A Primary Design of Neutron Beam Shaping Assembly for AB-BNCT

Zhaopeng Qiao, Sheng Wang*

School of Energy and Power Engineering, Xi'an Jiaotong University,
Xi'an, 710049, China
qiaozhaopeng@stu.xjtu.edu.cn; shengwang@mail.xjtu.edu.cn

Boron neutron capture therapy (BNCT) is a unique type of radiation therapy that enable cancer to be targeted at the cellular level. It was devised in 1936 and the very first attempt was performed in a patient diagnosed with Malignant Glioma in 1951. In last century, reactor-based BNCT (RB-BNCT) was mainly used. The incompatibility between reactor and hospital is one of the obstacles of BNCT development. Around 2010, the first accelerator-based BNCT (AB-BNCT) system developed by Japanese scientists, which was steadily pioneering the new era of BNCT.

The reactions of $^{7}Li(p,n)^{7}Be$ and $^{9}Be(p,n)^{9}B$ are commonly used in accelerator driven neutron source for BNCT. But the neutron emits in all angles and the neutron energy is too high to apply to patients directly. So a beam shaping assembly (BSA) is needed to moderate the neutrons to proper energy and make them shoot out at the beam port. This work will show some design and simulation results of BSAs with different materials and structures. Specifically, we assumed an accelerator driven neutron source that works by 2.8 MeV protons hitting a solid lithium target. Based on the recommendation values of the IAEA-TECDOC 1223 report, we compared with different moderation materials, such as magnesium fluoride, Fluental, aluminum fluoride, calcium fluoride and so on, and different reflection materials, such as lead, nickel, graphite and so on. We also compared different BSA structures, such as cylindrical and cone structure from the points of epithermal neutron flux, fast neutron and gamma contamination. We found that lithium oxide has a good performance to get a high epithermal neutron flux. However, it easily absorbs vapor and reacts with carbon dioxide, which is negative to BSA. Cone structure is more effective to reflect neutrons to get more neutrons at the beam port. In the near future, we will design and modify the collimator system and the beam port to get a complete BSA system with good performance.