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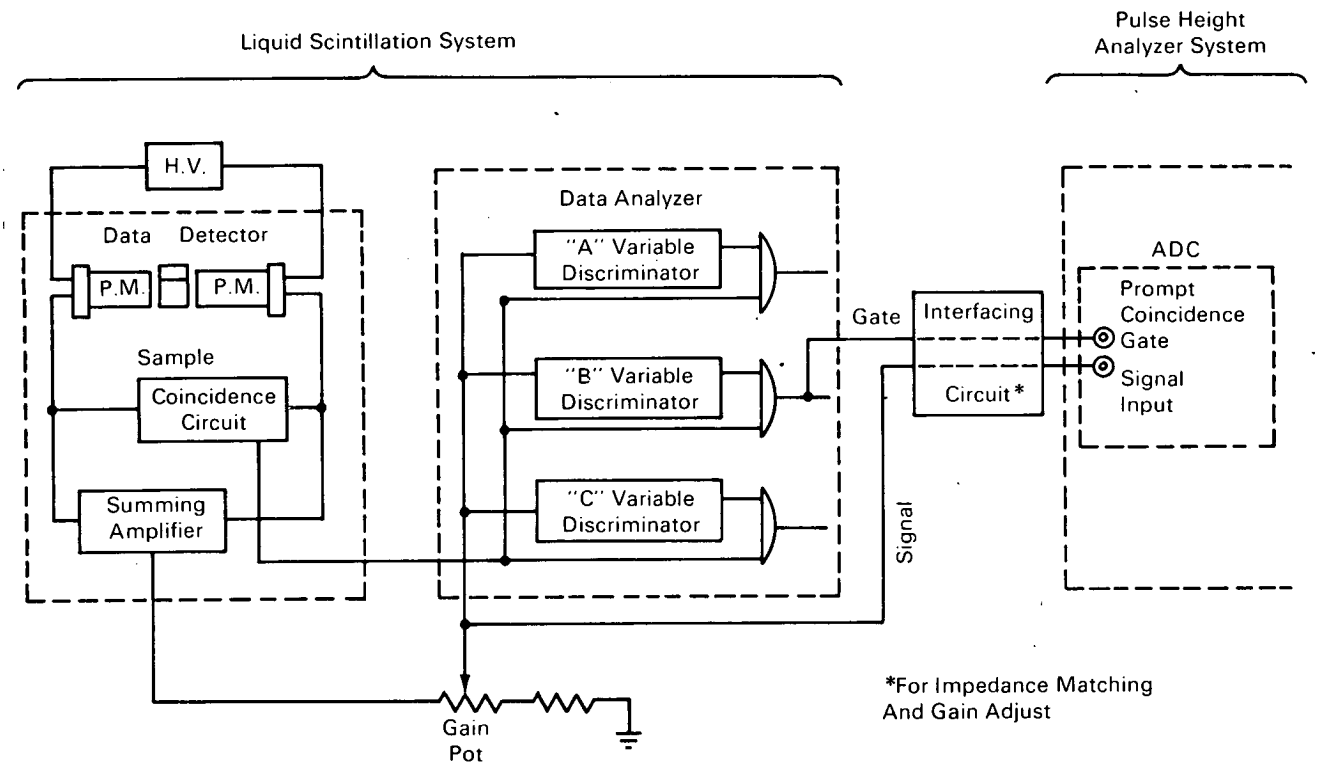
Direct Determination of Lead-210 by Liquid-Scintillation Counting



The problem:

To develop a direct method of determining ^{210}Pb concentrations. Direct determination has always been difficult because of the low energy of the beta particles, so that determination has almost always been made by measurement of one of the two daughters.

The solution:

The soft betas, the internal-conversion electrons, and unconverted gamma rays from ^{210}Pb are efficiently detected in a liquid-scintillation counting system; the overall counting efficiency (cpm/dpm) is 97–98%. To facilitate interpretation of the data, the liquid-scintillation counter is interfaced with a multichannel pulse-height analyzer. The liquid-scintillation spectra obtained can then be conveniently stored on paper tape and plotted on an *x-y* plotter.

How it's done:

Two standardized RaDEF (secular equilibrium) solutions were used as sources of supply of ^{210}Pb(RaD), ^{210}Bi(RaE), and ^{210}Po(RaF). The separated isotopes were prepared by a modified version of an ion-exchange procedure. The liquid-scintillation solution

(continued overleaf)

contained 6.0 g of PPO (2,5-diphenyloxazole) and 100 g of reagent-grade naphthalene dissolved in "spectro-quality" *p*-dioxane to 1 liter.

Depending upon the type and volume of sample solution, either the sample was evaporated directly in a standard, low-potassium-glass, liquid-scintillation vial and then taken up in 0.2 ml of 1*N* HNO_3 before addition of 10 ml of the scintillation solution; or 200 ml of the sample in 1*N* HNO_3 was added to 10 ml of scintillation solution contained in either a glass or a polyethylene vial.

A Beckman three-channel liquid-scintillation system was used as the primary measuring instrument. Two outputs from this unit were connected through an interfacing circuit to a 1600-channel pulse-height analyzer (PHA). Only one quadrant (400 channels) of the PHA was used in analysis of the spectra. The summing-amplifier output (picked off after the gain control) of the liquid-scintillation unit was used as the signal to be analyzed by the PHA unit; this output signal was gated at the PHA by the digital logic signal generated in the liquid-scintillation unit by a pulse appearing in the window of the variable discriminator.

The background counting rate in the ^{210}Pb window is 20 cpm for polyethylene vials and 40 cpm for low-potassium-glass vials. It is possible to determine 0.98± 0.58 pCi of separated ^{210}Pb at the 95% confidence level in a 100-minute sample-counting period when polyethylene vials are used.

The ^{210}Pb can also be measured in the presence of its daughter activities: ^{210}Bi and ^{210}Po. Both the ^{210}Bi beta and the ^{210}Po alpha are counted at essentially 100% efficiency. There is no interference between the ^{210}Pb and ^{210}Po spectral counting regions. The ^{210}Bi beta spectrum overlaps the other two spectral regions; however, there is a spectral-energy range in which no ^{210}Pb or ^{210}Po counts occur. Thus one can determine the concentration of each component of a mixture of lead, bismuth, and polonium-210.

Notes:

1. Determination of ^{210}Pb is important in radium-toxicity and atmospheric-tracer studies, uranium mining, etc.
2. This information may interest organizations concerned with radiation biophysics.
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B69-10611

Source: W. D. Fairman and J. Sedlet
Industrial Hygiene and Safety Division
(ARG-10462)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439