An Investigation of Electrostatically Deposited Radionuclides on Latex Balloons

Terry Price, Adam Caly
University of Ontario Institute of Technology
Terry.Price@gmail.com

Summary

Use of Canadian Nuclear Society (CNS) education material for a community science education event to promote science awareness, science culture and literacy (Science Rendezvous 2011) lead to investigation of observed phenomena. Experiments are done on balloons that are electrostatically charged then left to collect particulate. Alpha spectroscopy was performed to identify alpha emitting radioisotopes present on the balloons. The time dependent behaviour of the activity was investigated. Additionally, the Alpha activity of the balloon was compared to Beta activity. The grounds for further investigations are proposed.

1. Introduction

Webecame aware of the radioactive balloon experiment in the summer of 2011 when the Canadian Nuclear Society chapter at the University of Ontario Institute of Technology(UOIT) participated in the public science education event: Science Rendezvous. We received the "Beware of Naturally Occurring Radioactive Materials (NORM) kit" from the CNS educational outreach committee. We investigated the kit, demonstrating for ourselves various aspects of NORM. One demonstration in particular stirredour curiosity: the *radioactive balloons experiment.*

The general ideaof the radioactive balloon experiment is when a balloon is rubbed against a surface such as wool or cat-fur, producing static charge, then left in a room for several dozen minutes, deflated, and measured with a Geiger counter; the Geiger counter registers radioactivity apparently on the balloon surface.

When we performed this experiment, several interesting questions occurred, i.e., what radioisotopes were causing this radioactivity? How were these isotopes beinggenerated? How long did the balloon have heightened radioactivity? How radioactive were these balloons?

To investigate these questions, three experiments were performed. First, alpha spectroscopy was performed on a balloon. The radioactivity of the balloon was measured with respect to time. Finally, alpha / beta discrimination was performed on the balloon.

2 . Materials and Methods

Severalinvestigations were performed. First, alpha spectroscopy was performed with an Ortec Alpha Spectrometer under vacuum and high voltage. This was done by inflating a balloon with laboratory suppliedair andthen rubbing it on an acrylic-wool sweater 300 times while being rotated, ensuring all the surface was reasonably charged to the same level. The balloon was then left on a lab bench for 30 minutes to collect activity. The balloon was then deflated through a small hole on the bottom of the balloon and the balloon was inserted into the sample chamber of an alpha spectrometer. The spectrometer had been calibrated using its built in 8MeV pulsar. Measurements were taken over a 3.5 hour period. It is important to note that the laboratory in which these measurements were done had uranium and thorium bearing minerals stored. It was thought any naturally occurring radionuclides found on the balloon should have higher concentration for a balloon which collected its activity inside the lab with alpha and beta emitters, compared to one which collected its activity outside this lab.

A measure of the another balloon's activity was taken by following the same preparation procedure as before, and then immediately measuring the balloon with a RM-80 Geiger Counter by Aware Electronics.

The activity was then measured as a function of time using an RM-80 Geiger Counter by Aware Electronics. A balloon was inflated by human breath and rubbed on the head of a man. The balloon was then left to collect activity in the sub terrain basement of a house for 20 minutes then deflated. The balloon was then affixed to the window of the RM-80 Geiger counter and measurements of activity were taken for 4 hours.

Finally, the alpha activity of the balloon was measured and compared to its beta activity using a Canberra LFP579 gas flow detector with P-10 gas. Once again, a balloon was inflated by human breath then rubbed on the head of a man, and left on an office desk to collect activity for 20 minutes. The balloon was then deflated and placed in the sample chamber of the Alpha/Beta detector and measured for 7.5 hours.

3. Results and Interpretation

The results of the alpha spectroscopy are shown in figure 1(counts v energy in KeV).

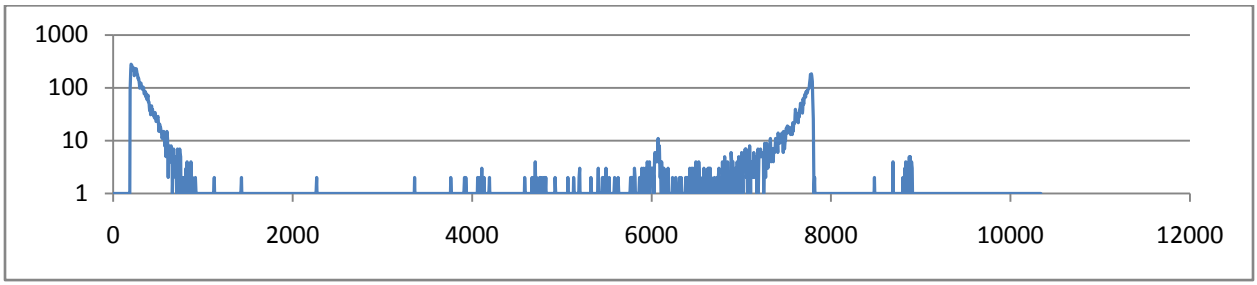

Figure 1- Results of Alpha Spectroscopy

The most prominent peaks in this spectrum occur at 7.83 MeV and 6.115 MeV. These valuesare highly indicative of the Po-218 and Po-214 radioisotopes from the Uranium series. Furthermore, there is considerable activity around 8.95 MeV which is indicative of the decay of Po-212.

The result of the balloon activity measurement was 1308CPM. Brouwer [1] had reported creating balloons which read 56,484, and 2440 CPM using the same RM-80 radiation monitor by Aware Electronics. The values reported in Walkiewicz averaged to 1137 CPM with a standard deviation of 687 CPM [3]. It is seen there is wide deviation between the reported activities of different balloons.

The results of the measurements done with the RM-80 to investigate the time-dependent behaviour of the balloon are shown in figure 2.

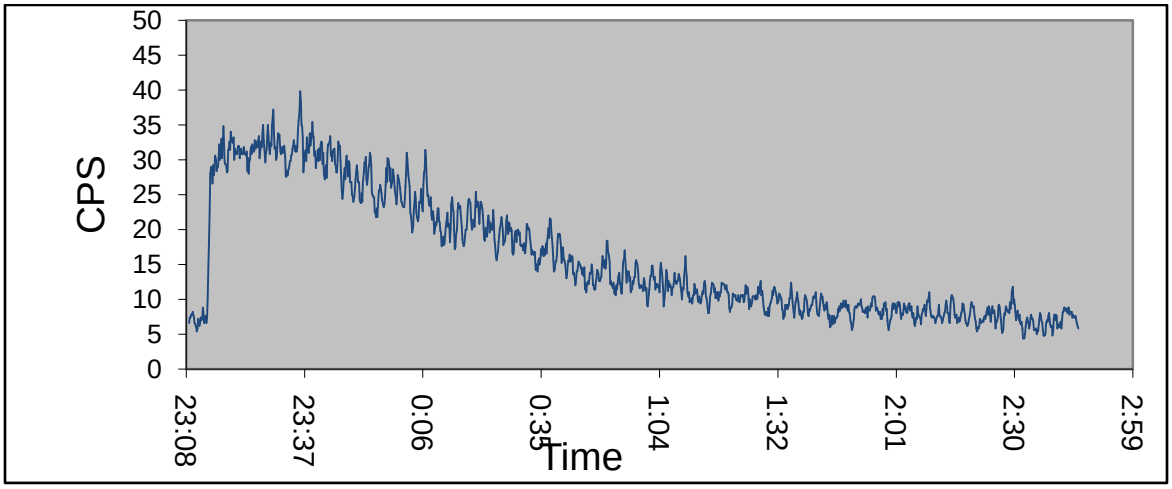

Figure 2- Results of Time Investigation

The jump in activity a few minutes into the experiment is due to the balloon being placed on the detector. The counts are averaged over a 5 second period. It can be seen that the activity climbs to a peak approximately 30 minutes into the experiment followed by a decline in activity.

A numerical model that presupposed an initial population of polonium atoms was developed to attempt to investigate this decay activity. This model is shown figure 3. It is important to note that this model is of atom inventory and not activity.

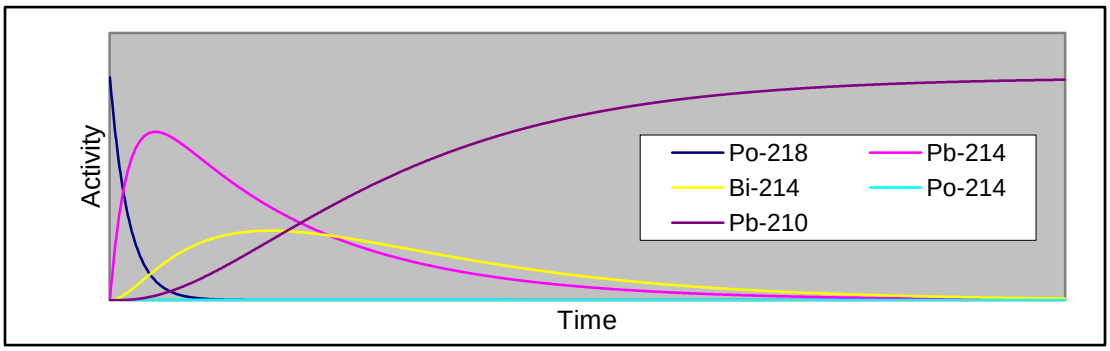

Figure 3 – Numerical Model

These decay curves were summed and normalized to fit the existing data. The results are shown in figure 4:

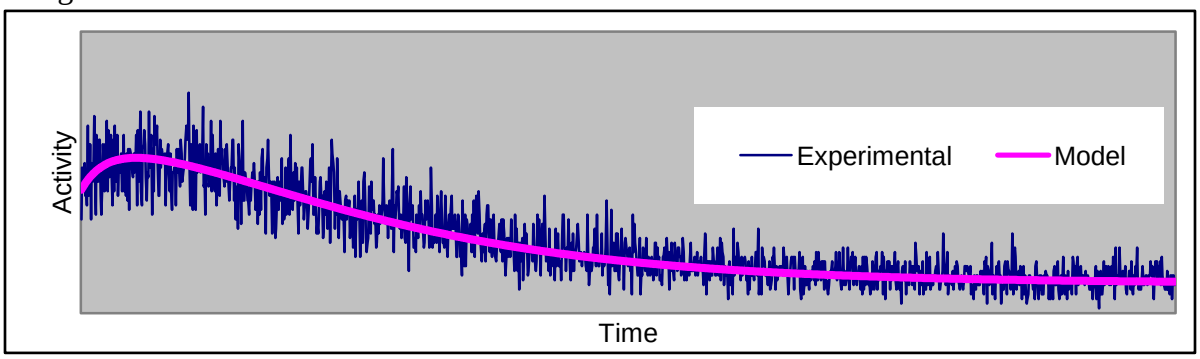

Figure 4 – Numerical Model Fit to Data

Concluding the measurements, the results of the Alpha/Beta Discrimination are as shown in Figure 5.

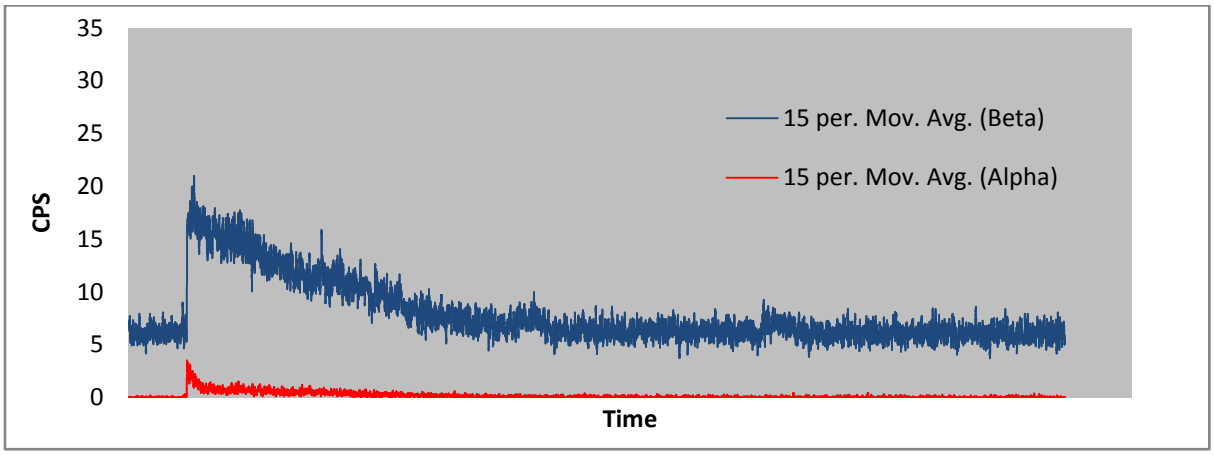

Figure 5 – Results of Alpha / Beta Discrimination

It is seen from these results there is significantly more beta activity than alpha activity. Austen and Brouwer report that the majority of activity was due to the beta decay of Pb-214 and Bi-212[1], so these data are in good agreement with that finding.

4. Conclusion

The nature of the electrostatically deposited radionuclides on electrostatically charged balloons has been investigated. Alpha spectroscopy has been performed which indicated the existence of naturally occurring radioisotopes. The time dependent behaviour of the balloons has been investigated. It was confirmed that the majority of the activity came from beta emitting radioisotopes. Although our experimentation might seem trivial, there can be real world applications to this research. In particular, it might be possible for false alarms to be created at radiation scanning stations due to radioisotopes being collected on electrostatically charged clothing. If this occurs, it might be possible to discriminate the electrostatically collected radioisotopes at normal levels from abnormally collected radioisotopes.

5. Acknowledgements

Dr. EledorNichita, Associate Professor, Faculty of Energy Systems and Nuclear Science, University of Ontario Institute of Technology, Oshawa, Ontario.

Mr. Sharman Perera, Faculty of Energy Systems and Nuclear Science, University of Ontario Institute of Technology,Oshawa, Ontario.

Bibliography

1. **David Austen and WytzeBrouwer**"Radioactive Balloons: Experiments on Radon Concentration In Schools or Homes",June 10, 1996*Physics Education* Volume 32, Number 2., pp. 87-100.

2. **Barry J. Solomon, Bill D. Black**"Radon-Hazzard Potential of the Lower Weber River Area, Tooele Valley and Southeastern Cache Valley": *Utah Geological Survey*, 1996.

3. **James Cowie, Jr, Thomas A. Walkiewicz***"*Radioactive Ball" : *The Physics Teacher*, January 1992, Vol. 30, pp. 16-17.

4. **Walkiewicz, Thomas A. "**The Hot Balloon (Not Air)", *The Physics Teacher*, September 1995 Vol. 33, pp. 344-345.