Proceedings of the Iowa Academy of Science

Volume 62 | Annual Issue Article 24

1955

A Simple Method for Counting Solutions Containing Radioactive Phosphorus

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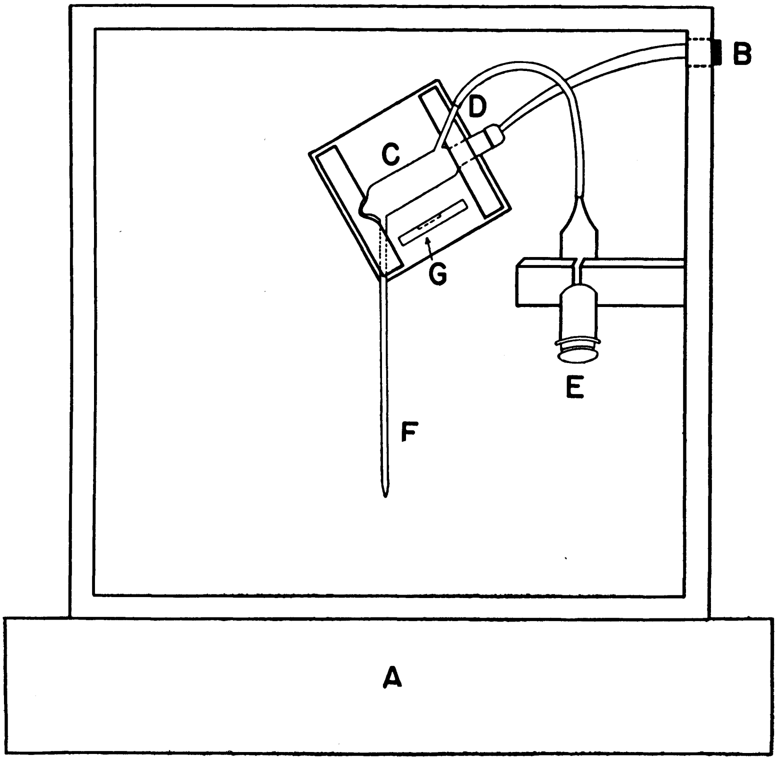
One of the most widely used radioactive istotopes for the study of metabolic reactions in plants is phosphorus-32, which has a convenient half life of 14.3 days and a maximum beta energy of 1.7 Mev. This radioisotope can easily be measured by ordinary electronic methods, e.g., a geiger tube and a proportional scaling unit.

For the work undertaken the equipment used was the Nuclear Scaler and a thin wall glass jacketed geiger tube (Mark 1, Model 70) manufactured by Radiation Counter Laboratories of Chicago, Illinois. The jacketed tube is made up of a central GM tube with a wall thickness of 6 mils (30 mg/sq. cm.) and a cathode of 2¾ inches in length. The outer jacket surrounding the cathode is $\frac{13}{16}$ inches in diameter and 6 inches long into which 5 ml. of radioactive solution is placed. There is a glass inlet and outlet for filling and emptying the jacket of radioactive solutions.

The preparation of dry samples for radioassay is time consuming, especially when accuracy depends on the preparation of samples that are uniform with reference to geometry and self absorption. At best, 20% of the emissions can be recorded when small dry samples are placed close to an end window counter. With the jacketed counter only 10% of the emissions from a liquid sample containing P-32 can be recorded, but the greater convenience in handling and reproducibility of results with liquid samples compensates for this lower sensitivity. With dry samples, small changes in position will cause much variation in the number of particles entering the end window counter, although with the jacketed counter and a liquid sample there is no variation due to geometry.

The counting rate of the active solution is almost independent of the volume used as long as the solution taken up is above the cathode. Beta ray energy of less than 0.3 Mev will fail to penetrate the counter wall; however, if the radioisotope has a gamma ray it can be counted. One of the variable features of this type of counter is the wall thickness. Gamma rays are little affected but with beta rays the thicker the wall the greater is the absorption, resulting in a smaller counting rate for a given active solution.

A special light, tight container and a mount for the geiger



counter was constructed of white pine (See drawing). The tube had to be shielded from light as these counters are sensitive to photons. The inside dimensions of the box were 18 x 19 x 11 inches deep. This was mounted on a heavy wood base (A) 4 inches wider on all sides than the black box. Any type of supporting base may be used, its height depending on the height of the operator. The box was equipped with light-tight double doors and a latch. The inside was painted dull black to absorb any light that might enter and affect the geiger tube. A hole (B) was drilled 1½ inches down from the top and 5½ inches from the back of the box for the shielded electrical cable connection to the scaling unit.

The jacketed counter was mounted on a ¼ inch block of wood 4¾ inches square between two padded supports to which the tube was clamped with wood clamps and screws (C). The upper filling tube (D) was attached by a piece of rubber tubing to a 500 cc. syringe (E). The syringe was clamped between two blocks of wood and mounted on the inside of the black box 8 inches down from the top of the box and 6 inches from the back. The position of the geiger tube depends on the angle the exit tube (F) makes from the jacket. This tube should be perpendicular to the base of the black box and high enough to permit a beaker of the radioactive solution to be placed underneath it.

The counter was calibrated with standard radioactive phosphate solution obtained from the Bureau of Standards. If this is not available any calibrated standard source of cobalt-60 may be used, placed in a mounted brass plate (G) centered below the sensitive volume of the counter. Counts may be taken with 5 ml. of water in the jacketed tube to simulate actual conditions when a standard radioactive solution is being assayed.

General procedure for radioassay is fairly routine. The radioactive solution (pH 2 to pH 3 desirable) under assay is sucked up into the jacketed counter by manipulation of the syringe. The rubber tube is clamped shut to prevent any leakage from the plunger in the syringe, doors are closed and the scaling unit activated. After the count has been taken the radioactive liquid is forced out of the jacketed tube and the inside walls of the jacket are washed free of radioactivity. This is usually done by washing with a dilute cleaning solution followed with distilled water. This procedure is carried out until the background of the tube is down to normal. The background readings are taken with the jacketed counter filled with water.

Acknowledgement

The writer wishes to express his appreciation to the Department of Botany and the Radiation Research Laboratory at the State University of Iowa for the use of their facilities and the purchase of the materials needed in this work.

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