6 - 33 Design of a Cylindrical Extended Range Neutron Monitor

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In order to meet the requirement of neutron dose measurement at intermediate and high energy accelerators, the improvement for standard Andersson-Braun neutron remmeter[1] is needed, because the A-B remmeter (AB) will badly underestimate neutron dose at neutron energy higher than 14 MeV. In this work, a cylindrical extended range neutron monitor (ABH) is designed for neutron field measurement at HIRFL-CSR since the highest energy of CSR is about 1 GeV/u. The cross sections of the remmeter (ABH) are shown in Fig. 1. A ^{3}He proportional counter of 2.54 cm outer diameter and 5.13 cm active length (97% ^{3}He enrichment, fill pressure 0.2 Map) is used for thermal neutron detector. The ^{3}He counter is surrounded by an inner polyethylene moderator (1.7 cm thick), a 0.6 cm thick boron doped synthetic rubber(30% ^{10}B mass ratio) absorber with a number of 10 mm diameter holes uniformly distributed about 22% of area, a 1cm of lead is placed around the absorber to increase the neutron response at high energy region through (n, xn) reaction, and an outer polyethylene moderator (21.86 cm outer diameter to 20.5 cm length). The chemical compositions and the densities of the materials, as applied in the calculations described hereafter, are given in Table 1.

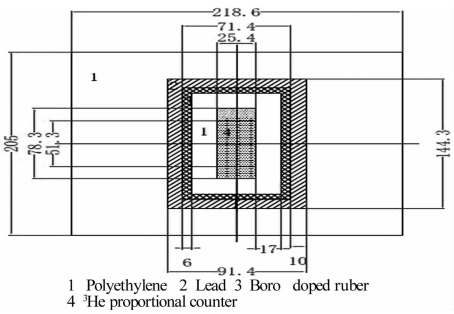

Fig. 1 Cross-section view of the cylindrical extended range neutron monitor.

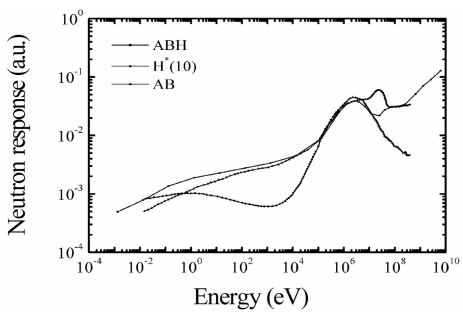

Fig. 2 Response functions of cylindrical extended range neutron monitor.

The neutron energy response of the AB and ABH remmeter were calculated by MCNP. The results are shown in Fig. 2. which are compared with the H*(10) from ICRP74. It can be seen that lead layer has no effect on low-energy neutrons responses, but at high- energy region, the neutrons sensitivity of ABH remmeter is increased remarkably. Compared to the AB remmeter, the response function ABH is more close to the H*(10). The neutrons responses of the AB remmeter and ABH remmeter are almost the same in energy region of lower than 15 MeV. In the higher energy range especially above 400 MeV, the ABH shows grate superiority in measuring neutron ambient dose equivalent.

Table 1 Density and atomic composition of the materials used by the transport calculations

Material	Density (gcm^{-3})	Constituents		
		Atomic number	Atom density(atoms 10^{24} cm^{-3})	
Polyethylene	0.95	$12:4.082\times10^{-2}$	$1:8.222\times10^{-2}$	
Lead	11.337	$206:8.32\times10^{-3}$		
Boron in silicon rubber	1.296	$1:4.86\times10^{-2}$	$207:7.16\times10^{-3}$	$208:1.717\times10^{-2}$
		$12:1.62\times10^{-2}$	$10:3.293\times10^{-3}$	$11:1.351\times10^{-2}$
^{3}He	3.16000×10^{4}	$3:5.65442\times10^{-5}$	$16:8.1\times10^{-3}$	$28:8.1\times10^{-3}$

Reference

[1] I. O. Andersson, J. A. Breun, Neutron Dosimetry, 2(1962)87.