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DIVISION OF SCIENCE & MATHEMATICS
218-755-2920

October 11, 1985

U.S. Nuclear Regulatory Commission
Region III
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn, IL 60137

ATTN: Evelyn R. Matson

RE: Control Number 78201 (Renewal of License 22-07944-01)

This correspondence describes our proposal for a satisfactory standard source with which to leak test our neutron source, the description of our instrument, and also addresses an additional concern.

We propose to buy a ^{210}Po source from The Nucleus Inc., Oak Ridge, having an activity of 0.10 ± 0.02 uCi. ($t_{\frac{1}{2}}$ - 138 days). We would replace this source every 3 years. We would assume in our calculations that the activity is + 20%. This would make our wipe test value 20% higher than the actual value. This standard source would only cost $15.00. We would like to keep the cost to a minimum at this time because Dr. Morine is not sure that our source is strong enough to be utilized effectively for neutron activation. He proposes to try this for his physical chemistry course this year (he is new to our faculty). If he finds that the activity is too low for his experiments, we plan to ship it back to Montsanto Corporation in Ohio. If he is satisfied with it, then we may want to investigate the possibility of buying a source with a longer $t_{\frac{1}{2}}$.

The instrument utilized for our leak test is the Bendix Electroscope. I have enclosed a copy of a laboratory exercise that describes this instrument. Please note that the sample is placed directly within the chamber, resulting in a counting efficiency of at least 50%.

Although Dr. Morine has had no classroom courses that involved working with unsealed sources, I will assume responsibility for the safe

handling procedures which will be posted in the laboratory and handed out to all students on the first day of wet lab activity.

Again, thank you for assisting us in these matters.

Sincerely,

Alice L. Lindgren

Alice L. Lindgren, Ph.D.
Radiation Safety Officer

encls: (1)

cc: Dr. Morine

ALL:bb

22. IONIZATION CHAMBERS

PROBLEM

To determine the activity of radioactive samples with an ionization chamber.

INTRODUCTION

Any instrument whose operation involves gas ionization, such as a Geiger counter, may be considered to be an ionization chamber, but in this discussion, the term "ionization chamber" refers to those instruments operating in the region of simple ionization without gas amplification (no avalanche effect as in the G-M tube).

Ionizing events which occur in an ionization chamber may be measured by means of either of two basic methods. In the first method, the ionization chamber behaves electrically as a simple capacitor. The chamber is charged by the momentary application of a potential across it. Exposure of the chamber to radiation causes the charge to be lost. The rate at which the charge is lost is a measure of the radiation intensity and the total loss of charge is a measure of the total radiation exposure. The classical gold leaf electroscope is of this type, and was used by Madame Curie in her early experiments with radioactive materials.

In the second method, the ionization chamber behaves electrically as a current regulating device. The amount of current which flows through the chamber is proportional to the radiation intensity. Sensitive electrometers are used to detect and measure this current.

Once charged, an electroscope (acting as a condenser) will retain the charge indefinitely unless a pathway is provided for its discharge. Discharge, exclusive of leakage through the supporting dielectric, occurs when ions, produced by ionizing radiation, migrate to oppositely charged electrodes, neutralizing the charge. As the charge is neutralized, the repelling electrostatic forces which hold the fiber away from its support are reduced. As a result, the fiber moves. The rate at which it moves (drift) is proportional to the radiation intensity. Thus, the rate of drift may be used as a measure of the amount of radiation.

Because the sample to be measured may be mounted directly inside the ionization chamber, the radiation emitted by the sample does not pass through any absorbing materials (such as a mica window) before it can cause ionization of the gas inside the chamber. This superior geometry results in counting efficiencies of 50% and higher, making such an instrument ideal for counting weak betas and alphas.

The greatest disadvantage of such an instrument is the relatively laborious manner in which the activities must be observed, as you shall see.

APPARATUS

Electroscope; stopwatch.

MATERIALS

Calibrated and uncalibrated C^{14} sources.

PROCEDURE

Familiarize yourself with the controls of the electroscope by carefully studying the diagram and comparing the controls. Remove any radioactive sources from the immediate area. The operating instructions given here are for the Bendix model 1050 electroscope. Other models, such as the Lauritsen and Landsverk, operate on the same basic principles but may differ slightly in operation of the charging and potentiometer knobs.

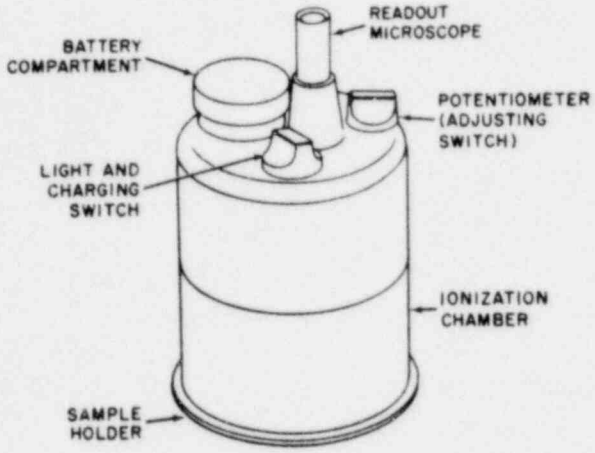

Figure 21. Bendix electroscope

Position the electroscope so the battery compartment faces away from you. Depress the charging switch to turn on the light, and turn it fully clockwise to close the charging switch. Hold it there. Look through the microscope; the fiber indicator should be in view somewhere on the scale.

The potentiometer adjusts the voltage when the electroscope is activated by the charging switch. The potentiometer may be turned to move the fiber up or down scale. Set the fiber on zero. Continue to hold the left knob in the clockwise position until the fiber is zeroed, then turn it fully counterclockwise before releasing and turning the light off. Check zero position of the fiber by depressing the charging switch, but do not turn it. Both knobs are turned only when the instrument is being zeroed. The reticle or scale may be observed at any time by depressing the charging switch only.

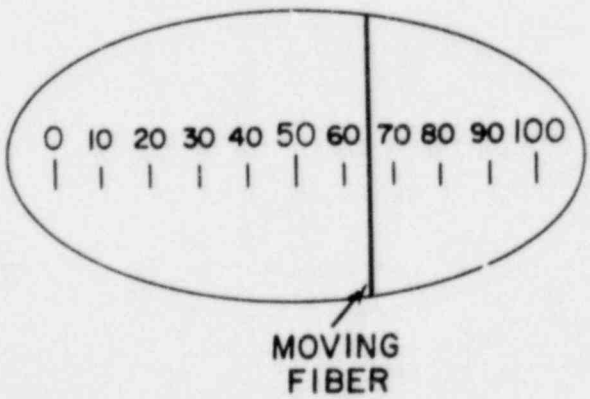

Figure 22. Scale of the electroscope

The above procedure must be used to zero the electroscope before starting any radiation measurement. It is not necessary, however, to rezero every time you desire to observe the drift rate.

To determine the background, zero the instrument and wait thirty minutes. The difference in the two readings is the background rate of drift. The reading should be converted to divisions per minute to be subtracted from future readings.

Observing the drift rate of the quartz fiber is the most critical part of making any radiation measurement with the electroscope. For extremely accurate results, the time should be noted with a stopwatch; if a stopwatch is not available, the stopping and starting of a time interval may be called off to a partner.

The most accurate way to observe the drift rate is given below:

> As the fiber just passes a mark on the scale, say 10, activate the stopwatch (or call off "mark" to your partner). Wait until the fiber passes another mark, say 20, and stop the stopwatch (or call off "mark" to your partner). Convert the divisions per unit of time to divisions per minute. It is not necessary to start at zero in recording the drift rate. In fact, it is probably better not to, for sometimes a slight residual charge causes the fiber to move slightly immediately after charging is completed.

Your instructor will now supply two C^{14} sources. One source is calibrated so that its absolute activity in μc is known. The other source will be used as the unknown. Both must be mounted in the same way to avoid backscatter errors.

Gently pull off the bottom of the electroscope to expose the sample holder of the electroscope. Place the calibrated sample in the center of the sample holder. It may or may not exactly fit inside the shallow well built to hold planchets. It is not necessary that source fit exactly inside the little well, as long as the geometry for both determinations is similar. Gently replace the body of electroscope on the sample holder, taking care to move the sample holder as little as possible. Rezero the instrument.

Determine the activity of the calibrated sample by observing the drift rate. Three determinations should be made and an average taken. Record all data. Determine the activity of the unknown in the same way. Subtract background, if significant, from the observed drift rates.

CALCULATIONS

Since the drift rate is directly proportional to the absolute activity of the sample, the activities may be compared with the following simple proportion:

$$\frac{D_1}{A_1} = \frac{D_2}{A_2}$$

where D_1 = drift rate of calibrated sample

A_1 = absolute activity of the calibrated sample in μc

D_2 = drift rate of unknown

A_2 = absolute activity of unknown

Remember to retain all significant figures when using the proportion. Insert the data into the proportion and solve to determine the absolute activity of the sample.

QUESTIONS

1. Assume that two samples are on hand, each 0.1 μc in activity. One is an alpha-emitter and the other is a soft beta-emitter. Which sample will cause the fiber to drift more quickly than the other?
2. Why would this instrument be a poor choice to determine the activity of a weak gamma-emitting sample?