Gas Analysis
Application Note 289

NO_x Detection

The detection of NO and NO_2 using the HPR-20

Summary

The Hiden HPR-20 gas analysis system has been used in a variety of applications in the fields of catalysis and thermal analysis.

One important aspect of catalysis research is the reduction of NO_x in such applications as car exhausts and power plants. This research involves many challenges in meeting current emission legislation whilst keeping catalyst cost low. Several NO_x reduction technologies have emerged in previous years, some of which have now been commercialized including selective catalytic reduction (SCR) with NH_3, urea and hydrocarbons, and NO_x storage and reduction (NSR). NSR technology consists of two cyclic steps that occur on a lean NO_x trap (LNT) catalyst. The LNT catalyst readily stores NO_2 as compared to NO [1,2]. For this reason, NO should be oxidized to NO_2 to achieve an acceptable level of NO_x storage.

This application note describes the measurement of NO_2 using the m/z 46 peak and the NO/NO_2 ratio in a research application using the Hiden HPR-20 QIC. The data highlights the ability of the QIC series gas analysis systems to deconvolute and quantify low levels of NO in high concentrations of NO_2.

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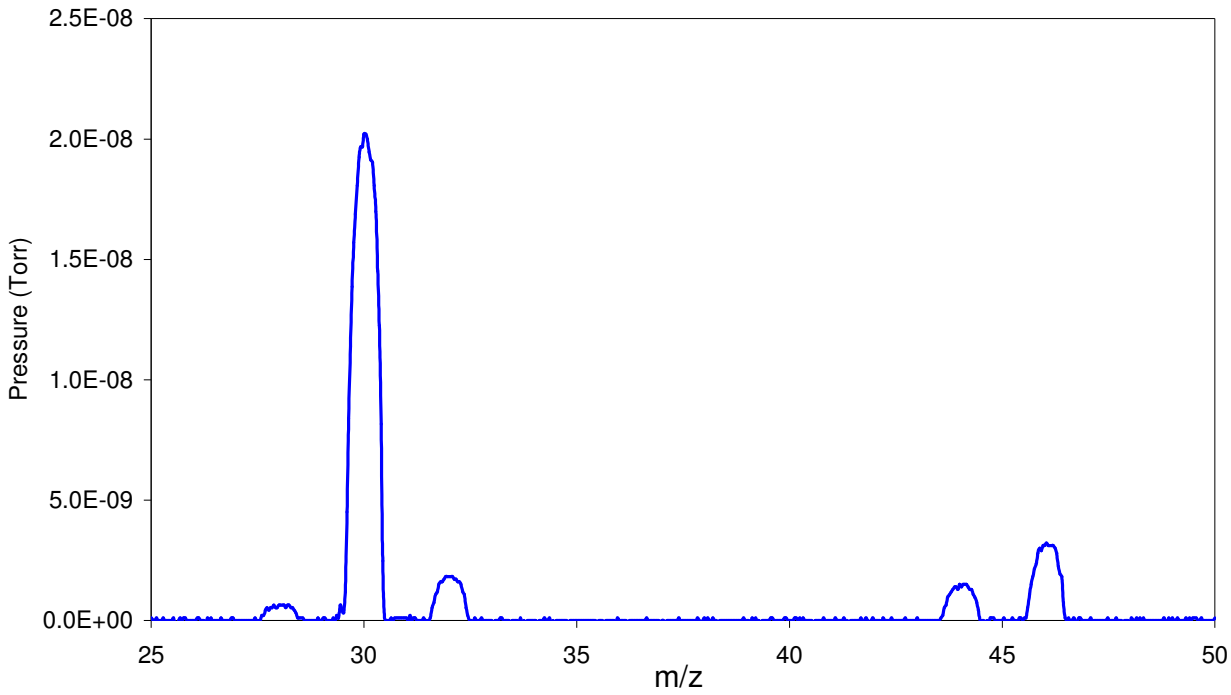

Figure 1: Profile scan for 10000ppm NO_2.

Introduction

The Hiden HPR-20 QIC gas analysis system is configured for continuous analysis of gases and vapours.

The Hiden QIC quartz-lined sampling interface operating up to 200°C provides fast response times of less than 300 millisecond for most common gases and vapours, including water vapour. For this particular application note, the HPR-20 system had the following specifications:

i) QIC capillary inlet with 2 metre heated capillary, operating up to 160°C

ii) Quadrupole probe with 100 amu mass range capability.

iii) Triple-stage mass filter

iv) Corrosion resistant pumping system

Test Data

Figure 1 shows the result of measuring NO_2 in a carrier gas of He. It clearly demonstrates that a distinct peak at m/z 46 can be measured using the HPR-20 system. This is important as it is known that NO_2 rapidly and easily fragments to NO^+ making analysis of any NO_x mixtures containing NO and NO_2 difficult to deconvolute thereby increasing the uncertainty in the NO and NO_2 concentration results. Assuming the major peak at m/z 30 represents 100%, the peak at m/z 46 is equivalent to 15% giving a 46/30 ratio of 1:6.6.

Another potential problem of the facile fragmentation of NO_2 to NO^+ is the measurement of low concentrations of NO in a high background of NO_2 (a vital measurement in developing NO_x reduction technologies such as the LNT catalyst). The NO_2 produces a high background at m/z 30, which could potentially mask any signal due to the NO in the gas mixture. Figure 2 shows an example MID scan for a range of different NO concentrations measured at m/z 30 with a background level of 1000ppm NO_2. It can clearly be seen that, for the Hiden HPR-20 system,

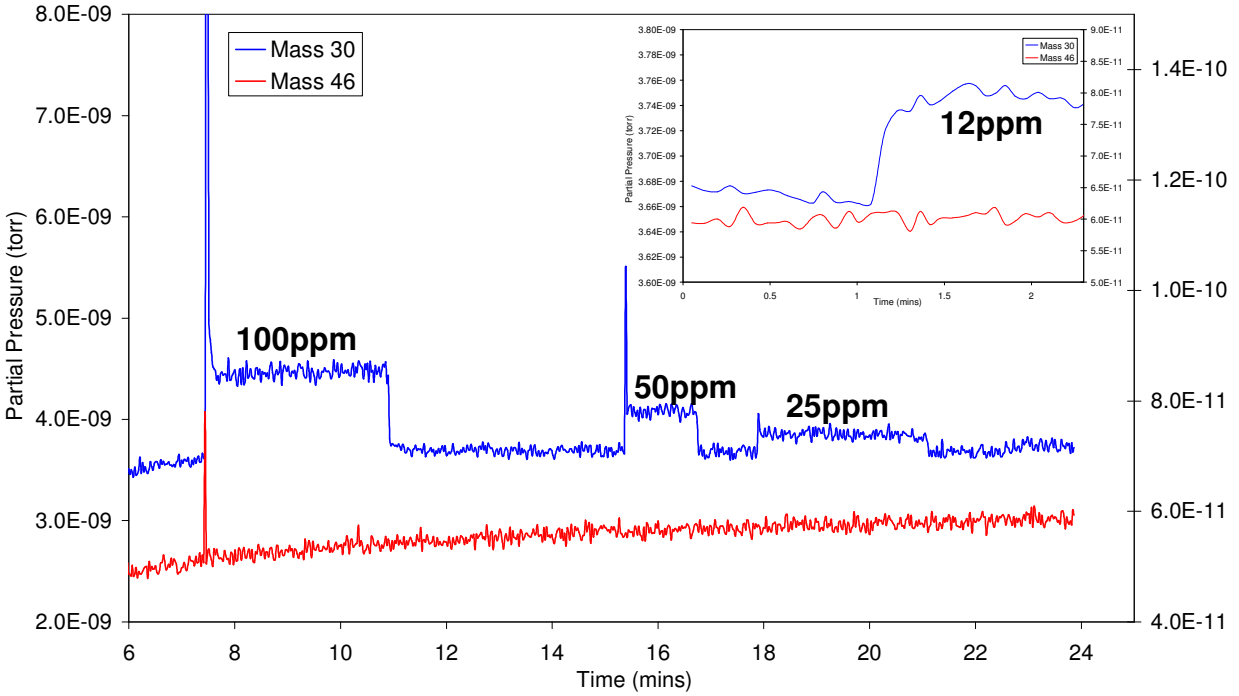

Figure 2: Detection Limit of NO in 1000ppm NO_2 (Inset: Expansion of detection of 12ppm NO in 1000ppm NO_2). Primary Axis represents Partial Pressure at m/z 30, Secondary Axis represents Partial Pressure at m/z 46.

detection limits better than 12ppm are achievable.

Correlating the NO peak signal intensity with the NO concentration level provides quantitative information on the NO detection levels as shown in Figure 3. The high degree of linearity indicates a high level of confidence in the detection of ppm levels of NO in a high background of NO_2.

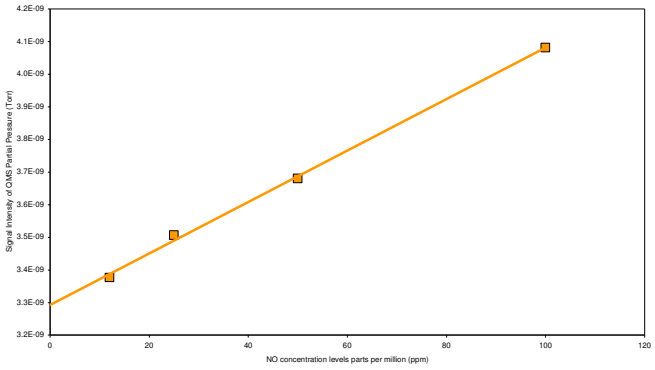

Figure 3: Relationship between partial pressure for m/z 30 and NO concentration (Note: The background at m/z 30 due to NO_2 has been subtracted).

Conclusions

- The Hiden HPR-20 QIC shows high sensitivities for NO_2 detection using the m/z 46 peak despite a large degree of fragmentation.
- Low levels of NO detection in a high background of NO_2 can be achieved without the requirement for other additional or tandem techniques.
- The specific data as detailed in this application note shows detection levels better than 12ppm of NO are attainable – a significant benefit of the Hiden QMS system.

References

[1] S. Erkfeldt, E. Jobson, M. Larrson, *Top. Catal.*, 2001, 16/17, 127.

[2] W.S. Epling, L.E. Campbell, A. Yezerets, N.W. Currier, J.E. Parks II, *Catal. Rev.*, 2004, 46, 164