Measurement of VOCs Using Passive Sorbent Tubes near Oil & Natural Gas Production Pads in Colorado and Texas

Extended Abstract #84

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INTRODUCTION

Improved understanding of near-source concentrations of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) around oil and natural gas production pads is important for several reasons. Production pads serve as the initial collection and storage location of product extraction, where producing wells deliver natural gas, condensate, oil, and water to the surface. Extracted products consist of VOCs and HAPs which have the potential impact air quality on local and regional scales. With new emission control requirements being rolled out in the U.S. Environmental Protection Agency's (EPA's) New Source Performance Standards for the sector,[1] it is prudent to have methods in place that aid in rule effectiveness determination.

EPA Draft Methods 325A[2] and 325B[3] focus on low-cost measurement and analysis of time-averaged fenceline concentrations of benzene near petrochemical refineries using passive-diffusive sorbent tubes (PSs). This study represents a first step in understanding the value of the PS approach to help inform VOC and HAP concentrations around upstream energy production operations. From fall 2013 through summer 2014, an EPA team deployed PSs as part of a method evaluation study around the two active oil and natural gas production pads, one in the Barnett Shale in Texas and the other in the Denver-Julesburg Basin in Colorado. PS deployments consisted of 14-day exposures at multiple locations around each pad, with preliminary benzene and toluene concentrations being discussed in this abstract. The study also compares the rural near-pad concentrations to PS data measured at an urban location in Denver, Colorado near a busy intersection with high traffic volume. Meteorological parameters were acquired from nearby weather stations and may provide additional insight in understanding VOC concentrations per location and by sampling period (described in poster presentation).

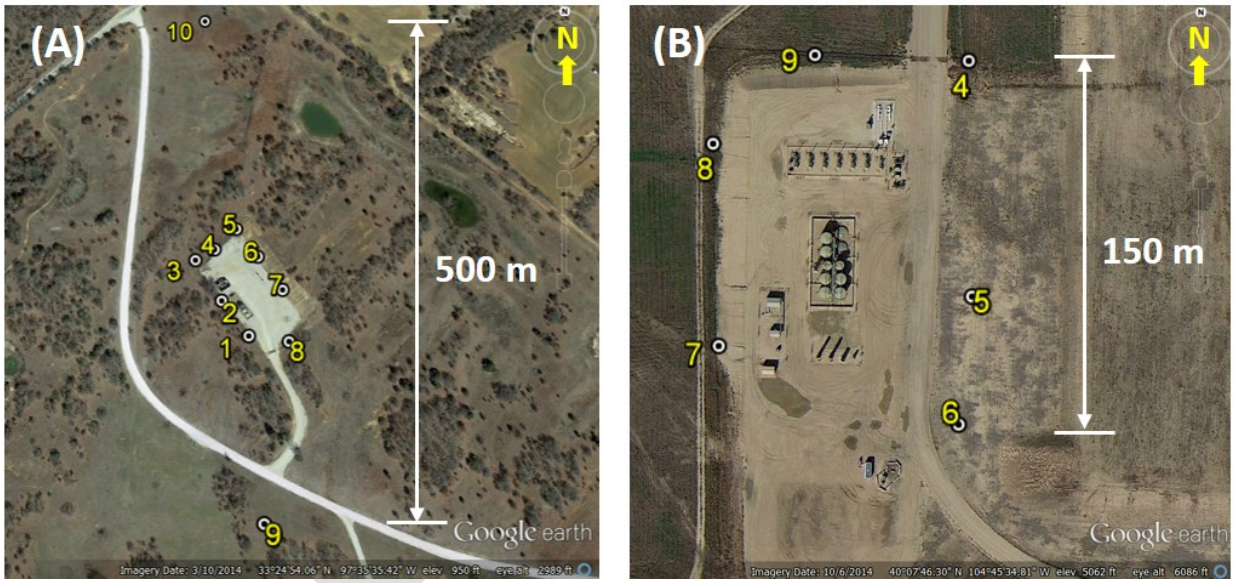
EXPERIMENTAL METHODS

Measurement Locations

Passive sampling locations in Texas, numbered 1 through 10, were deployed around a production pad in the Barnett Shale (Barnett) and are shown in Figure 1(A). A total of nineteen 14-day

sampling periods were collected at this location, starting in September 2013 and ending in September 2014. Locations 1-8 were in close proximity to each other and within 40 meters from the center of the pad. Locations 9 and 10 were located away from the pad > 200 m to investigate gradients in measured concentration. The Barnett production pad consists of one well, one separator, three product storage tanks, and one lift compressor. At the production pad in the Denver-Julesburg Basin (DJB) in Colorado, passive sampling locations 4 through 9 are shown in Figure 1(B). Due to limited resources, no gradient measurements were collected at the DJB pad. A distance of approximately 150 m separated Location 4 in the northern portion of Figure 1(B) from Location 6 in the southern portion. A north-south access road ran along the eastern extent of pad, which included frequent heavy-duty truck traffic. A total of thirteen 14-day sampling periods were collected at this site, starting in March 2014 and ending in September 2014. The production pad in the DJB consisted of seven wells, seven separators, ten storage tanks, one vapor recovery unit, and four enclosed combustors. A produced water treatment facility was operated on the southern end of the site, but was later removed in July 2014. The Barnett and DJB pads are located in rural areas with significant oil and natural gas production activities. For comparison to an urban setting, five 14-day passive sampling periods were collected at three locations on the roof of the Downtown Denver multipollutant air monitoring (CAMP) station from November 2013 through March 2014. It should be noted that special access to each of the three sites was provided to members of the EPA team by the respective site owner/operator.

Figure 1: Sampling locations at (A) Barnett production pad and at (B) DJB production pad



Passive Samplers

Each PS location was deployed around the perimeter of each production pad at a height of approximately 2 m above grade. Figure 2 shows an image of an individual PS location, which is Location 5 on the DJB pad. Ten sampling locations were installed at the Barnett pad and six locations at the DJB pad. Individual PSs were slid into a mounting bracket that sat below a sampling pod, which was mounted to an extended pole. Details of the passive-diffusive tube sampling and analysis procedure and some information on quality assurance duplicate sampler comparisons are found elsewhere in these proceedings.[4] Good PS duplicate, field blank, and detection limit performance was observed for the study and will be described in the poster.

RESULTS

Figure 2: Typical passive sampling location in the DJB

Barnett Shale

Deployment of PSs at the Barnett pad began on September 10, 2013 and ended on September 10, 2014. During this time, 19 complete 14-day sampling periods were collected. Benzene and toluene concentration statistics are reported in Table 3(A) and 4(A), respectively. The gradient locations 9 and 10 had the lowest overall benzene and toluene concentrations compared to locations 1 through 8. Locations 1 through 4 had the highest overall benzene and toluene concentrations of the ten sample locations.

Denver-Julesburg Basin

Deployment of PSs at the DJB pad began after sampling at CAMP was completed, with the first DJB sample period beginning March 12, 2013. The last sample period ended September 24, 2014, for a total of 13 complete 14-day sampling periods. Benzene and toluene concentration statistics are reported for DJB sampling locations 4-9 in tables 3(B) and 4(B), respectively. Location 7 had the highest overall benzene and toluene concentrations out of the six DJB sites, while Location 4 had the lowest concentrations.

Table 3: Benzene statistics in ppbV per sampling location at (A) Barnett and (B) CAMP (*Locations 1-3*) & DJB (*Locations 4-9*)

(A)

Location	1	2	3	4	5	6	7	8	9	10
Avg	0.20	0.24	0.26	0.24	0.18	0.19	0.17	0.16	0.15	0.15
Med	0.22	0.21	0.26	0.22	0.18	0.19	0.17	0.17	0.13	0.14
Min	0.09	0.14	0.17	0.16	0.11	0.12	0.10	0.09	0.08	0.08
Max	0.33	0.37	0.36	0.40	0.27	0.28	0.26	0.29	0.26	0.25
Stdev	0.07	0.07	0.06	0.06	0.05	0.04	0.05	0.06	0.06	0.05
n	19	18	19	19	19	19	19	19	19	19

(B)

Location	1	2	3	4	5	6	7	8	9
Average	0.36	0.37	0.37	1.27	2.10	2.81	3.59	2.38	1.95
Median	0.36	0.38	0.38	1.18	1.94	2.39	3.24	2.18	1.83
Min	0.31	0.31	0.32	0.72	0.80	0.74	0.77	1.00	0.96
Max	0.41	0.43	0.42	2.17	4.78	7.74	8.70	4.05	2.99
Stdev	0.04	0.04	0.04	0.41	1.09	2.02	2.41	0.93	0.66
n	5	5	5	13	13	13	13	13	13

Table 4: Toluene statistics in ppbV per sampling location at (A) Barnett and (B) CAMP (*Locations 1-3*) and DJB (*Locations 4-9*)

(A)

Location	1	2	3	4	5	6	7	8	9	10
Avg	0.22	0.29	0.31	0.29	0.20	0.21	0.18	0.17	0.16	0.15
Med	0.23	0.27	0.29	0.29	0.20	0.20	0.17	0.16	0.15	0.15
Min	0.12	0.20	0.22	0.20	0.14	0.13	0.12	0.11	0.09	0.09
Max	0.35	0.42	0.42	0.44	0.30	0.31	0.30	0.30	0.29	0.26
Stdev	0.07	0.07	0.06	0.06	0.04	0.04	0.05	0.05	0.05	0.04
n	19	18	19	19	19	19	19	19	19	19

(B)

Location	1	2	3	4	5	6	7	8	9
Average	1.11	1.14	1.17	1.91	3.35	4.84	6.72	3.59	2.73
Median	0.93	0.97	0.96	1.78	2.91	5.46	7.04	3.46	2.93
Min	0.77	0.80	0.76	1.04	1.11	0.91	1.09	1.32	1.26
Max	1.71	1.77	1.93	3.06	7.38	11.10	17.72	7.12	3.92
Stdev	0.40	0.40	0.49	0.59	1.89	3.50	5.36	1.60	0.77
n	5	5	5	13	13	13	13	13	13

CAMP Station

PS data collection at CAMP in Downtown Denver began on November 6, 2013 and ended on March 12, 2014. Five 14-day sample periods were collected during this time. Benzene and toluene concentration statistics for CAMP locations 1-3 are also reported in Tables 3(B) and 4(B), respectively. The three sampling locations on the roof of CAMP were within 8 m of each other.

DISCUSSION

For three locations measured, the highest overall average benzene and toluene concentrations were observed at the DJB production pad and the lowest were observed at the Barnett pad. A number of factors influence these concentrations, such as PS distance to sources, meteorological conditions, product composition, production rate, and control effectiveness. An initial analysis suggests meteorological conditions are not the major factor in site to site differences. A comparison of emission measurements on production pads in the Barnett Shale and the DJ-Basin showed highly variable VOC emission rates collected at a much higher time resolution,[5] so apportioning sources with 14-day exposures can be challenging. However, trend analysis can be useful when knowledge of operational changes at a site are available.

SUMMARY

This abstract reviews a pilot method study on use of EPA Draft Methods 325A and 325B for VOC monitoring around oil and natural gas production pads. This study represents a first step in understanding the value of the low-cost PS approach to help inform VOC concentrations around upstream energy production operations. Gradient measurements, when sufficient separation distances from sources are available, can help define the extent of enhanced concentrations of VOCs and HAPs. Benzene and toluene concentrations were significantly higher near the DJB production pad when compared to the concentrations measured at the Barnett pad. Condensate

and natural gas production rates, composition, and specific operations likely help explain these differences. Meteorological parameters and distance to the source also have a significant influence on PS concentrations measured at each location. These factors will be further explored in the poster presentation.

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KEYWORDS

Fenceline, Passive Samplers, Oil and Natural Gas, VOCs, Method 325A, and 325B.