

HD gas purification for polarized HDice targets production at Jefferson Lab

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Solid, frozen-spin targets of molecular HD were first developed for nuclear physics by a collaboration between Syracuse University and Brookhaven National Lab. They have been successfully used in measurements with photon beams, first at the Laser-Electron-Gamma-Source [1] and most recently at Jefferson Lab during the running of the E06-101 (g14) experiment [2]. Preparations are underway to utilize the targets in future electron experiments after the completion of the 12 GeV JLab upgrade [3]. HD is an attractive target since all of the material is polarizable, of low Z , and requires only modest holding fields. At the same time, the small contributions from the target cell can be subtracted from direct measurements.

Reaching the frozen-spin state with both high polarization and a significant spin relaxation time requires careful control of H_2 and D_2 impurities. Commercially available HD contains 0.5 - 2% concentrations of H_2 and D_2 . Low-temperature distillation is required to reduce these concentrations to the 10^{-4} level to enable useful target production.

This distillation is done using a column filled with heli-pack C [4] to give good separation efficiency. Approximately 12 moles of commercial HD is condensed into the mechanically refrigerated system at the base temperature of 11K. The system is then isolated and the temperature stabilized at 18K producing liquid HD , which is boiled by a resistive heater. The circulation established by the boil-off condensing throughout the column then filtering back down produces a steady-state isotopic separation permitting the extraction of HD gas with very low H_2 and D_2 content.

A residual gas analyzer initially monitors distillation. Once the H_2 concentration falls below its useful operating range, samples are periodically collected for analysis using gas chromatography [5] and Raman scattering. Where the measurement techniques overlap, good agreement is obtained. The operation of the distillery and results of gas analysis will be discussed.

References

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