compounds in exchange for stable sulphur, the older elongated cells should show heavier uptake than the younger dividing cells. The table shows that the reverse is the case, and exchange processes can therefore be only of minor importance.

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[1] Howard, Alma, and Pelc, S. R., *J. Exp. Cell. Res.* (in the press).

Measurement of Radioactivity in Human Breath

The breath from patients with radium or thorium in their bodies shows considerable radioactivity. Breath measurements are a useful indication of the type and amount of internal radioactive contamination. In this Laboratory, α-activity has been measured by two methods, both using apparatus supplied by the Atomic Energy Research Establishment, Harwell.

The first uses the α-radiation breath-monitor, type A.E.R.E. 1056*A*. A four-litre specimen of the patient's exhaled breath is collected and drawn into an evacuated ionization chamber; the α-disintegrations in this sample are then counted.

The second method permits continuous-flow measurements and has been developed here. The patient breathes normally, inhaling each time through the nose and exhaling orally through a drying tube and a flow counter, in which the exhaled air is the counter gas. Each α-disintegration in the air temporarily within the flow counter causes ionization and consequently a voltage pulse on the counter anode. This is amplified and counted.

The two types of breath counter have been used for thoron-counting and a little radon work also. Sixteen patients with internal thorium-contamination have been investigated, and all have thoron activity in the breath. With the continuous-flow apparatus they give counting-rates from about 30 to 100 counts per min., so that five minutes of breathing gives a few per cent statistical accuracy. The breath of the same patients measured on the type 1056*A* monitor gives initial counting-rates of about 1,000–3,000 counts per min., but these figures involve an uncertain extrapolation. Thus the 1056*A*, which is designed primarily for radon measurements, is not so suitable for quickly decaying activities as the continuous-flow counter.

Results obtained indicate that these patients have concentrations in the breath of about 100–300 μμC./litre. The corresponding thorium burden is 2–10 gm., initially equivalent to 0·2–1·0 μC. Thoron production increases over a period of years from the time of contamination due to the build-up of decay products from the parent thorium; at most, 1 per cent of the produced thoron escapes in the breath, the remaining 99 per cent producing the subsequent decay products inside the body. The radioactivities of different patients, as measured by the two methods and by quite separate β- and γ-measurements on other parts of the body, agree satisfactorily.

For comparison with the thoron results above, the radium–radon tolerance figures are as follows: 40 per cent of the total emanation produced from 0·1 μgm. radium fixed in the body escapes in the breath, giving the accepted tolerance dose 1 μμC./litre of breath, which corresponds to about ½ count per min. in the flow counter, and an initial counting-rate of about 9 counts per min. in the type 1056*A* breath monitor.

Details of the continuous-flow counter are as follows. The drying tube consists of the standard magnesium perchlorate anhydrone flakes in a column 10 cm. long × 4 cm. in diameter. The counter is the A.E.R.E. 'methane counter' type 1077, with volume 135 ml., a heavy brass cathode 14 cm. long × 3·2 cm. in diameter, and tungsten anode 11 cm. long × 0·01 mm. in diameter. It is operated with anode at + 2,000 volts, from a well-stabilized power supply. This gives small gas-amplification, absolute efficiency of *c.* 60 per cent, background 2 counts per min. and plateau slope 0·7 per cent per volt. To assist the patient to breathe out through the apparatus, the inlet hole is enlarged and a water suction pump attached to the outlet. The amplifier is type 1049*A*, the flow counter fitting directly to the head amplifier. Full gain of 16,000 is used, and the output pulses from the amplifier are taken to a scaler, type 1009*A*, working at 5 volts bias, 1 millisec. paralysis time.

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Time-delays in Low-voltage Halogen-quenched Geiger–Müller Counters

Low-voltage halogen-quenched Geiger–Müller counters find increasing applications in many fields, especially for use in portable survey and assay instruments[1]. Their chief advantages are: (i) very low temperature coefficient down to − 50° C.; (ii) very long counting life; (iii) extreme electrical robustness; (iv) simple battery requirements; (v) large output pulse necessitating no pre-amplification.

These characteristics would greatly simplify the problems associated with Geiger–Müller counters arranged in multiple coincidence circuits, as often occurs in cosmic-ray research, provided that no other difficulties were introduced. One important possibility which would limit the use of halogen-quenched counters would be long time-delays between passage of the primary ionizing particle and development of the output pulse. This would be due, if it occurs, to the low mobility of negative ions formed in gaseous bromine and chlorine, which have high values of electron attachment coefficient.

Accordingly, work is in progress in this laboratory to investigate any time-delays and their dependence on counter parameters. The first results were obtained from a counter constructed of chrome-iron foil in a glass envelope; the centre wire was 0·12 mm. in diameter and its effective length was 195 mm. It was mounted between two argon-alcohol counters of 20 mm. diameter forming a simple cosmic-ray coincidence telescope, the axes being parallel and vertically above each other.