The Neutron Metrology Research at China Institute of Atomic Energy

Division of Radiation Metrology

Rong Chaofan Chen Jun Wang Zhiqiang Luo Hailong

1. Neutron reference radiation field and neutron fluence standard

The 5SDH-2 pelletron accelerator is used to generate monoenergic neutron. The terminal voltages are from 0.1 to 1.7MV, therefore, the energies of deuterium or proton are from 200keV to 3.4 MeV, the beam current is up to about 30μA. The monoenergic neutrons of different energy can be produced by the reactions such as ^{7}Li(p , n)^{7}Be,T(p , n)^{3}He, T(p , n)^{3}He ,D(d ,n)^{3}He and T(d , n)^{4}He.The neutron energy ranges are from 0.1 to 6.0 MeV and from 13.5 to 19 MeV.

In addition, thermal neutron field has been established on the thermal column of heavy water reactor at China Institute of Atomic Energy and the energy spectrum measured with time-of- flight method which deviates from Maxwell distribution because there is a silicon filter in the hole. ^{235}U fission ionizing chamber and ^{197}Au foil were used to measure fluence rate of thermal neutron, the results are the same within 1%. ^{235}U sample mass is weighted with two methods which are electroplating and measuring Alpha counts, the results are the same within uncertainty ranges.

2. Radioactive nuclei neutron source standard

1) A Manganese bath measurement system with circulating-style has been established. The vessel was made of stainless steel 1m in diameter and filled with about 500 liter Manganese sulfate solution. The gamma ray of activated ^{56}Mn can measured by two NaI(Tl) 2×2 inch detectors. The measured source strength ranges are from 10^{5} to 10^{7}/s and the measuring uncertainty is less than 1% to Am-Be neutron source. A ^{252}Cf neutron source which emission rate is about 10^{9}/s had been measured with relative method. Some neutron sources were calibrated for the customer each year.

2) Calibration for neutron dosimeter and neutron personal dosimeter.

There are three Am-Be neutron sources which strengths are respectively 4×10^{7}/s, 7×10^{6}/s and 5×10^{5}/s at Division of Radiation Metrology. The strengths of these sources have been measured with Manganese bath method and their angle distributions have also been measured.

A calibration hall (6m×8m×6m) is used for calibrating a neutron dosimeter and neutron personal dosimeter. The personal dosimeter is usually located 75cm far away from the center of neutron source, and a phantom of Plexiglas water box is behind the personal dosimeter. We have calibrated some dosimeters such as CR-39 solid trace detector and digital pocket personal dosimeter.

3. Measurements of neutron dose

1) A double dosimeter composed of an equivalent tissue ionizing chamber, a Mg chamber or a G-M counter have been established. We had attended the intercomparison organized by Section ? of CCRI.

2) We are engaged in the research on properties of neutron personal dosimeter including TLD,CR39 and compound dosimeter.

4. Measurement of neutron energy spectrum

1) A time-of-flight instrument for measuring energy spectrum of thermal column of heavy water reactor has been established.

2) A Bonner Sphere System including a series of spheres in different diameter have been established and a spherical ^{3}He proportional counter is used as central detector. We had

used it to measure the neutron energy spectra of Am-Be and ^{252}Cf neutron source and the workshop where neutron sources are produced and the hall of reactor. Its response had been measured for several energy such as 144keV,565keV,2.8MeV and 14.8MeV and the results are coincident with the calculating results by MCNP code.

5.Measurements of fluence and dose of high energy gamma ray

The 6.13~7.12MeV gamma ray can be product by $^{19}F(p,a?)$ reaction with the 5SDH-2 pelletron accelerator. The gamma ray yields of different proton energy and angle distribution had been measured and their doses have also been measured by using ionizing chamber. The results are not coincident. It may be the reason that influence of low energy gamma ray wasn't estimated enough .

6.Plan in the future

1) Research of the properties of $^{45}Sc(p, n)^{45}Ti$ reaction and development of some work by it.
2) Research of measuring 25 MeV neutron fluence rate with ^{238}U fission ionization chamber.
3) Development of neutron energy spectrum measurement methods.