

# Technical Note 08

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## PID Pre-Filter Tube for Benzene Measurement

### Introduction

Benzene is an aromatic hydrocarbon widely used in industry to make plastic, resins, dyes, detergents, pesticides, etc. It is found in varying concentrations (0.1 – 3%) in crude oil, gasoline and other auto fuels. Benzene is both carcinogenic and highly toxic with a TLV-TWA of 0.5 ppm. As a result, the toxicity of the fuel is primarily decided by the concentration of benzene, as other constituent hydrocarbons in auto fuel are much less toxic with their TLV ranging from 50 – 1000 ppm. Hence, the measurement of the benzene concentration in the presence of other accompanying hydrocarbons of various fuels is a must to ensure personal safety.

### Benzene Specific Measurement

The Uniphos PID Pre-filter tube for benzene, selectively scrubs all other hydrocarbons (VOC) present in the fuel and allows only benzene to reach the PID instrument. This is achieved by using a hydrocarbon scrubbing “chemical selective filling material” in the pre-filter tube, which reacts only with hydrocarbons and changes its color while benzene passes through unreacted.

### Calibration Procedure

Calibrate the instrument using a Uniphos PID Pre-filter tube for Benzene. This is done by using a benzene calibration standard of five ppm as recommended by the instrument manufacturer.

### Sampling Procedure

A calibrated instrument should be used for making measurements. Score and open the tips of a PID pre-filter tube and insert it into the tube holder of the PID instrument and start the sampling. The air sample is drawn at about 350 ml/min by the instrument. The instrument displays the benzene concentration reading after 30 – 300 sec depending upon the pre-filter tube temperature. The pre-filter tube is to be used only once for each measurement.

### Co-existing Gases and Measurement Range of Benzene

The PID pre-filter tubes, are designed to provide benzene specific measurements in the presence of other hydrocarbon constituents of various fuels, and have been tested for several possible hydrocarbons likely to be present in a sample gas. Table-1 (page two) gives the response of the PID instrument tested at a chosen concentration of these gases. The test concentrations chosen for different VOCs are not necessarily the maximum allowable concentration. Using the PID Pre-filter tube, the PID instrument can measure 0.05 - 200 ppm of benzene in the sample air.

**TABLE-1**

| Sr. No. | Compounds         | Concentration (ppmv) | Apparent Benzene response |
|---------|-------------------|----------------------|---------------------------|
| 01      | Toluene           | 400                  | 0.0                       |
| 02      | P-Xylene          | 200                  | 0.0                       |
| 03      | Ethyl Benzene     | 200                  | 0.0                       |
| 04      | Styrene           | 100                  | 0.0                       |
| 05      | Nitrobenzene      | 100                  | 0.0                       |
| 06      | Phenol            | 100                  | 0.0                       |
| 07      | Hydrogen Sulphide | 150                  | 0.0                       |
| 08      | Methane           | 25000                | 0.0                       |
| 09      | Propane           | 1000                 | 0.0                       |
| 10      | Isobutane         | 100                  | 0.0                       |
| 11      | Isobutylene       | 500                  | 0.0                       |
| 12      | n-Pentane         | 1500                 | 0.0                       |
| 13      | 1,3-Butadiene     | 300                  | 0.0                       |
| 14      | n-Hexane          | 100                  | 0.0                       |
| 15      | Cyclohexane       | 10                   | 0.0                       |
| 16      | n-Octane          | 300                  | 0.0                       |
| 17      | β-Pinene          | 50                   | 0.0                       |
| 18      | Ethanol           | 50                   | 0.0                       |
| 19      | Isopropanol       | 100                  | 0.0                       |
| 20      | Cyclohexanone     | 200                  | 0.0                       |
| 21      | Tetrahydrofuran   | 100                  | 0.0                       |
| 22      | Ethyl Acetate     | 100                  | 0.0                       |
| 23      | Acrylonitrile     | 100                  | 0.0                       |
| 24      | Epichlorohydrin   | 100                  | 0.0                       |
| 25      | Acetone           | 100                  | 0.150                     |
| 26      | Chlorobenzene     | 20                   | 25.25                     |
| 27      | Dichlorobenzene   | 50                   | 5.7                       |
| 28      | Trichloroethylene | 100                  | 14.35                     |
| 29      | Perchloroethylene | 50                   | 49.85                     |

### Humidity Effect on Measurement

Calibrate the instrument using a Uniphos PID Pre-filter tube for Benzene. This is done by using a benzene calibration standard of five ppm as recommended by the instrument manufacturer.

**TABLE-2**

| Sr. No | Relative Humidity | Benzene response on Instrument Reading (ppm) |
|--------|-------------------|--|
| 1      | Dry air           | 5.1  |
| 2      | 50 %              | 5.1  |
| 3      | > 90 %            | 5.2  |

### Sample Measurement

Fig-1 plots the PID response for different standard concentrations of benzene in sample air with 400 ppm of toluene. The graph demonstrates the benzene measurement is not affected by the presence of 400 ppm of toluene in the sample air.

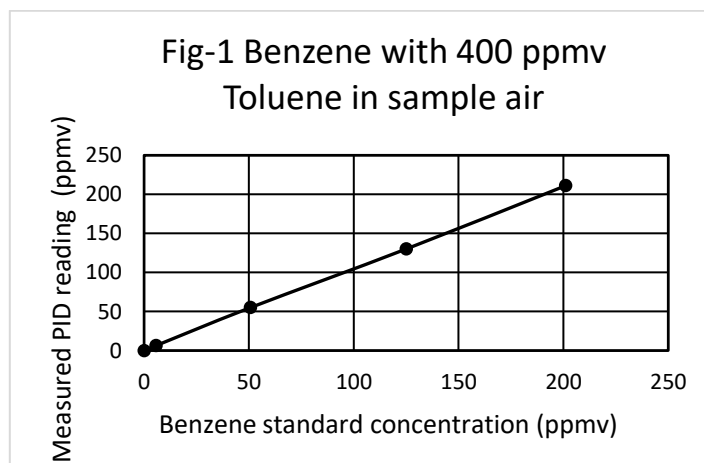
**FIG-1**


Fig-2 plots the PID response for different standard concentrations of benzene in sample air with 250 ppm of gasoline (Table-3). Gasoline sample (250 ppm) itself, without addition of benzene, showed 2.1 ppm on the instrument. Subsequent addition of benzene showed an enhanced reading on the instrument over the added concentration of benzene. The graph Fig-2 demonstrates that measurement of added benzene is not affected by the presence of 250 ppm of gasoline in the sample air.

**TABLE-3**

| Benzene standard concentration (ppmv) | Measured PID reading (ppmv) |
|---------------------------------------|-----------------------------|
| 0                                     | 2.1                         |
| 5                                     | 7.1                         |
| 51.29                                 | 53.5                        |
| 126.28                                | 129.1                       |
| 201.26                                | 202.8                       |

### Summary

The Uniphos PID Pre-filter tube for benzene, shows excellent selective scrubbing capacity for hydrocarbons (VOC) present in auto fuels and allows only benzene to reach the PID instrument. Humidity has no effect on the measurement. The benzene response of the instrument using the PID Pre-filter tube in presence of gasoline shows that the benzene response is not affected by the presence of trace amounts of benzene in gasoline. The instrument reads the total concentration of benzene, which is the sum of the added concentration plus the concentration of benzene in the matrix air.

