July 1970

Brief 70-10057

NASA TECH BRIEF

Mass Spectrometer Detects High Molecular Weight Components

A novel sweep method for monopole mass spectrometers permits the detection of vacuum system contaminants of very high molecular weight with little increase in scanning time.

The basic monopole mass spectrometer uses a radio frequency electric field between a two-electrode configuration for analyzing ions of different e/m. One electrode has a right-angle cross section; the other has a circular cross section whose center is located on the bisector of the right angle. It employs a field configuration similar to that of the better known quadrupole mass spectrometer. In this case, however, the three rods are replaced by grounded symmetry planes between the rods. The two planes form the so-called V-electrode which is on ground potential so that only a single rod is required to produce the characteristic field. Ion orbits in both instruments are identical and consist of two independent oscillations in a direction y from the apex of the V-electrode to the center of the rod, as well as in an orthogonal direction x. The oscillation amplitudes are relatively small for ions of one particular mass associated with the superimposed ac and dc voltages supplied to the rod electrode. These ions pass the filter and are detected thereafter by a Faraday cage or an electron multiplier. Relatively high oscillation amplitudes result when ions of larger masses enter the same field; these ions impinge on the rod electrode or on the exit aperture. Ions of smaller masses impinge on the V-electrode.

The novel sweep method for monopole mass spectrometers consists of two parts: (1) A low mass range is swept in the usual manner by increasing the ac voltage and keeping the dc to ac voltage ratio constant and rather high to obtain good resolution and sensitivity. (The highest mass which can be measured in this way depends primarily on the maximum ac voltage available from the power supply.) (2) An adjacent high mass range is swept by reducing the dc voltage and keeping the ac voltage constant at its maximum value. The mass is inversely proportional to the dc voltage. In this regard the mass scale is identical to the one obtained in a conventional magnetic mass spectrometer, if the magnetic field strength is kept constant and the scanning is performed with the acceleration voltage. The monopole mass spectrometer provides much better transmission and sensitivity for high masses than a small magnetic vacuum analyzer. This spectrometer is free of the hysteresis errors of a magnetic spectrometer.

The mass range of the monopole mass spectrometer can be extended to infinity if the ac rod-voltage is kept constant and the dc rod-voltage is reduced. The mass is inversely proportional to this dc voltage. If the ion energy is kept constant, the sensitivity stays essentially constant over the whole mass range and the resolution is inversely proportional to the mass. If the ion energy is reduced in proportion to the dc voltage, the resolution stays constant and the sensitivity is lessened. This method of mass scanning permits the detection of vacuum system contaminants of very high molecular weight with little increase of total scanning time. No ions, regardless of how heavy, can escape detection.

Notes:

1. Laboratory equipment companies may be interested in this novel sweep method, which would be of use in monopole mass spectrometers used for gas analysis, leak detection, and air pollution studies.

(continued overleaf)

2. Requests for further information may be directed to:

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
Reference: TSP70-10057

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: R. F. Herzog of
GCA Corporation
under contract to
NASA Headquarters
(HQN-10477)