Gas distillation system for polarized HD target

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We plan to carry out an experiment to measure double polarization asymmetries for the $\vec{\gamma}\vec{p} \to \phi p$ and $\vec{\gamma}\vec{n} \to \phi n$ reactions at SPring-8 [1]. The first purpose of the experiment is to investigate the $s\bar{s}$-quark content of proton and neutron. The asymmetries are sensitive to the $s\bar{s}$-quark content in the nucleon [2].

We are developing the polarized HD target system for this experiment [3]. We employ the static method using "brute force" to polarize the proton in HD at low temperature (15mK) and high magnetic field (17T). The polarization degree of about 90% is possible for the proton. The life time of the polarized HD target depends on the purity of HD gas. Since we have to keep the polarization of the HD target for about one month for the experiment, high purity HD gas is needed. However, if we use the high purity HD gas, the aging time for polarizing the HD becomes long. The way to solve this dilemma is to dope ortho-H_2 and para-D_2 impurities in the pure HD. The appropriate amount of the impurities in the HD is approximately an order of 0.01% [4]. The purity of commercial HD gas is about 96% and most of contaminations are H_2 (2%) and D_2 (2%). We must develop a device to purify the HD gas up to ∼99.99% in order to optimize the amount of impurities.

Gas distillation system used to purify the HD gas is shown in Fig. 1 [5]. There are 20 stainless steel packings called "Stedman Packing" inside the distiller. Temperature gradient is made by cooling the top and heating the bottom of the distiller. Heat exchange between gas and liquid takes place on the packings. A low-boiling element is vaporized and extracted from the top of the distiller. The difference of the boiling points of HD, H_2 and D_2 enables for the HD gas to be separated from the others.

Figure 2 shows the concentration of H_2 and D_2 for the extracted gas plotted as a function of the operation time of the distillation system. The concentration of H_2 and D_2 is measured by a quadrupole mass spectrometer. Although the H_2 concentration of ∼0.01% has been achieved after the operation of two weeks, the D_2 concentration increases to ∼1%. The reason of the increment is as follows. The pressure inside the distiller has to be increased gradually for continuous gas extraction, and the amount of D_2 gas increases because the relative vapor ratio changes. If the contact area between gas and liquid is large on the packings, the increment of the D_2 concentration can be suppressed. However, the contact area of present distiller is not large enough, which gives high D_2 concentration. We plan to replace the packings with different ones. One is called Sieve-tray, and the other is called Good-roll-packing. Since their contact area is larger than Stedman-packing's contact area, it is expected that the heat exchange efficiency will become higher and the gas separation will become better. After these improvements of the gas distillation system, we will try to polarize the HD target in 2007.

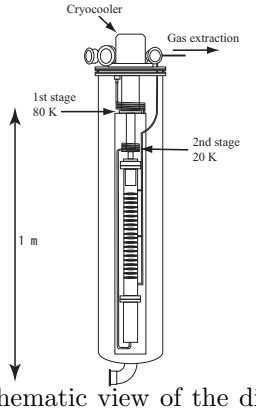

Figure 1: Schematic view of the distillation system.

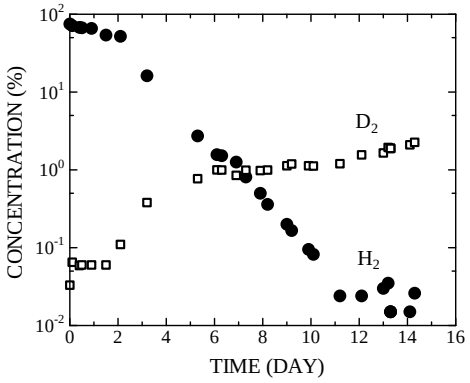

Figure 2: The circles and squares are the concentrations of H_2 and D_2, respectively, in the extracted gas.

References

[1] M. Fujiwara *et al.*, Photoproduction Experiment with Polarized HD Target at SPring-8, LEPS/RCNP proposal (2003).

[2] A.I. Titov, Y. Oh, and S.N. Yang, Phys. Rev. Lett. 79, 1634 (1997).

[3] H. Kohri *et al.*, Annual Report of RCNP, (2006).

[4] A. Honig, Phys. Rev. Lett. 19, 1009 (1967).

[5] S. Bouchigny *et al.*, Nucl. Inst. And. Meth. A 544, 417 (2005).