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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

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OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Results of Methanol Impinger Study

FROM: Charles Moulis, Chemical Engineer
Engine and Vehicle Regulations Branch

TO: The Record

INTRODUCTION

Last year, the Test and Evaluation Branch performed an investigation of the behavior of methanol impingers. The overall objective of this project was to provide data which would allow us to determine the need for upper limits on flowrates of sample through the impingers. Experiments were designed to indicate whether high flow rates or vacuum conditions could cause some of the methanol to remain in the sample gas after the first two impingers. The first part of the work involved drawing high concentrations of methanol in air (nominally 50 to 200 ppm) through three impingers in series at flow rates as high as eight liters per minute (LPM). The second part of the work involved drawing samples of methanol in air (nominally 100 ppm) through two impingers in series (while measuring pressures), then into a FID. The most significant portions of this work are described here.

EXPERIMENTAL

Mixtures of methanol in air were prepared by mixing a known mass of methanol with a known volume of air. These samples were drawn through one of two impinger systems. The first system included three impingers in series. This system was designed to determine the collection efficiency of the secondary impinger when either the flow rate or the concentration of the methanol in air is high. Flowrates were varied from 2.1 to 8.0 LPM, and concentrations of methanol in air ranged from 51 to 218 ppm.

In the second system, the sample was drawn through two impingers in series and then pumped into a sample bag. The bag contents were then analyzed for organics using a flame ionization detector (FID). A flow restrictor was placed before the impingers to simulate a critical flow orifice, and impinger pressures were measured. This system was designed to determine whether the effectiveness of the normal two impinger sampling system would be affected by vacuum conditions. Flow rates were varied from 4.0 to 7.8 LPM, and concentrations of methanol in air ranged from 98 to 151 ppm.

RESULTS

Data from the first set of experiments showed that the secondary impinger is very efficient at collecting methanol from the sample gas. In all cases, there was no detectable methanol in the third impinger (detection limit was 1 mg/l). The primary impinger collected most of the methanol, while the secondary impinger collected 2 to 7 percent. One test was voided because there was a significant, but unexplainable loss of methanol. The results of the valid tests are shown in Table 1. Unusually heavy splashing was observed in the impingers during the experiments which involved flow rates over six liters per minute.

Table 1

| Initial Gas Concentration (ppm) | Flow Rate (l/min) | Impinger #1 Concentration (mg/l) | Impinger #2 Concentration (mg/l) | Impinger #3 Concentration (mg/l) |
|---|---|---|---|---|
| 217.8 | 6.98 | 276.8 | 10.8 | 0 |
| 112.6 | 2.07 | 139.9 | 6.1 | 0 |
| 115.0 | 8.01 | 142.8 | 7.2 | 0 |
| 51.5 | 2.07 | 66.7 | 5.2 | 0 |

The data from the second set of experiments showed similar results; in all cases, no methanol was detected by the FID (detection limit was not reported) after the secondary impinger. The vacuum across the two impingers was measured and found to vary from 3.1 to 15.4 inches of mercury. There was moderately heavy splashing observed during the first two experiments, where the flow rates were between seven and eight liters per minute. The results are summarized in Table 2.

Table 2

| Initial Gas Concentration (ppm) | Flow Rate (l/min) | Impinger #1 Concentration (mg/l) | Impinger #2 Concentration (mg/l) | Impinger Vacuum ("Hg) |
|---|---|---|---|---|
| 110.2 | 7.00 | 141.1 | 10.3 | 13.3 |
| 150.8 | 7.85 | 185.1 | 10.9 | 15.4 |
| 98.5 | 4.05 | 122.6 | 7.4 | 3.1 |

## CONCLUSION

The primary purpose of this work was to determine if high flow rates caused breakthrough to occur (i.e., the effectiveness of the primary and secondary impingers is reduced to a point where a significant amount of methanol remains uncollected). While flow rates in the seven to eight liter per minute range did cause some moderately heavy splashing to occur, they did not cause methanol breakthrough at detectable levels. These results do not appear to justify the establishment of a strict upper limit on the flow rates for methanol sampling. It may be appropriate, however, to establish a surrogate limit which controls the amount of methanol collected in the secondary impinger. While such a limit would not prevent the use of very high flow rates, it could serve to prevent conditions where breakthrough would occur. Based on the data above, it appears that an upper limit of ten percent for the portion of the methanol that is collected in the secondary impinger would be feasible, even for relatively high flow rates.