Development of detection geometry for Thin Layer Activation experiments

M. A., França[1], C. M., Salgado[1], J. C., Suita[1].
e-mail: mchldante@gmail.com, -otero@ien.gov.br, suita@ien.gov.br

[1] *CENS, IEN;* [2]*DIRA, IEN*

Keywords: Thin Layer Activation, geometry of detection, wear, MCNP-X.

The Thin Layer Activation (TLA) is a nuclear technique used to measure wear/wear rate on machineries. It produces a semi-constant activation on the surface of the target of analysis [1], from this it is possible to determine the wear/wear rate based on the activity registered either from the activated piece (TLM), or from the material worn from it and accumulated on a filter (CMM). An example of how they work can be seen on Figure 1.

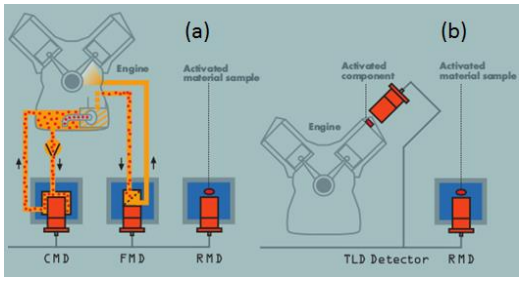

Figure 1. CMM (a) and TLM (b) [2]

This work provides a counting system for a system based on the TLA experiments, the Wearing System, which can be seen on Figure 2. The methodology used was to simulate on MCNP-X code the needed equipment in different settings: use of 1x1" or 2x2" NaI(Tl); use of lead shield; use of collimations and; general positioning and specifications. Through the analysis on the resultant counts per second on each detector from each source on each configuration, the best configuration was defined. The sources simulated were the Main Source (activated piece, 3 MBq) and the Second Source (filter,13 kBq), these are the expected values of activity after the activation of the metal piece and the accumulation of material from 1 µm worn from the Main Source on said filter [3]. To confirm the counting system will be reliable, an experiment was conducted; its methodology consists of a fixed geometry and the addition of thin (0.25mm) activated foils in front of the detector to emulate the increase of activated material in the filter.

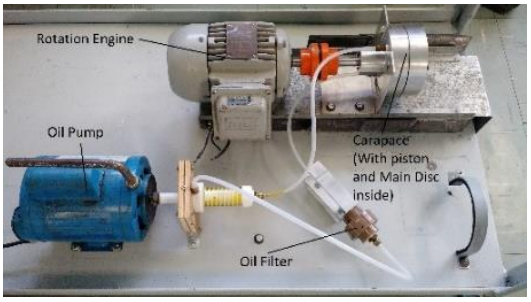

Figure 2. Wearing System

The chosen scenario: for TLM a 1x1" NaI(Tl) positioned 6.75 cm from the Source; for CMM the 2x2" NaI(Tl) and placed 3.75cm from the filter, with side and rear 3 cm thick lead shielding and; around the Wearing Apparatus and the 1x1" detector a 5.1 cm thick square shaped open on both ends lead shielding.

Using this scenario the results were: 100 CPS registered for the TLM; 20 CPS for CMM and; an important result was the counts registered from the Main Source on the Second Detector (related to the CMM), which was minimized to 2 CPS after the application of the lead shielding, this is rather important because unlike background, these counts are expected to vary in time with an unpredictable ratio. With these results it is possible to obtain statistically reliable data for experiments as short as 30 min and CMM results from the 1µm worn.

For the emulation experiment, the expected result is a straight line on the Counts vs. Foils' Activity graph. The obtained result was a visually straight line with r^2=0.99935, which confirms the system is stable and reliable for the desired measurements, specially because the foils used added up ~1 kBq, far less than the expected from the experiments.

References

[1] INTERNATIONAL ATOMIC ANGENCY ENERGY. Thin layer activation (TLA) technique for wear measurement. Vienna: IAEA, 2017a. Disponível em: <https://www-nds.iaea.org/tla/>Acesso em: 28 mar. 2018.

[2] FEHSENFELD, P.; KLEINRAHM, A.; SCHWEICKERT, H. Radionuclide technique in mechanical engineering in Germany. **Journal of radioanalytical and nuclear chemistry**, [S.l], v. 160, n. 1, p. 141-1511992.

[3] INTERNATIONAL ATOMIC ANGENCY ENERGY. Calculation tool for thin layer Application, TLA2. Vienna: IAEA, 2017b. Disponível em: <https://www-nds.iaea.org/tla/.> Acesso em: 28 mar. 2018.