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Application Note Number 3:
What are Typical Stainless Steel Vacuum System Mass Spectra Like?

Abstract: The Extorr probe is placed into a typical turbopumped vacuum system. Linear and logarithmic spectra are observed. Typical spectral peaks are identified.

The mass spectra below give you an idea of the operation of the Extorr XT Series quadrupole RGA instrument. The pressure is given in Torr (mmHg).

These mass spectra were taken inside of a 170 l/s turbopumped system which has not been baked out and has some elastomer seals. When the spectra were taken, the total pressure of this system was about 1.6×10^{-8} Torr. This pressure is displayed in the Extorr VacuumPlus software using the Bayard / Alpert ion gauge built into the probe.

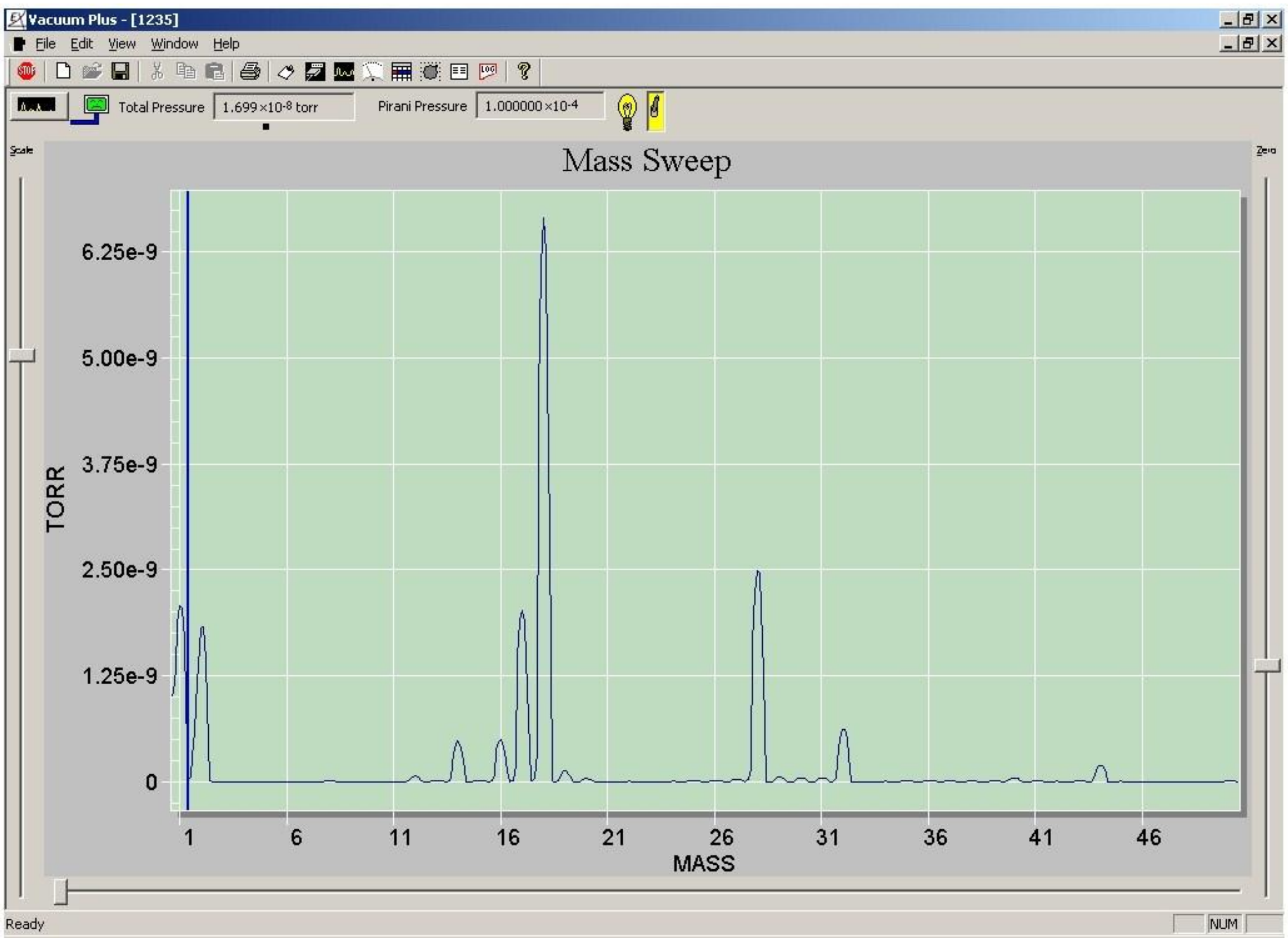

Figure 1 Analog Mass Sweep from 1 amu to 60 amu with Linear Intensity Scale

The mass sweep settings were: low mass equals 1, high mass equals 60, and the dwell time was 0.5 seconds per measurement. Figure 1 above shows the sweep on a linear intensity scale.

A good RGA will come close to producing such a scan but the outstanding Extorr XT Series can do so much more. When set for a logarithmic intensity scale, as shown in Figure 2, a great many more peaks may be seen. These include small peaks in the 10^{-12} Torr range.

Figure 2 Analog Mass Sweep from 1 amu to 60 amu with Logarithmic Intensity Scale

The peaks at 1 and 2 amu are atomic and molecular hydrogen. Mass 1 (H^+) is most likely from water vapor and hydrocarbons left in the system. Hydrogen (forming H_2^+ after ionization) is known to permeate into the surfaces of stainless steel vacuum systems. The largest peak is water vapor (H_2O^+) at mass 18. Mass 17 (HO^+) is derived from the water molecule losing one hydrogen atom upon ionization. Mass 16 (O^+) is both from the dissociation of the oxygen molecule (O_2) and the water molecule (H_2O) losing two hydrogen atoms. A very small air leak is seen as masses 28 (N_2^+), 32 (O_2^+) and 40 (A^+) which have intensity ratios of 1 to 1/4 to 1/100.

Notice that there are peaks at masses 7 and 8 which correspond to the doubly charged molecules of nitrogen (N^{++}) and oxygen (O^{++}). Carbon dioxide at mass 44 is another common vacuum system gas. Hydrocarbons at intensity levels in the 10^{-11} and 10^{-12} Torr range produce peaks between 20 amu and 50 amu.

Finally vestiges of a perfluorinated calibration compound are seen in the vacuum system at masses 19 (F^+), 20(HF^+), 31 (CF^+) and 50 (CF_2^+). It is important to remember that these smallest peaks are 3,000 times smaller than the main water peak which is already in the 10^{-9} Torr range.

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