Characteristics of the Pneumatic Transfer System (PTS #2) at the HANARO Research Reactor

Sun-Ha Kim, Jong-Hwa Moon, Sung-Yeol Baek, Yong-Sam Chung and Young-Jin Kim

Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong-gu, Daejeon 305-353, Korea
shkim4@kaeri.re.kr

1. Introduction

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A pneumatic transfer system (PTS) is one of the facilities to be used in 무 irradiation of a target material for an instrumental neutron activation analysis (INAA) in a research reactor. There are two systems in the PTS at the HANARO research reactor, the manual system (PTS #1) and the automatic system (PTS #2) with and without a Cd lined tube for the thermal NAA and epithermal NAA, respectively. The PTS has been operated since 1995. This pneumatic transfer system consists of many devices and assemblies, for the sending and loading of the irradiation capsules from the NAA Laboratory into three holes in the reflector tank of the reactor and the retrieving of the irradiated capsules after an irradiation. PTS #2 has not been operated from 2001 due to a contamination of the Cd lined tube which was removed in Oct. 2004. One of them was reinstalled after some improvement at the end of 2004. This paper reports for the irradiation test and the characteristics of the reinstalled PTS #2 for user information and the reactor management.

2. Methods and Results

The irradiation tube of the PTS #2 is located at the NAA #3 hole in the reflector of the reactor and about 47.2 cm from the core as shown Figure 1. The length of the irradiation tube is about 14 m from the bottom of the core to the top of the reactor and that of the transfer tube is about 28 m from the end of the irradiation tube to the receiver as shown Figure 2.

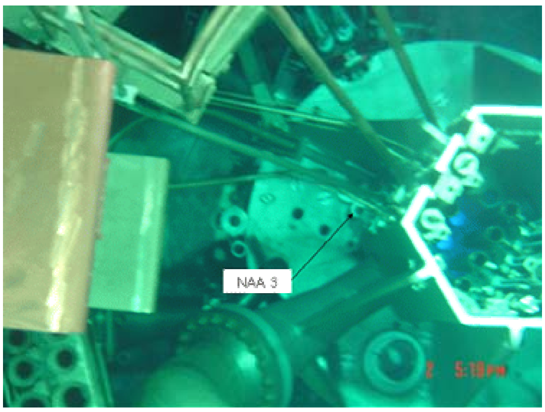

Figure 1. Irradiation sites of PTS #2 at HANARO research reactor.

2.1 Decontamination and Reinstallation of PTS

For the reuse of the irradiation tube in the PTS #2, the inside of the tube was decontaminated according to the procedures and an appropriate cleaning method. The old PTS #2 line was removed and a new line was reinstalled. The automatic operation mode was changed to a manual one by using the controller of the old PTS #1. The loader /receiver was remodeled for a fitting of the old small rabbit. The connection between the irradiation tube and the transfer tube used the coupling method to prevent a collision with the rabbit. The outer and inner diameters of the transfer tube are 34.1 and 27.5 mm, respectively. N_2 gas pressure of the PTS lines is adjusted to within the range of 10 to 15 psi. Air cushion valve is used for the prevention of a strong impact at the end of the irradiation tube and the receiver.

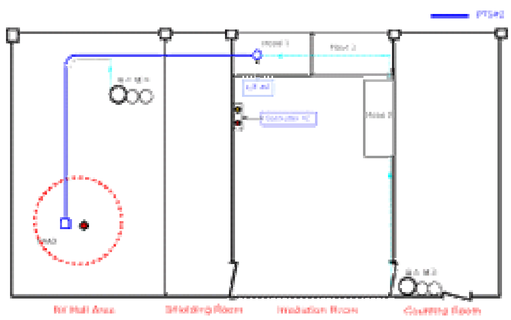

Figure 2. Layout of PTS #2 at HANARO research reactor.

2.2 Transportation of Rabbit

The sending and receiving of the rabbit in the PTS is controlled by a system controller with a preset timer, manually or automatically. The moving of a rabbit is detected by the photo-sensor which is located at the transfer tube. To obtain an accurate and a precise irradiation time, the transfer time of the rabbit in the PTS #2 was measured by an acoustic method in both the manual and automatic modes of the controller. The average sending time to the reactor was 9.8±0.5 s and the average receiving time back to the receiver was 3.2 ±0.3 s.

2.3 Characteristics of Irradiation

The requirement of an irradiation for the PTS is based on the parameters such as the neutron flux and distribution, temperature, gamma heating of the irradiation site, the radiation dose rate and materials and types of rabbit and the sample for a safe operation of the reactor. In particular, the lifetime and the corrosion of the irradiation tube and the vulcanization of the poly-ethylene (PE) transfer tube are very important for its safety. Therefore, the condition and the damage of an irradiation tube and transfer tube should be checked regularly.

The gamma heating rate was estimated to be about 5 Watts·g^{-1}. The temperature on the irradiation position of the PE rabbit has to be limited to less than 80 ℃ because the melting point of the PE is about 120℃. The temperature of the irradiation site was measured with the irradiation time from 10 s to 80 s using the thermo-label for the inside and surface of the rabbit. As shown in Figure 3, the measured temperature was the range of 50 to 80 ℃. The optimum irradiation time was estimated as 80 s.

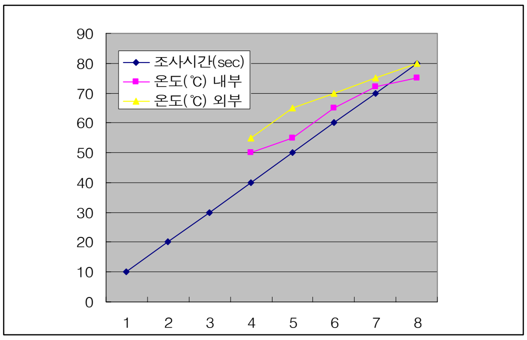

Figure 3. Temperature of the irradiation position at PTS #2 with irradiation time.

When the irradiated rabbit is returned, the radiation dose rate of the near receiver was in the range of 20 to 70 μSv h^{-1} and that of the transfer line in the reactor hall was less than 15 μSv h^{-1}.

For the neutron flux monitoring and the measurement of the cadmium ratio, activation wires (R/X activation wire, Reactor Exp. Inc.) such as Au-Al, Co, Fe and Zr and Cd box were used. The measurements were carried out using a calibrated gamma-ray spectrometer (HP-Ge detector, GEM 35185P and 919A MCB, Gamma Vision software, EG&G ORTEC, USA). Energy and efficiency calibrations were done using multi-nuclide reference sources (Isotope Products Lab., ML 7500 series, 0.118" active diameter, disc type) traceable to NIST (National Institute of Standards and Technology, USA).

The calculation was carried out using the new Windows PC-code, Labview software of KAERI with the nuclear data library, which was developed at this laboratory for a rapid and simple data treatment for the gamma-ray spectrum obtained at preset detection conditions.

The thermal, epithermal and fast neutron flux at 30 MW thermal power were 1.5E+14 n·cm^{-2}·s^{-1}), 3.3E+11 n·cm^{-2}·s^{-1} and 3.0E+10 n·cm^{-2}·s^{-1}, respectively. The cadmium ratio, R_{Cd}, was about 15.

3. Conclusion

For the efficiency and the safety for the utilization of the reinstalled PTS #2, the irradiation test was carried out and the result of the parameters measured such as the neutron flux, the temperatures of the irradiation position with a irradiation time, the radiation dose rate when the rabbit is returned, etc. were reported. The experimental characteristic values will be useful information for several kinds of users and for the reactor management.

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