Neutron Backscattering Technique for Landmine Detection

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Introduction:

To develop & design a portable neutron source based detection system for hydrogenous rich materials such as landmines, explosive, licit drugs etc, we have carried out feasibility experiments using Pu-Be neutron source for detection of landmines. Fast neutrons from the Pu-Be source are back scattered more by the buried landmines than the surrounding soil. Landmines include anti-tank mines (ATM) and anti-personnel mines (APM). ATM are typically about 5 kg or more in mass while APM are much smaller, often less than 300 g, thus making them difficult to detect. Although conventional methods like metal detectors are available, but they are not very successful for non-metallic landmines and/or landmines buried at relatively greater depth. Therefore a more confirmation method is needed to unambiguously detect landmines. To supplement metal detector, we are conducting feasibility study using isotopic neutron source which primarily detected back scattered neutrons. This way one can supplement the information of metal detector through neutron sensors. Additionally we are also exploring the possibility of the using prompt gamma sensor.

Experimental results with explosive simulant melamine and High Density Polyethylene (HDPE) are presented, along with effect on count rates due to the variations in the distance between source and soil (standoff distance).

Methodology:

Pu-Be ($1x10^6$n/s)) neutron source with two identical sets of He-3 detectors (each set containing three detectors) placed above the sand (See fig1). A wooden box (1m X 0.5m X 0.5m) filled with the dry sand is designed in such a way that it acts as a soil bed. The scans were made over sand with a step size of 5cm and a measuring time of counts is 10s per step. When detectors are moved over the sand horizontally, the hydrogenous samples buried in sand were detected by observing the anomalies in the back scattered neutrons. We studied melamine ($C_3H_6N_6$) sample (which is very good explosive simulant) of 300 g placed in a cylindrical holder of 5cm diameter and 10 cm height embedded into the surface of the sand layer. Other hydrogen rich substances like HDPE (9cm X 9cm X 5cm) and coal (bitumen), were also studied

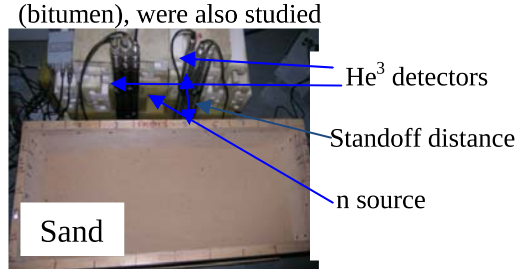


Fig (1) Experimental Set up

Experimental results & discussion:

We have investigated effects on back scattered neutrons due to variation in standoff distance, sample depth, spatial distribution of count rates. Our measurement (fig2.) shows that small variations in the standoff distance significantly influence the count rate. It was therefore decided to use two identical sets of detector, with a certain distance (14cm) between them and a source positioned exactly in the middle. In this way, there is always a reference value available if one detector is above the hydrogenous sample (fig3.) and the other is not. Also the distribution of the count rates becomes symmetrical in both side of sample and the measured points can be well fitted by a Gaussian curve.

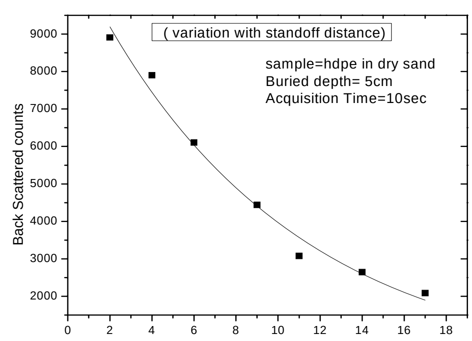


Fig (2) Count Rates with standoff distance

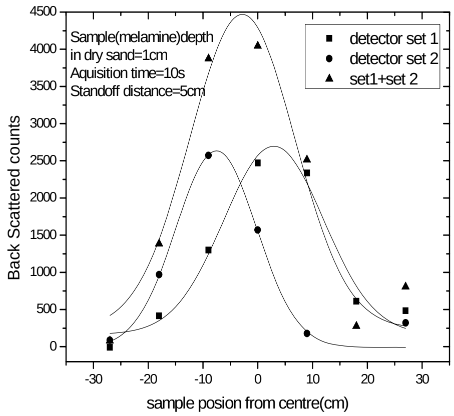
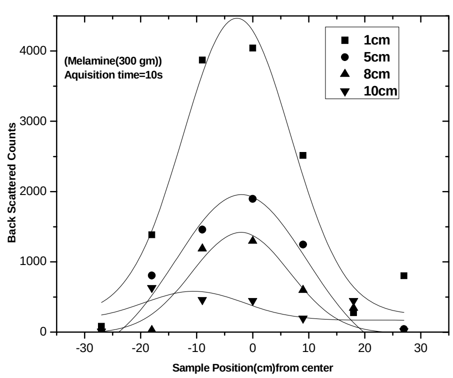


Fig. (3) Spatial distribution of count rates for melamine by individual detectors set.

An important feature of the scans shown in Fig.3 is that the distance between the two peaks is approximately equal the distance between the detectors. This is due to the fact that the highest back scattered counts are measured when the sample is positioned approximately in front of each detector set. Also when the sample is placed at the centre position then we get peak at sample position by taking the sum of both detectors. From result of explosive stimulant melamine (fig4) and the HDPE (fig5), it is evident that the peaks values get reduce as well as get broaden, with increase of the sample depth in sand and



Fig(4). Spatial distributions of count rates for the melamine sample.

After a certain depth (10cm in case of melamine and 15cm in case of HDPE) it gets flatten as equal to background. Also on comparing the results (fig 6) of the hdpe and Melamine we can see that the signals are much higher in HDPE compared to that of the melamine since melamine is less hydrogenous. Further experiments are being planned to repeat the experiments with D-D neutron source.

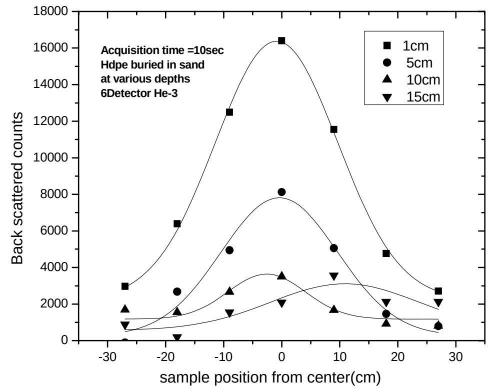


Fig (5). Spatial distributions of count rates for the HDPE sample

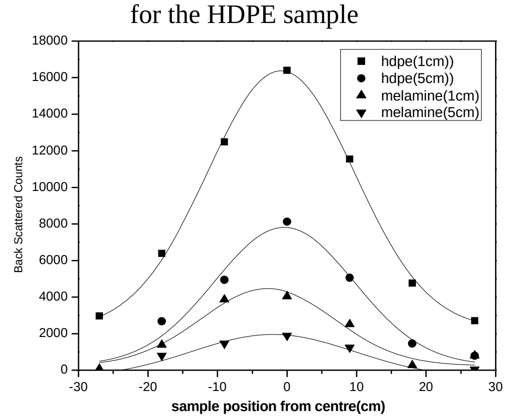


Fig (6) Comparison of the spatial distributions for HDPE &melamine

Conclusion:

The feasibility experiments with Pu-Be has successfully been used for the detection of landmines. Additionally, it may be possible using prompt gamma detector techniques to try to identify the chemical composition of various elements at a range. This could allow the detection of materials within landmines such as various plastics or explosive.

References:

[1] Cor P.Datema *et al*, IEEE Transactions on Nuclear Science, Vol. 48, No. 4, August2001

[2]B. Kirlaly *et al*, Radiation Physics and Chemistry 61 (2001) 781–784