

# Application News

## No. AD-0073

### HS-20 & GCMS-QP2010Ultra

## Quantitative Determination of Volatile Organic Compounds in Drinking Water by EPA Method with Headspace Trap GC-MS

### □ Introduction

Volatile Organic Compounds (VOCs) refer to a group of easily vapourised organic compounds. Under atmospheric pressure, these compounds boil below 250°C. Studies have shown that prolonged exposure to the VOCs could increase the risk of various health problems, such as cancer. VOCs are commonly present in gasoline, dry cleaning solvents and degreasing agents. Due to improper storage, disposal or spillage of chemicals, these hazardous chemicals could contaminate the drinking water. In order to protect human health and the environment, the U.S. Environmental Protection Agency (EPA) has developed a standard method, namely EPA 524.3 to identify and quantify the purgeable organic compounds in finished drinking water by using purge-and-trap with GC-MS.

Headspace with trap mode could serve as an alternative option in analysing the purgeable VOCs. During incubation, VOCs from water samples are effectively partitioned into the headspace. Shimadzu HS-20 headspace sampler is ideal for extraction and concentration of VOCs from water samples. This application news reports a robust analysis method of VOCs complying with the EPA 524.3 criteria based on dynamic headspace coupled with gas chromatography-mass spectrometry. The combination of HS-20 headspace sampler and GCMS-QP2010 Ultra provides an alternative method of choice to extract purgeable organic compounds from drinking water followed by analysis of GC-MS.

### □ Experimental

#### Instrument and Analytical Conditions

The HS-20 Trap sampler utilizes the headspace technology. A water sample containing VOCs is sealed tightly inside a headspace vial. Under specified conditions of temperature, agitation and time, the VOCs in water sample achieve equilibrium between water phase and the gaseous phase. HS-20 Trap was used as an alternative sample preparation technique for the purge-and-trap. The trap mode HS-20 extracts analytes from the water sample and concentrates on a sorbent trap prior to desorbing to GC-MS. The analytical parameters of both headspace and GC-MS are presented in Table 1.

#### Preparation of Tuning Standard

Based on the EPA 524.3, the mass and abundance scales of the mass spectrometer was calibrated in order to meet the ion ratio specification for 4-bromofluorobenzene (BFB). Prior to the analysis, the mass spectrometer was tuned according to

Table 1: GC-MS and Headspace sampler conditions

| HS-20              |   |
|--------------------|---|
| Mode               | Trap  |
| Oven Temp.         | 60°C  |
| Trap Cooling Temp. | 5°C   |
| Trap Equilib Temp. | 25°C  |
| Trap Desorb Temp.  | 250°C   |
| Equilibrating Time | 30 min  |
| GC                 |   |
| Column             | Rtx-VMS 60mx0.25mmx1.4µm  |
| Carrier Gas        | He  |
| Flow Control Mode  | Linear Velocity   |
| Linear Velocity    | 31.3 mL/min   |
| Purge Flow         | 3 mL/min  |
| Split Ratio        | 10  |
| Column Oven Temp   | 45°C(4.5min), 12°C/min<br>→100°C(0min), 25°C/min →<br>240°C (5.32min) |
| MS                 |   |
| Ion Source Temp.   | 200°C   |
| Interface Temp.    | 200°C   |
| Ionization Mode    | Electron impact (EI)  |
| Ionization Voltage | 70 eV   |
| Solvent cut Time   | 1.5 min   |
| Acquisition Mode   | SCAN  |
| m/z                | 35 - 300  |

the instrument default condition. Approximately 10mL of 0.4 µg/mL BFB was prepared and filled into headspace vials. The BFB solution was introduced into the system by dynamic HS and analysed by GC-MS using the same sample analysis condition (Table 1).

#### Preparation of Primary Dilution Standard

Primary dilution standard was the most important as it will be used to prepare the calibration standards and standard for fortification. A series of primary dilution standards, concentration ranged from 2µg/mL to 160µg/mL were

prepared in 2mL microreaction vials with Mininert caps. The EPA 524.3 analytes, internal standards and surrogate standards were commercially available in 2000µg/mL ampules. 20µL of internal standard/surrogate standard mixture was spiked into each primary dilution standard. VOCs standard stock solution was added accordingly as 2, 4, 8, 20, 40, 80 and 160. Finally, methanol was added into the microreaction vials to obtain 2mL of final volume.

### Preparation of Final Calibration Standard

Ascorbic acid and maleic acid with a final concentration of 0.625g/L and 5g/L respectively in reagent water was first prepared. Seven 100mL volumetric flasks were prepared, labelled with respective concentration level and filled with 95mL of reagent water. Subsequently, 25µL of each primary dilution standard was spiked into the respective volumetric flask. Reagent water was filled to reach the gauge line of volumetric flasks. After the analytes and reagent water were mixed homogeneously, 10mL of the sample was taken into headspace vials. Immediately, the headspace vials were crimped tightly to minimize loss of VOCs.

### Preparation of Field Samples

Tap water was used as the field sample. In preparing field samples, water was collected directly from the tap and dechlorinated with ascorbic acid at pH 2.00. 0.625g of ascorbic acid and 5g of maleic acid were added into a 1L volumetric flask. 400mL of tap water was added to volumetric flask to dissolve the solid preservatives. After that, tap water was then used to fill the volumetric flask to the gauge line.

## Results and Discussion

### Initial Mass Spectrometry Tune

The MS was tuned based on the default parameter. BFB was analysed under the same analytical condition. The system performance was evaluated based on a single spectrum at the apex of the BFB peak with subtraction of the background. Shimadzu GCMSsolution QA/QC function is able to check the BFB tuning results with respect to the EPA 524 method. Figure 1 shows the result of the BFB evaluation using the QA/QC function. All BFB mass spectrum criteria must be achieved before carrying out further analysis. If the MS tune results does not meet the required mass intensity criteria, the MS should be retuned by changing the tuning conditions and repeated with BFB analysis.

### Chromatogram

This revised EPA 524.3 has included some new emerging contaminants, gasoline additives and potential breakdown of MtBE which gives a total of 76 target analytes, 3 internal standards and 3 surrogate standards. Most of the compounds have distinctive mass fragmentation. By matching the retention time, target ions and reference ions, all compounds could be identified. All the target compounds were well separated based on the respective mass chromatogram (MC), except m-xylene and p-xylene. Due to the same elution time and mass fragmentation, these two compounds were integrated together. Figure 2 showed the standard Total Ion Chromatogram (TIC) of all the compounds, including targets, internal standards and surrogate standards.

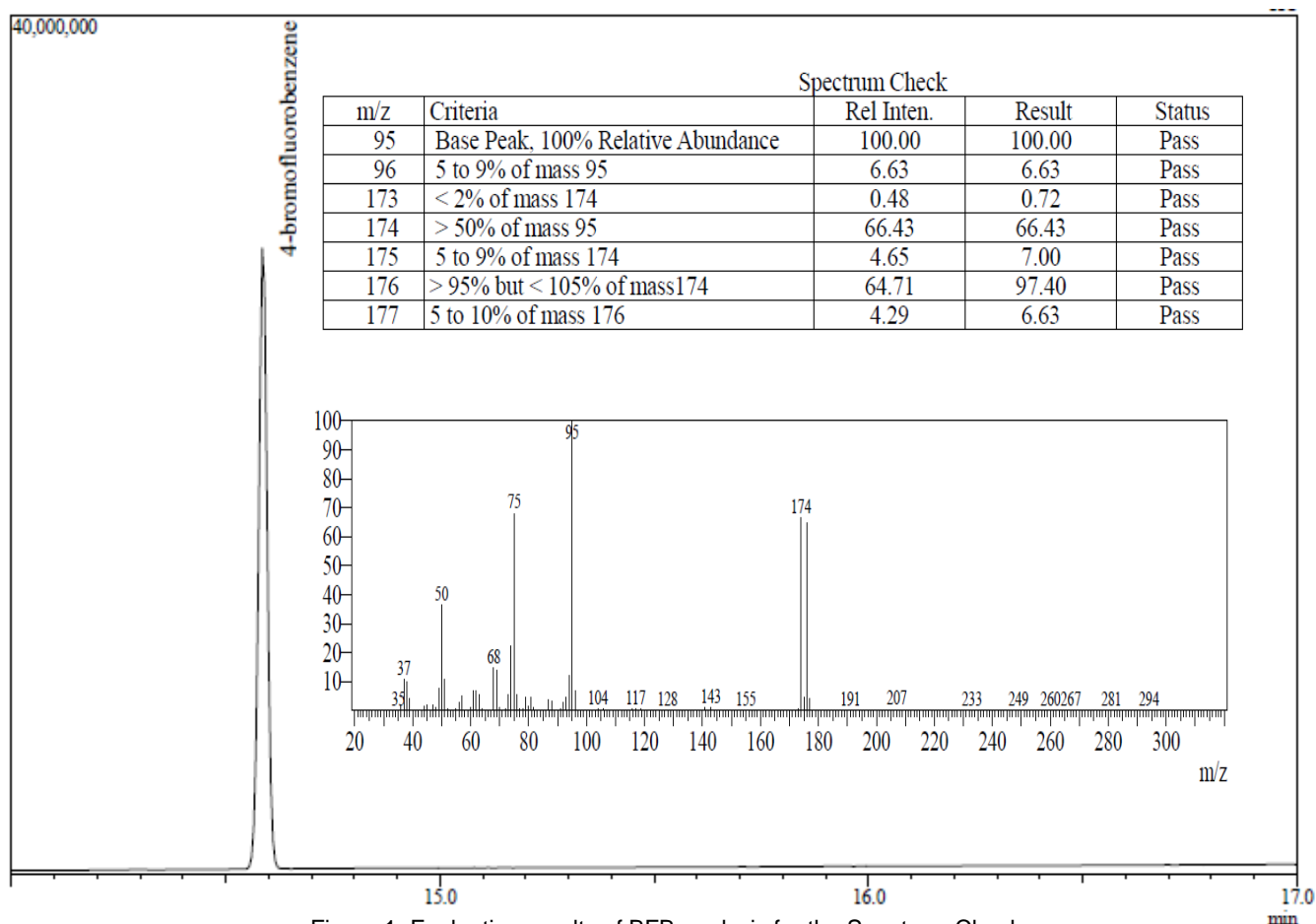


Figure 1: Evaluation results of BFB analysis for the Spectrum Check

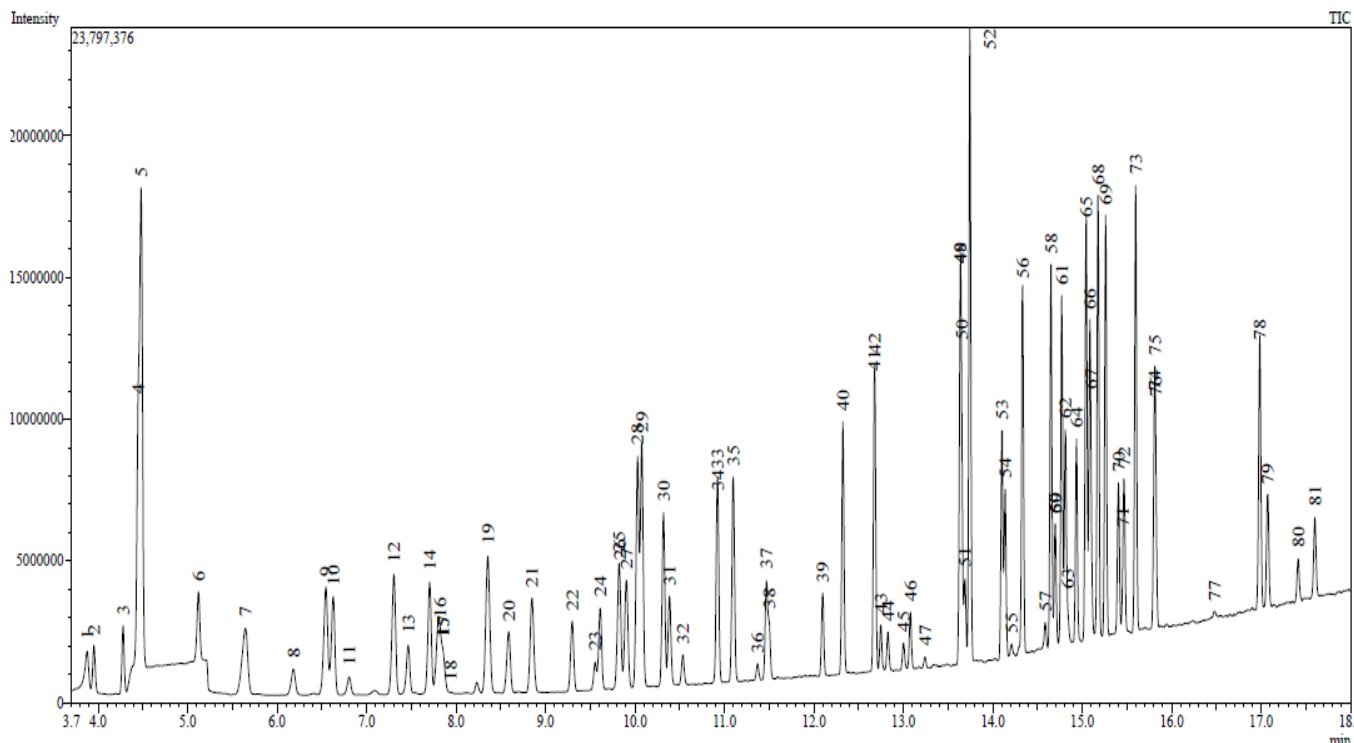


Figure 2: TIC chromatogram of VOCs based on EPA method 524.3 and analysis at 20 µg/L

### Calibration

All the target analytes were calibrated by using internal standard technique. Seven calibration standards, ranging from 0.5µg/L to 40µg/L were prepared and analysed. Each calibration point is treated as an unknown. Concentration of the calibration point is calculated based on the calibration curve. According to the EPA 524.3, either linear or quadratic regression is permitted as long as the initial calibration point is within ±50% of its true value and all other points are within ±30% of their true values. An example of Benzene quadratic calibration curve is illustrated in Figure 3. Correlation coefficient for all the compounds were more than 0.995. Some of the compounds gave R<sup>2</sup>-value as high as 1.000. Recovery of each calibration point and correlation regression are tabulated in Table 2.

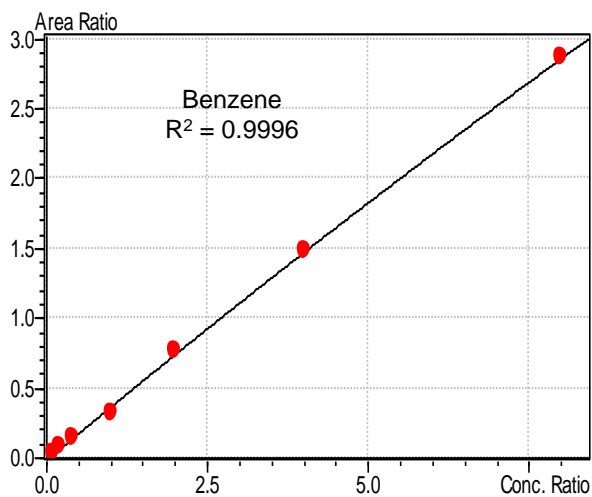


Figure 3: Calibration curve of Benzene from 0.5µg/L to 40µg/L

### Detection Limit

Method detection limit is a statistical method used to determine reported value that is greater than zero with 99% confidence level. The MDL of each analyte was calculated based on the equation below.

$$MDL = s \times t_{(n-1, 1-\alpha=0.99)}$$

Seven replicated control samples were prepared at 0.1µg/L. The Shimadzu GCMSsolution QA/QC function will automatically generate the calculation of MDL. As shown in Table 2, target analytes MDL is lower than the first calibration point, except *t*-butyl alcohol which commonly gives poor MS response.

### Precision and Accuracy

In the demonstration of system stability, seven replicate samples in reagent water were prepared at 5µg/L which is the midrange of the initial calibration curve. Percentage of relative standard deviation (RSD) was calculated based on the equation below to determine the system precision.

$$\%RSD = \frac{\text{Standard deviation of Measured Concentrations}}{\text{Average Concentration}} \times 100\%$$

System accuracy is calculated based on the percentage of recovery using the same seven replicate samples.

$$\%Recovery = \frac{\text{Average Measured Concentration}}{\text{Fortified Concentration}} \times 100\%$$

These seven replicate samples concentration must not deviate more than 20% from the true concentration with %RSD less than 20%. All analytes %RSD and %Recovery are found to be within the allowable limit. Chromatogram of chlorodifluoromethane from seven replicate samples were overlaid in Figure 4. 90% of this highly volatile analyte were recovered with deviation of 2.9%.

Table 2: Summary of the response of all the target analytes which showed the correlation coefficient, detection limit and recovery at each calibration level ranged from 0.5 to 40 µg/L. Internal Standards and Surrogate Standards were omitted for the ease of data comparison.

| ID | Compound                    | Correlative Regression (R <sup>2</sup> ) | Recovery at each calibration level (%) |        |        |        |         |         |         | Method Detection Limit (MDL, µg/L) |
|----|-----------------------------|--|--|--------|--------|--------|---------|---------|---------|------------------------------------|
|    |                             |  | 0.5 µg/L                               | 1 µg/L | 2 µg/L | 5 µg/L | 10 µg/L | 20 µg/L | 40 µg/L |                                    |
| 1  | Dichlorodifluoromethane     | 0.9988                                   | 148                                    | 131    | 119    | 73     | 101     | 102     | 100     | 0.100                              |
| 2  | Chlorodifluoromethane       | 0.9999                                   | 118                                    | 104    | 107    | 92     | 101     | 100     | 100     | 0.163                              |
| 3  | Chloromethane               | 0.9996                                   | 132                                    | 114    | 104    | 95     | 94      | 103     | 100     | 0.113                              |
| 4  | Vinyl Chloride              | 0.9995                                   | 144                                    | 121    | 105    | 87     | 97      | 103     | 100     | 0.092                              |
| 5  | 1,3-Butadiene               | 0.9991                                   | 150                                    | 123    | 111    | 77     | 102     | 102     | 100     | 0.181                              |
| 6  | Bromomethane                | 0.9999                                   | 134                                    | 97     | 103    | 96     | 99      | 101     | 100     | 0.179                              |
| 7  | Trichlorofluoromethane      | 0.9993                                   | 134                                    | 127    | 108    | 80     | 100     | 102     | 100     | 0.100                              |
| 8  | Diethyl ether               | 0.9998                                   | 114                                    | 118    | 95     | 91     | 104     | 100     | 100     | 0.039                              |
| 9  | 1,1-Dichloroethene          | 0.9995                                   | 118                                    | 123    | 106    | 82     | 106     | 100     | 100     | 0.024                              |
| 10 | Carbon Disulfide            | 0.9996                                   | 112                                    | 115    | 107    | 85     | 105     | 100     | 100     | 0.065                              |
| 11 | Methyl Iodide               | 0.9998                                   | 124                                    | 114    | 102    | 88     | 103     | 100     | 100     | 0.047                              |
| 12 | Allyl Chloride              | 0.9996                                   | 134                                    | 113    | 98     | 86     | 106     | 99      | 100     | 0.028                              |
| 13 | Methylene Chloride          | 0.9998                                   | 110                                    | 110    | 95     | 93     | 105     | 99      | 100     | 0.241                              |
| 14 | trans-1,2-Dichloroethene    | 0.9996                                   | 108                                    | 108    | 102    | 88     | 107     | 99      | 100     | 0.055                              |
| 15 | Methyl Acetate              | 0.9993                                   | 142                                    | 124    | 110    | 81     | 101     | 102     | 100     | 0.285                              |
| 16 | Methyl-t-Butyl Ether (MtBE) | 0.9999                                   | 92                                     | 101    | 102    | 97     | 103     | 99      | 100     | 0.033                              |
| 17 | t-Butyl Alcohol (TBA)       | 0.9998                                   | 114                                    | 75     | 87     | 110    | 102     | 99      | 100     | 0.881                              |
| 18 | Diisopropyl Ether (DIPE)    | 0.9999                                   | 114                                    | 99     | 104    | 95     | 102     | 100     | 100     | 0.026                              |
| 19 | 1,1-dichloroethane          | 0.9998                                   | 118                                    | 105    | 103    | 89     | 105     | 99      | 100     | 0.071                              |
| 20 | t-Butyl Ethyl Ether (ETBE)  | 0.9998                                   | 100                                    | 96     | 101    | 94     | 106     | 98      | 100     | 0.026                              |
| 21 | cis-1,2-dichloroethene      | 0.9997                                   | 88                                     | 97     | 99     | 95     | 107     | 98      | 100     | 0.060                              |
| 22 | Bromochloromethane          | 1.0000                                   | 94                                     | 92     | 102    | 99     | 103     | 99      | 100     | 0.037                              |
| 23 | Chloroform                  | 0.9997                                   | 86                                     | 91     | 97     | 98     | 107     | 98      | 100     | 0.387                              |
| 24 | Carbon Tetrachloride        | 0.9997                                   | 132                                    | 114    | 112    | 85     | 99      | 102     | 100     | 0.035                              |
| 25 | Tetrahydrofuran             | 0.9978                                   | 108                                    | 97     | 66     | 95     | 119     | 94      | 100     | 0.121                              |
| 26 | 1,1,1-Trichloroethene       | 0.9998                                   | 130                                    | 110    | 108    | 89     | 100     | 101     | 100     | 0.019                              |
| 27 | 1,1-Dichloropropene         | 0.9996                                   | 118                                    | 117    | 102    | 85     | 106     | 99      | 100     | 0.039                              |
| 28 | 1-Chlorobutane              | 0.9997                                   | 110                                    | 108    | 107    | 87     | 105     | 99      | 100     | 0.033                              |
| 29 | Benzene                     | 0.9998                                   | 130                                    | 117    | 98     | 89     | 103     | 100     | 100     | 0.023                              |
| 30 | t-Amyl Methyl Ether (TAME)  | 0.9999                                   | 122                                    | 96     | 106    | 94     | 101     | 100     | 100     | 0.038                              |
| 31 | 1,2-Dichloroethane          | 0.9998                                   | 86                                     | 90     | 98     | 100    | 105     | 98      | 100     | 0.041                              |
| 32 | Trichloroethene             | 0.9999                                   | 98                                     | 105    | 104    | 92     | 104     | 99      | 100     | 0.048                              |
| 33 | t-Amyl Ethyl Ether (TAEE)   | 0.9998                                   | 104                                    | 98     | 102    | 92     | 106     | 99      | 100     | 0.021                              |
| 34 | Dibromomethane              | 0.9999                                   | 98                                     | 100    | 103    | 94     | 104     | 99      | 100     | 0.021                              |
| 35 | 1,2-Dichloropropane         | 0.9998                                   | 114                                    | 123    | 103    | 89     | 100     | 101     | 100     | 0.035                              |
| 36 | Bromodichloromethane        | 0.9998                                   | 102                                    | 102    | 100    | 93     | 105     | 99      | 100     | 0.060                              |
| 37 | cis-1,3-Dichloropropene     | 0.9997                                   | 92                                     | 90     | 101    | 96     | 107     | 98      | 100     | 0.035                              |
| 38 | Toluene                     | 0.9996                                   | 104                                    | 106    | 106    | 88     | 106     | 99      | 100     | 0.063                              |
| 39 | trans-1,3-Dichloropropene   | 0.9995                                   | 80                                     | 104    | 105    | 90     | 108     | 98      | 100     | 0.048                              |
| 40 | Tetrachloroethene           | 0.9995                                   | 118                                    | 110    | 110    | 84     | 105     | 100     | 100     | 0.047                              |
| 41 | Ethyl Methacrylate          | 0.9995                                   | 94                                     | 107    | 100    | 90     | 108     | 98      | 100     | 0.043                              |
| 42 | 1,1,2-Trichloropropane      | 0.9997                                   | 100                                    | 95     | 98     | 96     | 107     | 98      | 100     | 0.270                              |
| 43 | Dibromochloromethane        | 0.9998                                   | 64                                     | 104    | 108    | 95     | 105     | 99      | 100     | 0.054                              |
| 44 | 1,3-Dichloropropane         | 0.9995                                   | 100                                    | 100    | 98     | 92     | 109     | 98      | 100     | 0.070                              |
| 45 | 1,2-Dibromoethane           | 0.9992                                   | 136                                    | 94     | 107    | 84     | 108     | 98      | 100     | 0.054                              |
| 46 | Ethylbenzene                | 0.9998                                   | 120                                    | 103    | 105    | 90     | 103     | 100     | 100     | 0.173                              |
| 47 | Chlorobenzene               | 0.9996                                   | 108                                    | 102    | 106    | 88     | 106     | 99      | 100     | 0.062                              |
| 48 | 1,1,1,2-Tetrachloroethane   | 0.9999                                   | 128                                    | 97     | 106    | 94     | 100     | 101     | 100     | 0.077                              |
| 49 | m-Xylene, p-Xylene          | 0.9992                                   | 150                                    | 115    | 101    | 87     | 99      | 103     | 86      | 0.249                              |
| 50 | o-Xylene                    | 0.9999                                   | 94                                     | 96     | 104    | 96     | 104     | 99      | 100     | 0.110                              |
| 51 | Styrene                     | 0.9997                                   | 112                                    | 103    | 102    | 91     | 105     | 99      | 100     | 0.084                              |
| 52 | Bromoform                   | 0.9993                                   | 66                                     | 71     | 108    | 99     | 109     | 96      | 100     | 0.101                              |
| 53 | Isopropylbenzene            | 0.9995                                   | 138                                    | 114    | 110    | 85     | 100     | 102     | 100     | 0.043                              |
| 54 | n-propylbenzene             | 0.9989                                   | 150                                    | 133    | 105    | 82     | 97      | 104     | 99      | 0.039                              |
| 55 | 1,1,2,2-Tetrachloroethane   | 0.9999                                   | 106                                    | 96     | 102    | 96     | 103     | 99      | 100     | 0.196                              |
| 56 | Bromobenzene                | 0.9995                                   | 96                                     | 110    | 98     | 88     | 109     | 98      | 100     | 0.182                              |
| 57 | 1,3,5-Trimethylbenzene      | 0.9997                                   | 142                                    | 119    | 102    | 85     | 102     | 101     | 100     | 0.033                              |
| 58 | 2-Chlorotoluene             | 0.9998                                   | 124                                    | 104    | 100    | 90     | 105     | 99      | 100     | 0.024                              |
| 59 | 1,2,3-Trichloropropane      | 0.9995                                   | 128                                    | 76     | 93     | 114    | 93      | 101     | 100     | 0.303                              |
| 60 | 4-Chlorotoluene             | 0.9998                                   | 118                                    | 111    | 100    | 89     | 104     | 99      | 100     | 0.062                              |
| 61 | t-Butylbenzene              | 0.9998                                   | 110                                    | 112    | 99     | 89     | 106     | 99      | 100     | 0.030                              |
| 62 | 1,2,4-Trimethylbenzene      | 0.9998                                   | 138                                    | 120    | 105    | 86     | 100     | 101     | 100     | 0.058                              |
| 63 | Pentachloroethane           | 0.9998                                   | 114                                    | 103    | 113    | 88     | 103     | 100     | 100     | 0.067                              |
| 64 | sec-Butylbenzene            | 0.9988                                   | 148                                    | 133    | 109    | 80     | 98      | 104     | 99      | 0.032                              |
| 65 | 4-Isopropyltoluene          | 0.9995                                   | 150                                    | 127    | 104    | 83     | 100     | 102     | 100     | 0.061                              |

| ID | Compound                    | Correlative Regression (R <sup>2</sup> ) | Recovery at each calibration level (%) |        |        |        |         |         |         | Method Detection Limit (MDL, µg/L) |
|----|-----------------------------|--|--|--------|--------|--------|---------|---------|---------|------------------------------------|
|    |                             |  | 0.5 µg/L                               | 1 µg/L | 2 µg/L | 5 µg/L | 10 µg/L | 20 µg/L | 40 µg/L |                                    |
| 66 | 1,3-Dichlorobenzene         | 0.9999                                   | 108                                    | 109    | 101    | 93     | 103     | 100     | 100     | 0.147                              |
| 67 | 1,4-Dichlorobenzene         | 0.9998                                   | 112                                    | 104    | 94     | 94     | 105     | 99      | 100     | 0.059                              |
| 68 | n-Butylbenzene              | 0.9994                                   | 150                                    | 125    | 103    | 84     | 99      | 102     | 100     | 0.034                              |
| 69 | Hexachloroethane            | 0.9997                                   | 106                                    | 123    | 95     | 87     | 107     | 99      | 100     | 0.107                              |
| 70 | 1,2-Dichlorobenzene         | 1.0000                                   | 84                                     | 102    | 103    | 97     | 103     | 99      | 100     | 0.065                              |
| 71 | 1,2-Dibromo-3-chloropropane | 0.9982                                   | 112                                    | 95     | 100    | 78     | 118     | 96      | 100     | 0.379                              |
| 72 | Hexachlorobutadiene         | 0.9998                                   | 124                                    | 116    | 102    | 86     | 105     | 100     | 100     | 0.081                              |
| 73 | 1,2,4-Trichlorobenzene      | 0.9997                                   | 138                                    | 106    | 93     | 89     | 107     | 99      | 100     | 0.169                              |
| 74 | Naphthalene                 | 0.9998                                   | 108                                    | 105    | 97     | 92     | 106     | 99      | 100     | 0.122                              |
| 75 | 1,2,3-Trichlorobenzene      | 0.9992                                   | 86                                     | 106    | 89     | 93     | 112     | 97      | 100     | 0.136                              |

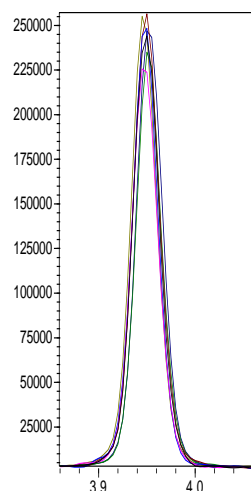


Figure 4: Recovery of Chlorodifluoromethane which is the most volatile compounds of the analysis gave 90% recovery with RSD of only 2.9%.

### Quality Control

The system stability and accuracy of existing calibration were monitored through the Continuing Calibration Checks (CCC). CCC is a calibration standard which contains the method analytes, internal standards and surrogate analytes. CCC was analysed at the beginning of each Analysis Batch, after every tenth field sample and at the end of each Analysis Batch. Each CCC contained 5µg/L of method analytes, internal standards and surrogate analytes. Each analyte was calculated to be within 3.5µg/L and 6.5µg/L, which is equivalent to ±30% of true concentration. Throughout the analysis, all the target analytes in CCC detected were within the CCCs quality control criterion. Table 3 shows the recovery of the most volatile target, Chlorodifluoromethane in the CCCs analyses.

Table 3: Recovery of Chlorodifluoromethane which is the most volatile compound of the analysis in the Continuing Calibration Checks was within the QC check criteria.

| Injection | Recovery Requirement (%) | Actual Recovery (%) |
|-----------|--------------------------|---------------------|
| 1         | 70 - 130                 | 74                  |
| 2         | 70 - 130                 | 93                  |
| 3         | 70 - 130                 | 98                  |
| 4         | 70 - 130                 | 89                  |
| 5         | 70 - 130                 | 87                  |

### Internal Standards

EPA Method 524.3 is quantitated based on the Internal Standards. Internal Standards were spiked into all calibration standards, CCCs and field samples. Stability of internal standards is crucial to obtain precise response factor of the analytes which will be used to plot the calibration curve. Internal standard peak areas of all analyses should not deviate more than 50% for the lowest calibration level and 30% of other calibration levels from the most recent CCC. Figure 5 shows the stability of internal standards for the analysis of 10 field samples.

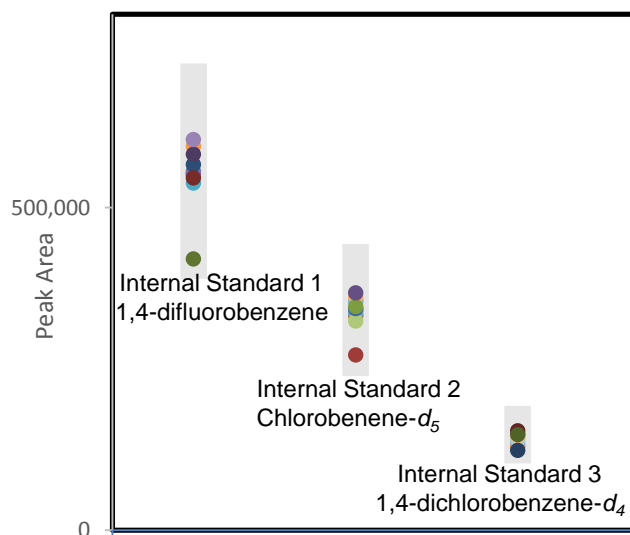


Figure 5: Peak areas of Internal Standards in all the field samples are within ±30% of peak areas (highlighted region) of internal standard in CCCs.

### Surrogate Recovery

In order to evaluate the matrix interference on sample, surrogates are spiked into the field samples prior to analyses. Surrogates are compounds which are chemically similar to the target analytes and thus behave similarly in the matrix. In the EPA Method 524.3, methyl-t-butyl ether-d<sub>3</sub>, 4-bromofluorobenzene, and 1,2-dichlorobenzene-d<sub>4</sub> were fortified as Surrogate Standards for all analyses including calibration standards, CCCs and field samples. The surrogate standards were closely monitored to confirm that the recovery percentage of samples were within the range of 70% to 130%. Figure 6 shows the recovery of all surrogates in 10 field samples analyses.

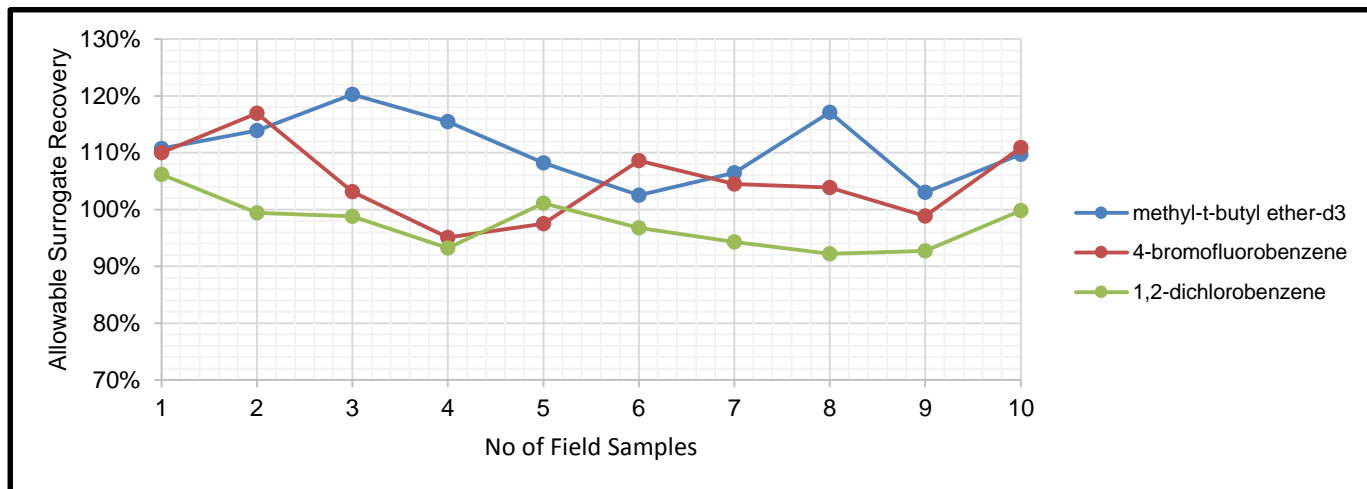


Figure 6: Recovery of all surrogates, namely methyl-t-butyl ether-d<sub>3</sub>(Surrogate 1), 4-bromofluorobenzene(Surrogate 2), and 1,2-dichlorobenzene-d<sub>4</sub>(Surrogate 3) of all 10 CCCs are within the acceptable QC criteria (70 – 130%).

### □ Conclusions

The results shows that the HS-20 Trap mode is a viable alternative method in analysis of VOCs following EPA 524.3. The correlation coefficient, recovery and RSD obtained in this study complies with the EPA Method 524.3. Matrix effect of the real samples is insignificant as recoveries of the internal standards and surrogate standards are within the limits of the standard method. In brief, the system of Shimadzu HS-20 Trap sampler coupled with GCMS-QP2010 Ultra provide another choice for analysis of VOCs in drinking and underground water samples.

### □ Reference

B.Prakash, A.D. Zaffiro, M. Zimmerman, D. J. Munch and B.V. Pepich, Method 524.3 Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, EPA Document # EPA 815-B-009, Version 1.0, June 2009