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DETERMINATION OF NETURON THERMAL AND EPITHERMAL AT REACTOR TRIGA PUSPATI THERMAL COLUMN BEAM PORT EXIT USING NEUTRON SPECTROMETRY TECHNIQUE

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ABSTRACT

This work main aim is to study the analysis of slow neutrons which include thermal and epithermal neutrons and also analysis on fast neutrons. The outcome from this work showed that the comparison result between fast and slow neutrons. The safety assessment at reactor TRIGA PUSPATI (RTP) is one of the main objectives of the work and there is a detailed discussion on it which helped in accomplishing the task. Gamma Rays produced in this experiment was high and in the experiment and it is realized that the shielding plays a vital role in the success of this experiment which prevents all the radiations. From the results of the experiment it is realized that these gamma rays are not suitable for the application of Boron Neutron Capture Therapy (BNCT). However, these radiations are suitable for the application of Neutron Radiography (NR). The study on this work will help in study of nuclear applications such as BNCT, NR, SANS etc. These applications are using in medical and nuclear fields. The electronic device used in the experiment to detect neutron is Neutron Spectrometer. The results from Neutron Spectrometer and TLDs are very similar which showed that the experiment is a success. Numerical results were compared with those available in literature for validation.

ABSTRAK

Tujuan utama kerja ini adalah untuk menganalisis neutron perlahan yang termasuk neutron epitermal dan termal dan juga analisis di neutron cepat. Hasil dari kerja ini menunjukkan bahawa keputusan perbandingan antara neutron perlahan dan cepat. Penilaian keselamatan di reaktor TRIGA PUSPATI (RTP) ialah salah satu objektif utama kerja dan terdapat satu perbincangan terperinci yang membantu dalam menyempurnakan tugas. Sinar Gama dihasilkan dalam eksperimen ini tinggi dan dalam eksperimen dan perlu disedari bahawa yang perlindungan memainkan peranan penting dalam kejayaan itu eksperimen ini yang mencegah semua radiasi. Dari keputusan eksperimen ini penting disedari bahawa sinar gama ini tak sesuai untuk aplikasi sebagai Boron Neutron Capture Therapy. Bagaimanapun, radiasi ini sesuai untuk aplikasi sebagai Neutron Radiography. Kajian di kerja ini *akan membantu dalam kajian aplikasi-aplikasi nuklear seperti BNCT, NR, SANS dan lain-lain. Aplikasi ini menggunakan dalam bidang-bidang perubatan dan nuklear. Alat elektronik digunakan dalam eksperimen mengesan neutron ialah Neutron Spectrometer. Keputusan dari Neutron Spectrometer and TLDs serupa yang mana menunjukkan bahawa eksperimen ialah satu kejayaan. Keputusan berangka dibandingkan dengan itu didapati di kesusasteraan untuk pengesahan.*

Keywords: thermal column, neutron spectrometer, Boron Neutron Capture Therapy (BNCT), Neutron Radiography (NR)

INTRODUCTION

There are many nuclear researches being done using nuclear reactors. Most of the works are based on the thermal and epithermal neutrons beam emitted from the beam ports of the reactor. Inside the thermal column neutrons travel when they decelerate during fission, also in many reactors thermal neutrons are modified into epithermal for various applications. Neutron beam irradiation facilities are also used these days mostly for brain tumor treatment. The objective of this work is to carry out the research about the neutron energies that exit the thermal column beam port of the RTP (see Figure 1). The outcomes of this study will provide the following issues:

i. Types of radiations emitted from thermal column beam port.
ii. Safety assessment around the Reactor TRIGA Puspati thermal column for BNCT irradiation.
iii. Level of irradiations emitted at thermal column of RTP.

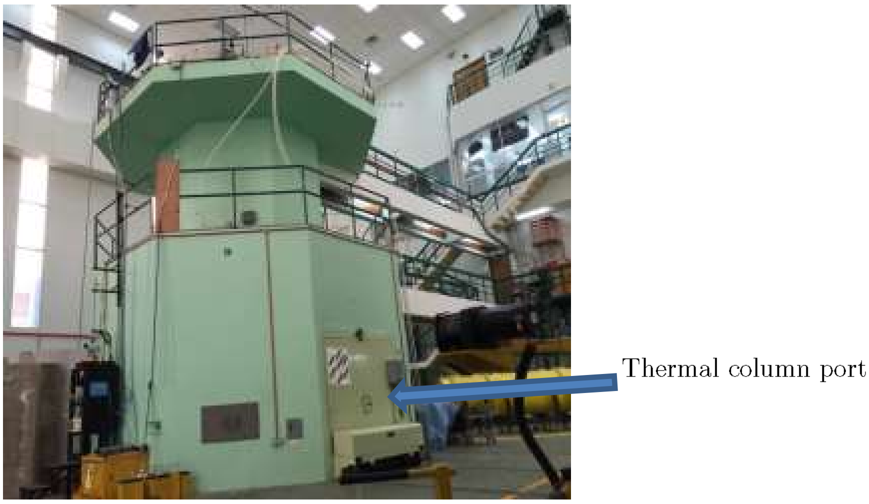


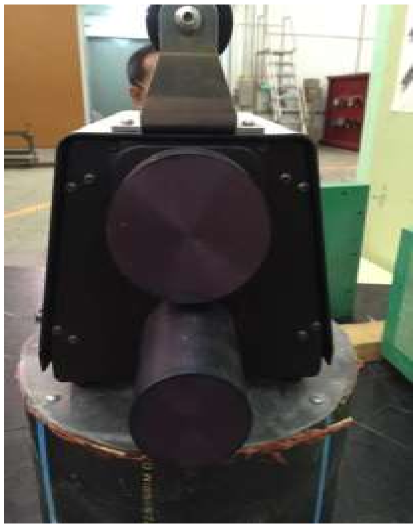
Figure 1: Reactor at RTP showing thermal column location.

EXPERIMENTAL AND INSTRUMENTATION

In order to detect and measure neutrons doses and energies emmited by the thermal column beam port (see Figure 2), nuclear detection devices are required. In this study, neutron spectrometer (see Figure 3), neutron detector (see Figure 4) and thermo-luminescent dosimeter (TLD) (see Figure 5) were used. Irradiation locations inside the irradiation chamber (see Figure 6) for TLD's and Neutron Spectrometer were also considered, i.e. during the experiment which were the positions where these instruments were placed in order to take the readings of the neutrons and gamma rays, see Figures 7 (set-up of the experiment). All the irradiations were analyzed, recorded all the data of all kind of irradiations and the safety limit of these irradiations. There were lot of radiations and they needed to be taken under special custody because if the irradiations were high then the gamma rays are high so the experiment cannot be processed. The experiment was performed at 100kW RTP power level.

Figure 2: Thermal column beam port.

(a) Side view



(b) Front view (detectors location)

Figure 3. Neutron Spectrometer Detector

Figure 4: Tele detector

Figure 5: TLD (Neutron)

Figure 6: Irradiation Box (Boron Polyethylene)

Figure 7. Experimental Neutron Spectrometer Set-up

RESULTS AND DISCUSSION

Figure 8 shows a typical representation of a neutron spectrum detected by the spectrometer. Figure 9 shows the recorded dosimetry of the experiment as collected by the spectrometer. Figure 10 shows the neutron fluence of the experiment. Figure 11 shows the dose distribution related to the energies of the experiment.

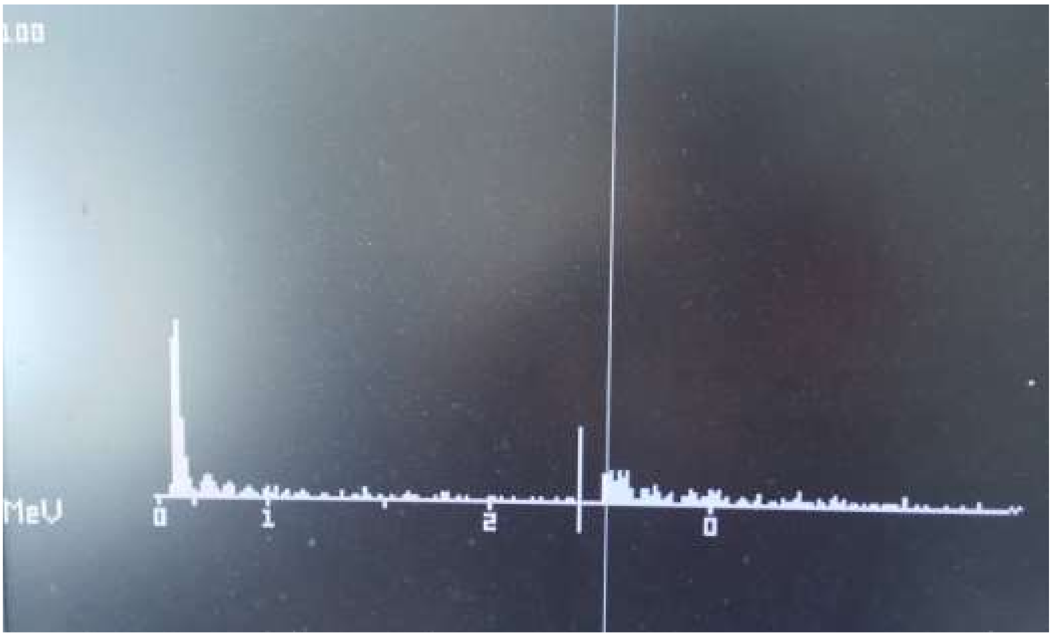


Figure 8: Neutron Spectrum taken by the neutron spectrometer.

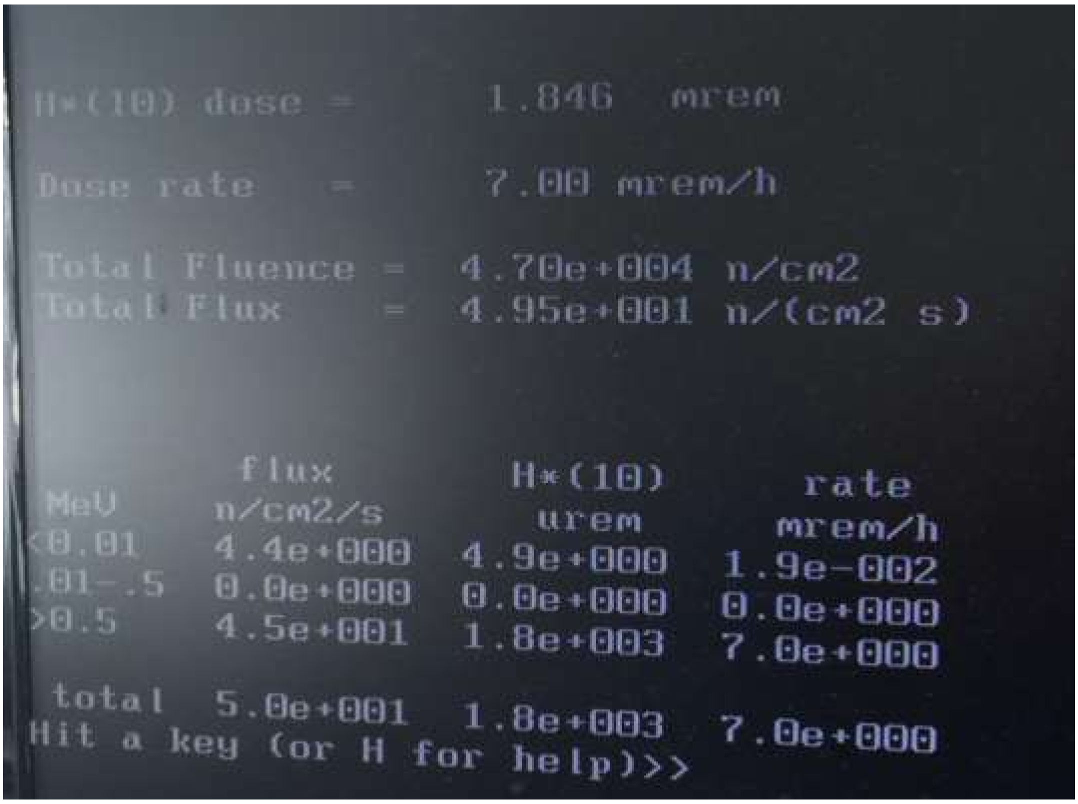


Figure 9: Neutron Dose Rate.

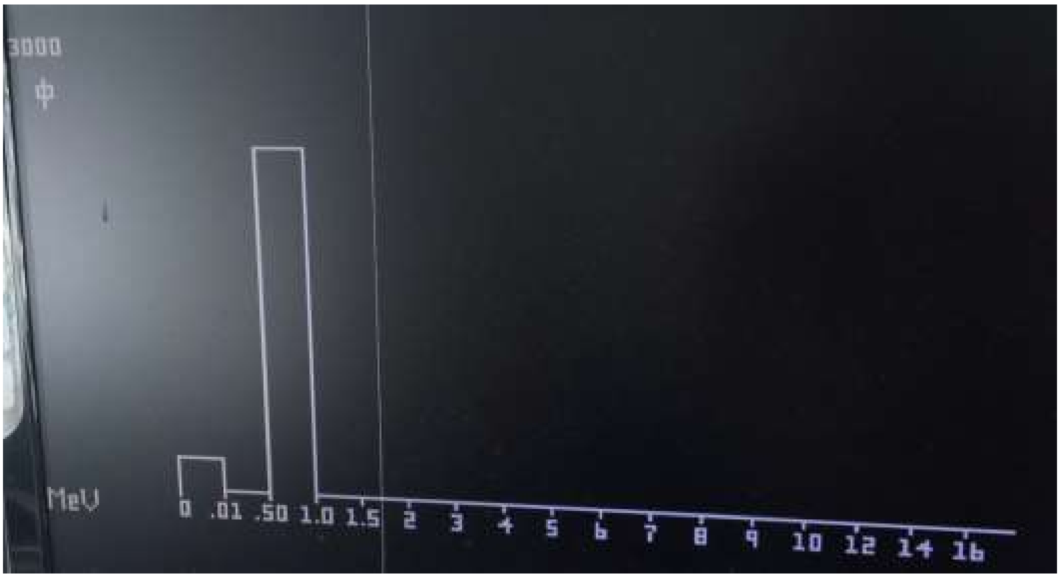


Figure 10. Neutron Fluence.

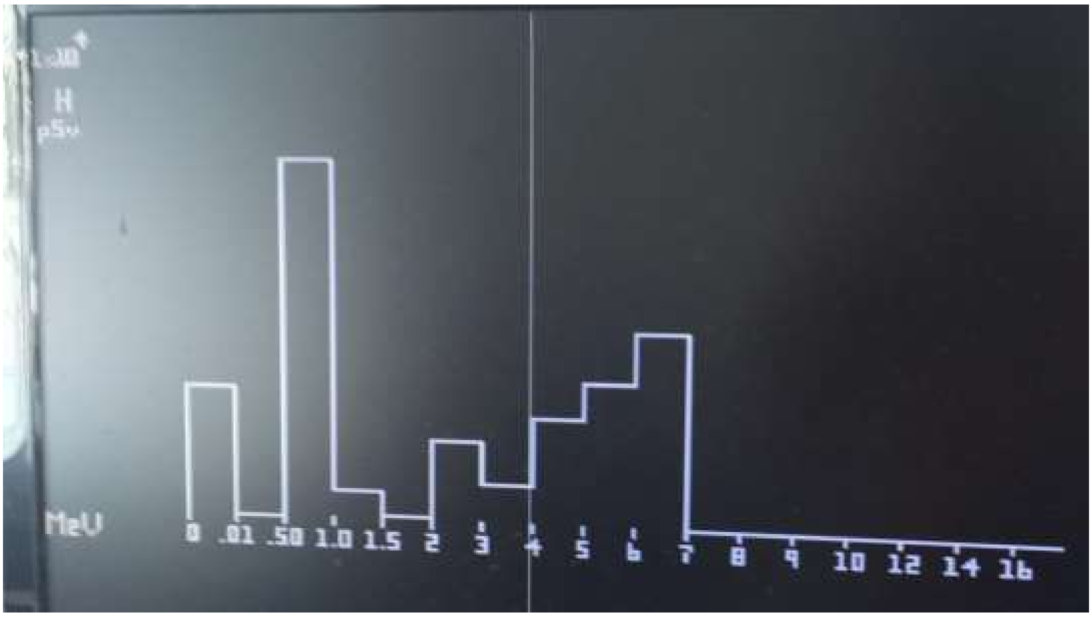


Figure 11. Dose Distribution Related Energy

Table 1 shows dose rates of gamma rays recorded in the experiment using Tele detector Scale: 500.

Table 1: Detection of Gamma Rays

No.	TLD's and their ID's	Counting Time	Gamma Rays Reading
1.	1 Neutron, 1 Gamma (10200) , (10196)	30 sec	17 μSv/h
2.	1 Neutron, 1 Gamma (10199) , (10197)	60 sec	21 μSv/h
3.	2 Gamma (10194) , (10198)	60 sec	19 μSv/h
4.	1 Gamma (10195)	60 sec	20 μSv/h

From the results of unfolded data and TLD's, it is seen that the results are very similar. From the Unfolded data results, it is seen that the slow neutrons and fast neutrons have different graphs. Slow neutrons include thermal and epithermal neutrons. From this experiment it is seen that the shielding plays an important role while determining the thermal and epithermal neutrons and I had to make sure all the time that the gamma rays emitting are not too high. In order to perform the experiment it had to be made sure all the time that the shielding and concretes are properly located so that the gamma rays does not affect the experiment.

From this experiment the measurements of thermal neutrons and epithermal neutrons were determined. The purpose of the experiment was to study the reactor is to provide sources of neutron beams via its beam ports. Thermal column beam port is one of them. In order to use the beam port for industrial and medical applications, it is very essential the neutron beam characteristics to be understood. Thermal column is considered as a pure thermal neutron beam. In this experiment total 6 Tlds were used and 4 of them were gamma Tlds and 2 of them were neutron Tlds. The scale use on teletector was 500.

CONCLUSION

The experiment was performed at 100kW and from the results, it has to be seen that the gamma rays detection are high. The neutrons produced from the Thermal column are slow neutrons which include thermal and epithermal neutrons and mostly fast neutrons. From these radiations and results, it is realized that these gamma rays produced are not suitable for Boron Neutron Capture Therapy. However, Neutron Radiography can be performed at a higher rate, so Neutron Radiography can be performed on it. All the objectives of this tasks were accomplished.

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