Analysis of gases by Raman spectroscopy: determination of isotopic composition on hydrogen mixtures (H_2, D_2 and T_2)

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In Valduc tritium facility, hydrogen isotopes separation is achieved on the Thermal Cycling Absorption Process (TCAP). On-line analysis by Raman spectroscopy is the most effective means for analyzing, monitoring and controlling gas processes in real time.

Owing to the capability of Raman spectrometer to be coupled with optical fibers, measurement of hydrogen isotopes (H_2, HD, HT, D_2, DT and T_2) can be performed in-situ, quickly, allowing the adjustment of a process to control the gas at different steps.

In this study, influence of pressure, temperature, acquisition time and accumulation, gas flow and gas amount are tested to demonstrate the capacity of Raman spectroscopy to determine the hydrogen isotopes ratios in different conditions. The use of a specific multi-passage probe is very important in so far as it allows a gain between 3 and 6 on peak intensity for the different hydrogen isotopes. Gas pressure, gas temperature in the probe and acquisition time have also an influence on the relative intensity.

The region of 2700cm^{-1} to 4300cm^{-1} is the area of the spectra being interrogated. The rotational-vibrational transitions (O_1, Q_1 and S_1-branch) of the hydrogen isotopes are found in this region. T_2 is found at a shift of 2464 cm^{-1} D_2 at 2971 cm^{-1} and H_2 shifts at 4132 cm^{-1}. The secondary peaks of tritium can be observed with the gas probe.

The device is a Raman RXN1, from Kaiser Optical Systems Inc, and is composed of a 100 mW laser at 532nm, a spectrometer, a charge coupled device (CCD) and a probe.

The Tritium analysis can be performed and the performances (LOD, sensitivity) could permit a lot of applications in the field of Hydrogen isotopes in-line analysis.

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