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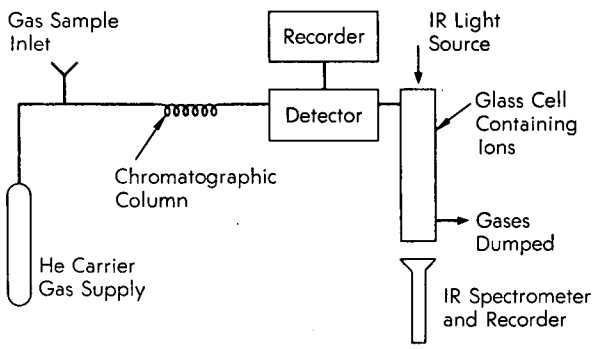
NASA TECH BRIEF

NASA Pasadena Office

Direct Analysis of Hydrogen/Deuterium Mixtures — A Concept

The problem:

To make a direct analysis of the ratio of deuterium to hydrogen in a mixture which is highly diluted with an inert carrier gas such as helium. For very low concentrations of deuterium (such as in the earth's atmosphere), direct analysis by gas chromatography is not feasible and mass spectrographic analysis is complicated by the presence of helium, adsorption of hydrogen on the walls of the sampling and ionizing system, fractionation by pumps, etc.



The solution:

Isolate a fraction of the deuterium/hydrogen mixture by column chromatography, ionize it, and measure the HD^+ 1-0 band adsorption with a conventional high-resolution infrared spectrophotometer.

How it's done:

Various attempts have been made to determine hydrogen-deuterium (HD) ratios directly by conventional infrared absorption analysis of gas samples because unionized HD species have distinctive bands in the infrared region. Unfortunately, electronic selection rules forbid transitions in the infrared region, and thus the bands are weak. However, it has been noted that the 1-0 band of ionized HD (HD^+) should be 10^6 times more intense than that of HD; the charge center in HD^+ is not coincident with mass center, and the induced dipole gives rise to absorption in the infrared region. With a 1-meter cell and ten passes of light, the detection limit for HD^+ is 0.3 N/m^2 (3×10^{-6} atm); with the gas at 1×10^5 N/m^2 (1 atm), 3 ppm of HD could be determined.

A conventional gas chromatograph may be modified readily to include an ionizing source to convert effluent HD to HD^+ ions, or the infrared analysis cell may be fitted with a suitable ionization device. The highest sensitivity for HD^+ would probably be obtained by presetting the infrared detector to monitor particular absorption peaks. As shown in the diagram, ions formed by a tritium-foil metastable helium detector can be transferred to an infrared cell for measurement. Another cell filled with pure helium or a mixture of helium and a known HD concentration can serve as a reference.

Hydrogen concentration can be determined easily with standard chromatographic detectors.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP 72-10244

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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