



HPR - 40

Detection of volatile organic compounds in waste water

Summary

A standard Hiden HPR-40 has been used for the detection of VOCs (volatile organic compounds) in water. This forms an important monitoring procedure for any installation that uses or produces such compounds and performs testing to help ensure that they do not impact on the environment. Such testing often forms mandatory government legislation for businesses. The data show the detection limits and sensitivity of the instrument for a range of species in aqueous media.

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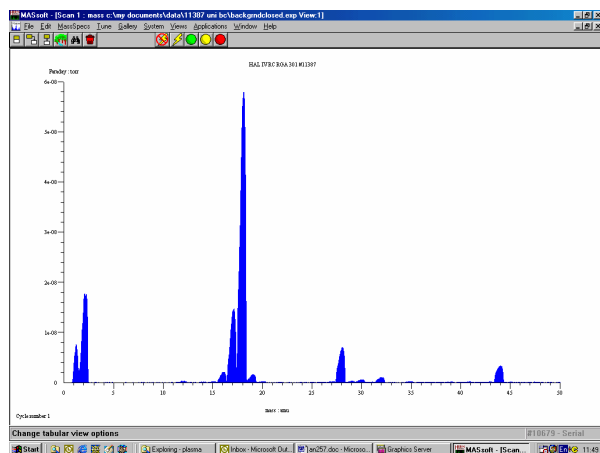
Species Detection

Hidden mass spectrometers afford the laboratory manager or production supervisor a convenient and powerful monitoring method for controlled substances in wastewater.

The Hidden HPR-40 inlet system consists of a 1m stainless steel tube with an osmotic membrane on the sampling end. Although the liquid samples will be at atmospheric pressure, the membrane allows diffusion through to the gauge, which operates at suitable pressures.

A background scan was performed with the probe immersed in deionised water. This allowed the osmotic membrane to equilibrate with the environment and could therefore be used as a calibration standard for subsequent experiments. One problem in the liquid media is a lack of well defined standards. This contrasts with gases, which can be relatively easily calibrated by atmospheric analysis, or standard gas mixtures. The background levels can be seen in Figure 1.

Figure 1: Scan of background levels.



The scan indicates the pressures of species in the gauge. Volatile components, such as solvents or gaseous constituents are seen, but

species expected in water, such as calcium, will not be seen due to the very lower vapour pressure of such inorganic species. Osmosis through the membrane is an additional required step, which is not required for RGA. This will change the sensitivity and response of the gauge towards different species. So, for instance, being dissolved in water will influence atmospheric gases, so the response obtained will not reflect true atmospheric ratios. However, the gauge can be calibrated against a standard to get quantitative data.

Following this satisfactory examination of background levels further investigation was performed. The sample of deionised water was monitored for the desorption and absorption of atmospheric gases. Over the course of several hours a resultant decrease in the levels of nitrogen (red), oxygen (blue) and carbon dioxide (green) was seen. This suggests that the storage container of the deionised water was at a different temperature. Therefore as the sample of deionised water equilibrated to room temperature, a gradual desorption of gases was measured.

Figure 2: MID Scan of deionised water.

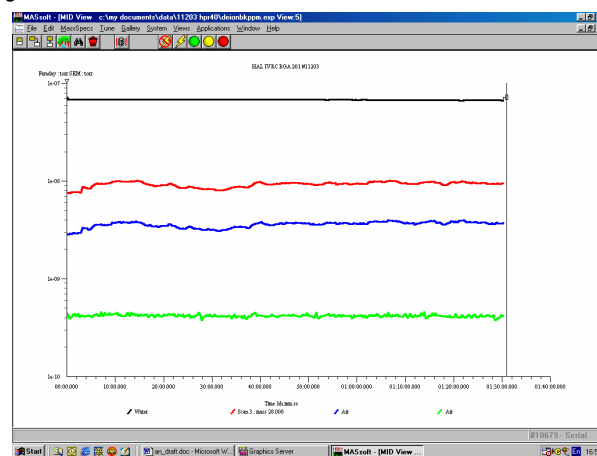
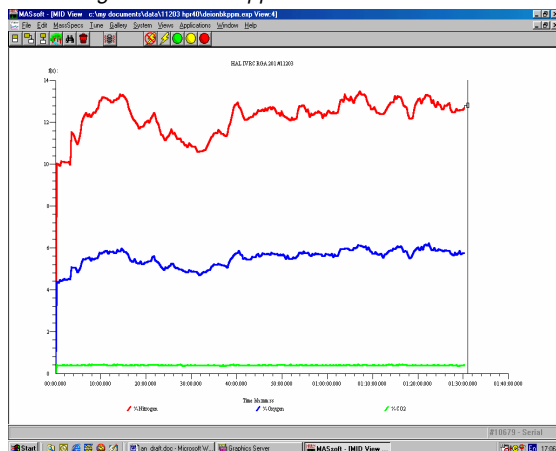


Figure 2 shows the MID scan monitoring the levels of gas over the

course of 90 minutes. Although the changes are small, there are noticeable changes despite the logarithmic scale.

For clarity, the same data is displayed in terms of change in ppm, with regard to the reference water peak (mass 18), for the species of interest is shown in Figure 3. These are oxygen (red), nitrogen (black) and carbon dioxide (blue). It can be seen that there is greater absorption and desorption occurring at the start of the scan. However, after about 40 minutes, the scan has settled to a much flatter level. This suggests that the absorption and desorption mechanisms have come to an equilibrium. This will give a clear baseline from which measurements can be made, if the presence of atmospheric gases is important in the study being conducted. A comparison of measured and true atmospheric gases is seen in Table 1. This highlights the differences with gas and dissolved species analysis processes.

Figure 3: Scan of ppm levels in deionised water.

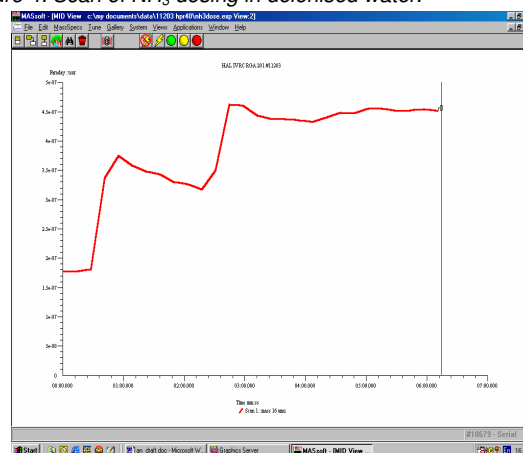


Gas	Dissolved level / ppm	Atmospheric level / ppm
Nitrogen	66	78
Oxygen	32	21
Carbon Dioxide	2	0.03

Table 1: Dissolved and Atmospheric Gas Levels

Once the background and water reference scans had been established, detection of the volatile organic compounds was investigated.

Figure 4: Scan of NH_3 dosing in deionised water.



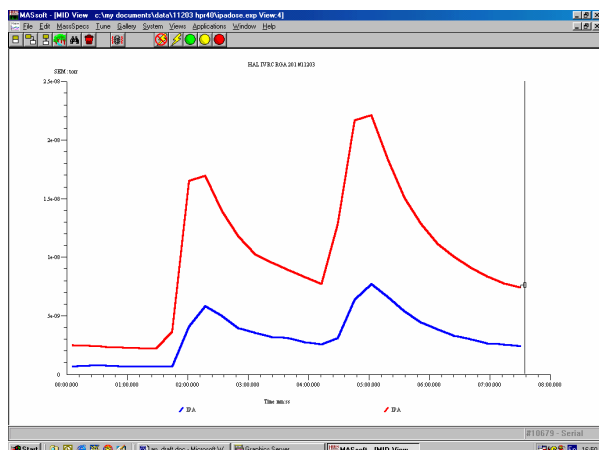
A topical emulsion for insect bites containing ammonia (3.5% w/v) was introduced into the reservoir of deionised water. At $t=0$ min a few drops were added and again at $t=2$ min. The response and the level of signal were monitored. Figure 4 shows the change of NH_2 (mass 16) and NH_3 (mass 17) over time.

It is clear that there is a delay due to the mixing, osmosis and transport time required for the species to reach the mass spectrometer gauge. However, the significant increase in signal clearly points to the continuing presence of the ammonia species in the water.

A second test using isopropyl alcohol was performed. Firstly IPA was introduced into a fresh reservoir of

deionised water. First a few drops at $t=1.5$ min and again at $t=3.5$ min. The response is shown in Figure 5 for both mass 31 (red) and mass 59 (blue).

Figure 5: Scan of IPA dosing in deionised water.



These two separate additions of IPA can be clearly distinguished. The time for the gauge to respond to the IPA is slightly quicker than that for the ammonia, highlighting the difference in volatility between the two species. The level of IPA in solution can be seen to decay, highlighting that this volatile species is evaporating out of the water at ambient temperatures at an observable rate.

A test was also performed using sugar dissolved in water. The components of sucrose, glucose and maltose are not volatile, but can be detected by the HPR-40. However, the level at which they are detected will be higher than that for a more volatile species. Also, the time delay from addition of the sugar into the water, to detection by the gauge is longer.

Therefore due to the physical processes involved in analysis there is excellent separation of the volatile species of interest and other less volatile organic or inorganic species, which may be present in the water sample. This is particularly useful in the case of benign compounds such as

sugars, as they will contribute to some extent to common low mass organic peaks, but at a lower level and with slower uptake. Therefore analysis of the volatile species of interest remains accurate.

Conclusions

In conclusion, the liquid monitoring probe provided excellent sensitivity and good response when the testing conditions were standardised. This also allowed more useful comparative data of ppm to be produced. The calculation of ppm is a useful feature of MASsoft and can be set up in a straightforward manner. MASsoft will then process the data automatically and give a real-time ppm level for the selected species. The difference between volatile and non-volatile species was highlighted.