MCNP- Criticality Exercises

Aims

- Perform simple criticality calculations in MCNP
- Further develop understanding of geometry input
- Explore simple physics related to criticality simulation
- Understand MCNP output for criticality calculations

Problem 1 – hemispheres

This problem is similar to the famous spherical assemblies e.g. godiva which caused some of the earliest criticality accidents.

Geometry: two half spheres each with a radius of 8.741 cm separated by a gap of 5 cm.

Material: U235 93.71% atom fraction, U238 remainder. All other space to be set to vacuum.

Add the following Kcode card to the data block

Kcode 1000 0.8 10 100

use ksrc card to add two starting source points one in each hemisphere.

(a) Examine how the value of Keff varies if you change the value of ikz and kct to 50, 500
(b) Gradually reduce the gap between the two hemispheres and see how the value of Keff increases. Hint: move both surfaces for the hemisphere not just the plane surface

Problem 2

This problem demonstrates the effect of the surroundings to the value of keff and that MCNP will include this effect if sampled sufficiently.

Geometry: Start with a fissile sphere of 12.5 cm radius, with the centre located 20 cm above a 10 mm thick cylindrical steel plate with a radius of 2.5 m centred on the same axis as the centre of the sphere. The space surrounding the sphere is set to vacuum within the radius of the steel plate.

Material: use HEU (Health Phyiscs) for the sphere and carbon steel from PNNL compendium

Add a suitable KCode

(a) Calculate Keff.
(b) Now add a 50cm thick layer of light water below the steel plate and re calculate Keff
(c) Now change the steel plate to wood (also from PNNL compendium) and re calculate Keff
(d) Add a surface tally and calculate the neutron spectrum through the top of the wood layer

Problem 3 – flask

A traditional thermometer style flask with neck internal radius 2cm, 8cm long and spherical bulb radius 4 cm. the glass layer is 1mm thick (use material “Glass, plate” from PNNL compendium). The flask is filled to 3 cm from the top with uranyl nitrate (also in PNNL compendium) solution.

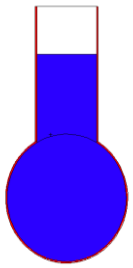

Figure 1 Representation of flask

a) Attempt to Calculate Keff with 100 source particle per cycle
b) Change to 1000 source particles per cycle and attempt to calculate Keff