

INTRODUCING THE SCION TO-15 AIR ANALYSER FOR MONITORING VOCS IN AMBIENT AIR

Many volatile organic compounds (VOCs) that occur in ambient air are the result of emissions from mobile, industrial, landfills and hazardous waste sites. The levels of these compounds in the air are regulated by national or local government agencies. Additionally, it is vital to monitor VOCs to determine the effect they have on human health, the environment and the global climate.

Detection of toxic compounds in ambient air is one of the most difficult analyses in gas chromatography, due to the trace levels needing to be quantified. Samples must be concentrated into a small volume in order to enhance detection limits.

The United States Environmental Protection Agency (US EPA) developed a harmonised test method (TO-15) for the measurement of VOCs in air, when analysed by GC-MS. US EPA TO-15 specifies that air must be collected in specially prepared canisters. TO-15 measures organics at a linear range of 0.5nmol/

mon (ppbv) to 30nmol/mon (ppbv), with expected detection limits less than 0.2nmol/mol, for a dynamic concentration range of 100.

Experimental

The SCION TO-15 analyser consists of a SCION 456 GC, with built in sample preconcentration trap (SPT) and single quad MS, specifically configured for the analysis of ambient air in accordance to US EPA TO-15 specifications. With its patented Extended Dynamic Range detector (EDR), the TO-15 analyser is capable of accurately measuring a wide concentration range of VOCs in

ambient air. The system handles both pressurised canisters and tedlar bags without hardware changes, whilst still meeting the exact requirements of EPA TO-15.

Multi-point calibration levels were prepared and analysed. 1µmol/mol (ppmv) standards were serially diluted into working standards from 0.01nmol/mol to 100nmol/mol with a Lotus Consulting Pressure Station. Bromochloromethane, Chlorobenzene-d5 and 1,4-difluorobenzene were used as internal standards. Water was added to all evacuated canisters to deactivate polar surfaces inside the canisters for analyte preservation.

A mass flow controller (MFC) was used for sample loading of low-level analytes. The sample is directed onto a hydrophobic mixed-bed adsorbent trap with water, methane, carbon dioxide and carbon monoxide passed to vent, before the sample is passed onto a cryofocus trap where the VOCs are isolated, with sample components reduced to a smaller volume, ready for injection into the analytical system. Samples were loaded through four automated valves on a 16-position automated sampler. The SCION TO-15 analyser is detailed in Figure 1.

Results

The chromatogram from a 100ppb V/V calibration mix standard can be found in Figure 2. Due to the vast number of analytes analysed, Toluene will be discussed throughout. Toluene is representative of all analytes analysed and detected, as it is the most prevalent hydrocarbon in the troposphere, with its dispersion dependant upon atmospheric reactivity. As Toluene is very pervasive, interferences within the system were minimised during instrument configuration.

The EDR of the MS allows a very wide dynamic concentration range, including low concentrations in ambient air samples to be analysed. Due to the extensive concentration range (of over 100), calibration curves were generated using a display of log[area]

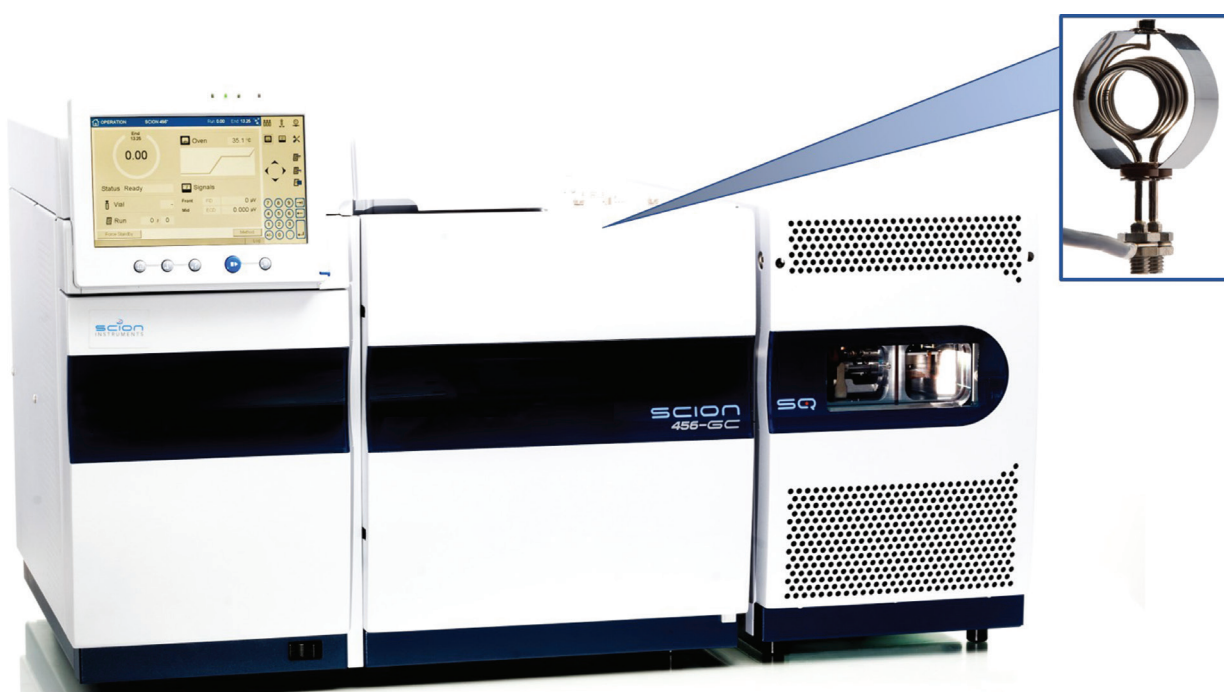


Figure 1. Scion Single Quad GC-MS with built in SPT

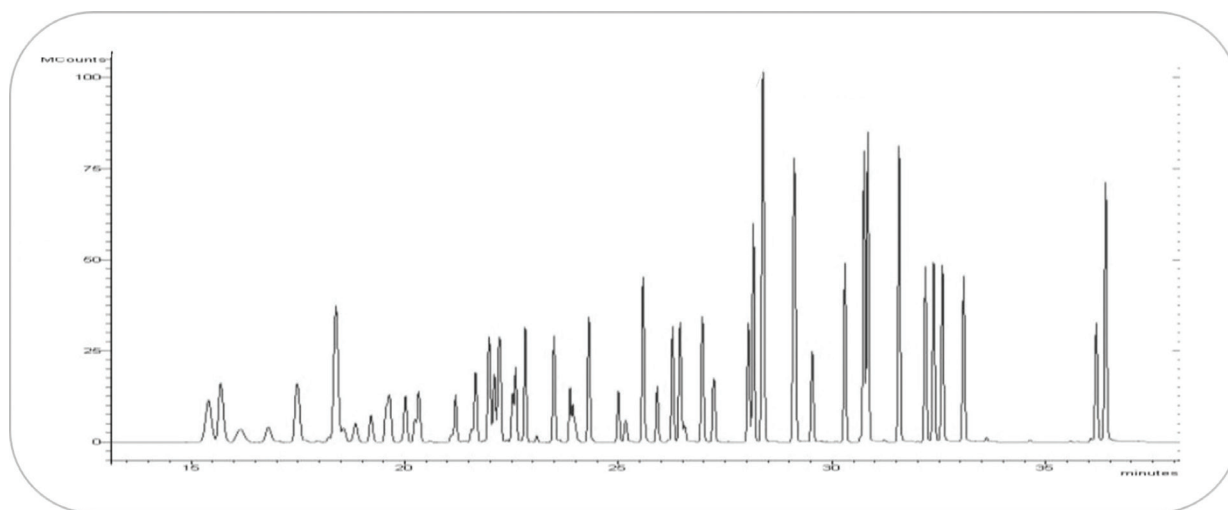


Fig 2. Chromatogram of 100ppb (v/v) calibration standard

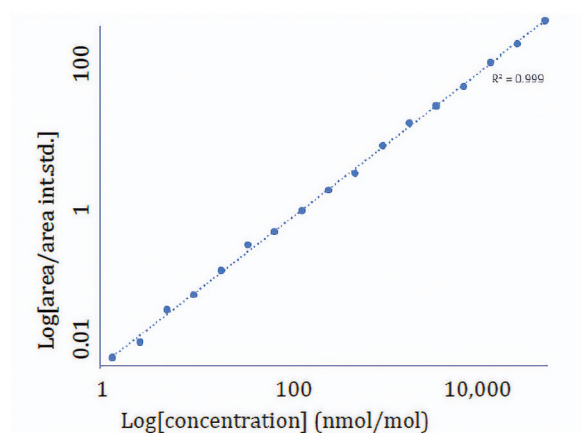


Fig 3. Linear calibration of toluene over a very wide concentration range

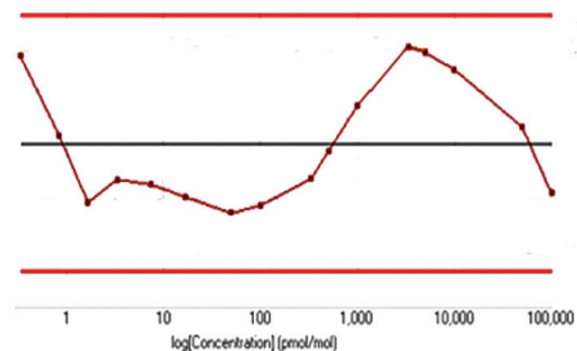


Fig 4. RRF plot of toluene over a very wide concentration range

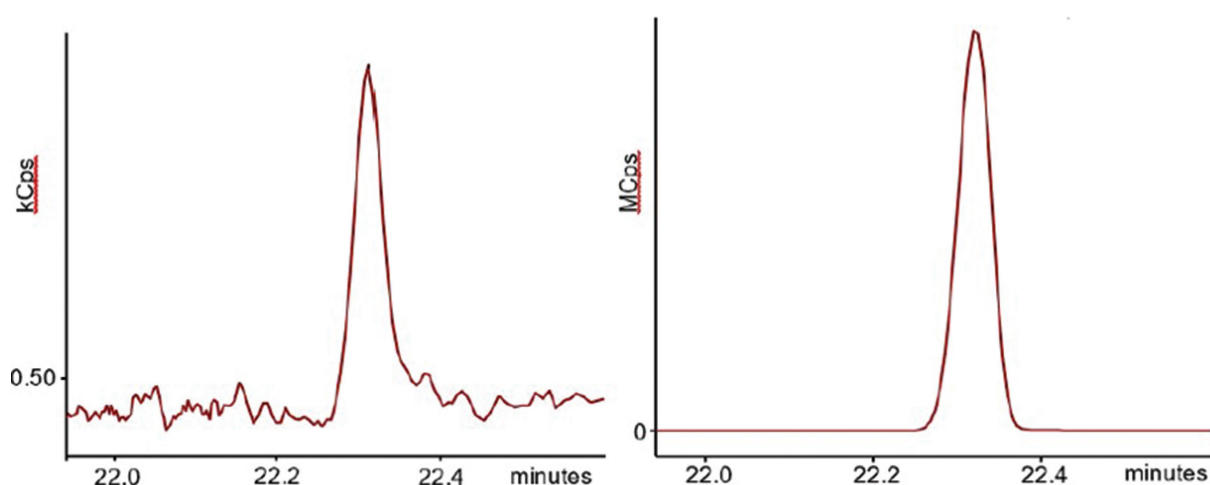


Fig 5. Extracted 91 ion of Toluene at 33fmol/mol and 100 nmol/mol.

versus $\log[\text{concentration}]$, as shown in Figure 3. The calibration curve of Toluene is representative of all compounds analysed.

The linearity of Toluene, over a wide concentration range, was 0.999 which was also reflected in the other VOCs. The response factors over the concentration range remained constant, with the excellent linearity of the system due to the EDR. Figure 4 displays a plot of relative response factors versus $\log[\text{concentration}]$ for Toluene covering a range from 0.33pmol/mol to 100nmol/mol, with a dynamic range in excess of 333,333.

EPA TO-15 specifies that acceptable relative response factor values must possess relative standard deviation, over the concentration range, of less than 30% for each analyte, with the exception of two response factors which may deviate, but still be under 40%.

Figure 4 shows that the response factors of Toluene are consistent, passing the strict criteria of the method, thus highlighting the capability of the MS. Figure 5 shows the extracted chromatogram of ion 91, the quantifier ion of Toluene, at both 33fmol/mol and 100nmol/mol.

Figure 5 demonstrates the excellent capability of the SCION MS to accurately measure a very wide dynamic range from fmol/mol to nmol/mol without altering the operating conditions; this is due to the EDR of the MS.

Excellent detection limits were achieved on the EPA TO-15 analyser, with the limit of detection, for Toluene, being 0.006ppb

V/V. The sample volume was 300mL with an injection volume of 5 μ L. Effective trapping and remarkable performance of the SCION MS enables low ppb V/V detection limits.

Conclusion

The SCION TO-15 analyser is specifically designed for the analysis of ambient air for the presence of VOCs. With the extended dynamic range of the MS and the built-in sample preconcentration trap, it is possible to accurately analyse a very wide concentration range of VOCs, including trace levels, in ambient air. The capability of the system to analyse such a wide concentration range eliminates the necessity for both sample re-runs and modification of the analytical setup. The SCION TO-15 analyser eliminates the difficult and time consuming restraints of alternative gas chromatography analysers.

SCION TO-15 Analyser Key Features:

- Built in sample preconcentration trap
- Ability to handle pressurised canisters and tedlar bags
- SCION MS with Extended Dynamic Range
- Wide linear range of calibration standards
- Extremely low detection limits
- EPA TO-15 configuration

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