Analysis on Thin Layer Activation's effective dose and statistical reliability for a tribology equipment

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TLA (thin layer activation) is a technique used to activate a small part of a target, it is then used to measure wear. However, it produces an effective dose. This report presents the use of MCNP-X to evaluate how viable TLA is. The methodology consists of simulating the equipment using the MCNP-X code to obtain an effective dose near the equipment through F5 function and the de/df cards for flux to effective dose conversion [1] and also Counts Per Second results using the F8 function. These results will be coupled to determine a range of effective activation that provides as little dose as possible while maintaining good statistical precision through enough source activity. Proving this scenario is safe for workers from the common public will also prove the TLA safe for such an environment with fewer restrictions.

The simulation is composed of the TE 92-6-5 tribology equipment and, inside of it, a small region of activated material. The dose was calculated using the conversion cards for Anteroposterior (AP) position placed 1 m far from the source for 16 h/week. For a worker from the common public the maximum yearly dose is 1 mSv [2]. The source is composed of Co56 and we'll determine which range of activity it must have to satisfy maximum dose and minimum CPS limits. Figure 1 and Figure 2 show the Equipment's schematics and simulation.

MCNP-X does not return dose or CPS results, but rather an "efficiency" that must be multiplied by the source's activity, or "events". For this scenario we've obtained dose efficiency of 4.56E-04 pSv*events^{-1} and detection efficiency of 1.75E-03 counts*events^{-1}. Using these, we can estimate the range of activity, which is given by the TLA2 tool with preset activation parameters [3]. Since we are aiming for a minimum of 20 Counts per Second for statistical reliability, this will determine our floor source's activity.

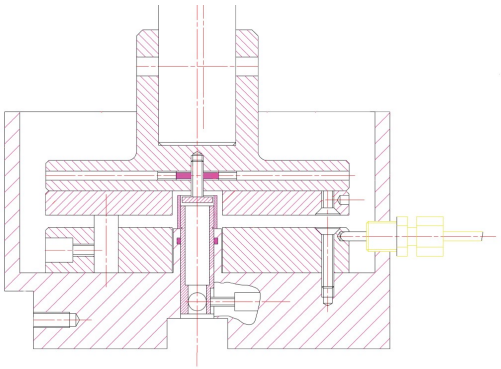

Figure 1. Equipment's schematics

The minimum total source's activity to achieve 20 CPS is around 2.7 MBq and specific activity (for each μm on the surface) is 11.5 kBq. The maximum values are 3.5 MBq and 15 kBq, respectively, for a maximum yearly dose of 1 mSv. Thus, TLA is a viable and safe option for wear measurement for the mentioned equipment even when someone from the common public is placed so close to the source for such a long exposure.

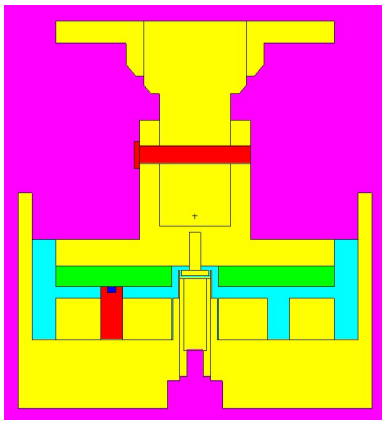

Figure 2. Simulated equipment: yellow – aluminum; pink – air; light blue – generic lubricant oil; red – steel 1010; green – cast iron.

References

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