tracy Tsai, Chris Rella, and Eric Crosson
Picarro Inc, Santa Clara, United States (ttsai@picarro.com)

Quantification of fugitive methane emissions from unconventional natural gas (i.e. shale gas, tight sand gas, etc.) production, processing, and transport is essential for scientists, policy-makers, and the energy industry, because methane has a global warming potential of at least 21 times that of carbon dioxide over a span of 100 years [1]. Therefore, fugitive emissions reduce any environmental benefits to using natural gas instead of traditional fossil fuels [2]. Current measurement techniques involve first locating all the possible leaks and then measuring the emission of each leak. This technique is a painstaking and slow process that cannot be scaled up to the large size of the natural gas industry in which there are at least half a million natural gas wells in the United States alone [3]. An alternative method is to calculate the emission of a plume through dispersion modeling. This method is a scalable approach since all the individual leaks within a natural gas facility can be aggregated into a single plume measurement. However, plume dispersion modeling requires additional knowledge of the distance to the source, atmospheric turbulence, and local topography, and it is a mathematically intensive process. Therefore, there is a need for an instrument capable of simple, rapid, and accurate measurements of fugitive methane emissions on a per well head scale.

We will present the “plume camera” instrument, which simultaneously measures methane at different spatial points or pixels. The spatial correlation between methane measurements provides spatial information of the plume, and in addition to the wind measurement collected with a sonic anemometer, the flux can be determined. Unlike the plume dispersion model, this approach does not require knowledge of the distance to the source and atmospheric conditions. Moreover, the instrument can fit inside a standard car such that emission measurements can be performed on a per well head basis.

In a controlled experiment with known releases from a methane tank, a 2-pixel plume camera measured 496 ± 160 sccm from a release of 650 sccm located 21 m away, and $4{,}180 \pm 962$ sccm from a release of 3,400 sccm located 49 m away. These results in addition to results with a higher-pixel camera will be discussed. Field campaign data collected with the plume camera pixels mounted onto a vehicle and driven through the natural gas fields in the Uintah Basin (Utah, United States) will also be presented along with the limitations and advantages of the instrument.

References:
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2. R.W. Howarth, R. Santoro, and A. Ingraffea. “Methane and the greenhouse-gas footprint of natural gas from shale formations.” Climate Change, 106, 679 (2011).
3. U.S. Energy Information Administration. “Number of Producing Wells.” <http://www.eia.gov/dnav/ng/ng_prod_wells_s1_a.htm>. Accessed 6 January 2013.