THE MOBILITY OF THE IONS OF THE ACTIVE DEPOSITS OF THORIUM AND RADIUM

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Abstract

The method used is the same as in a similar study of the active deposit of actinium.[1] As in the case of actinium, two positive active bodies differing in mobility were found in the active deposits of thorium and radium. In the case of these three deposits, all of the three swifter bodies have equal mobilities in air, and, likewise, all of the three slower bodies. The curves obtained indicate that one of the active bodies is not deposited as an A product and the other as a B product; nor is one ion atomic and the other polyatomic. It is believed, however, that one is singly and the other doubly charged.

IN an earlier paper[1] results were given showing that in the active deposit of actinium there are two positive bodies, one having a mobility of the order of 4.35 cm/sec/volt/cm and the other a mobility of 1.55.

In this paper are given the results of a similar investigation of the active deposits of thorium and radium. The method employed is similar to that used in the case of actinium.

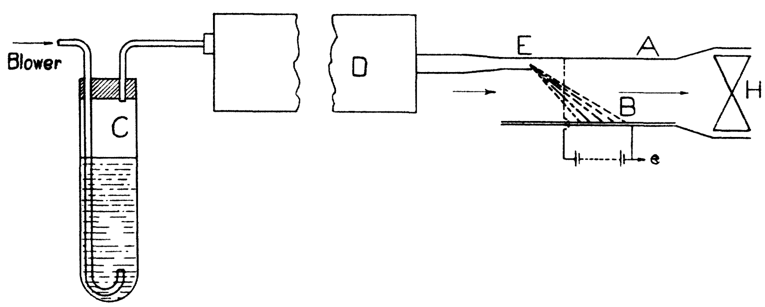

Fig. 1.

The active deposit ions were carried in a stream of air produced by the fan H, Fig. 1, and at E entered the space between two parallel plates A and B which were kept at a difference of potential of 3200 volts. The ions were then driven by the field across the air stream to the plate B where they were deposited. The plate B was removed and placed beneath an ionization chamber in the bottom of which there was a narrow slit, as shown in Fig. 2.

[1] Erikson Phys Rev. **24,** p. 622 (1924).

The rays from the active deposit passing through this slit produced an ionization current which was measured by means of a quadrant electrometer. In this way the down stream position of the different active deposits were located.

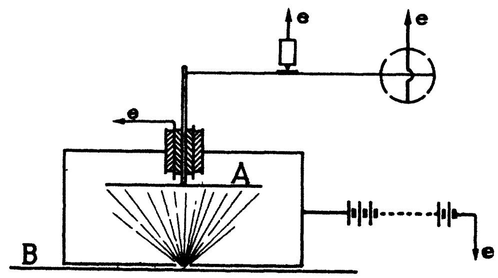

Fig. 2.

Results in the Case of Thorium Active Deposit

About 400 gm of thorium nitrate were dissolved in water and placed in a container *C*, Fig. 1. Air from a blower was forced through the

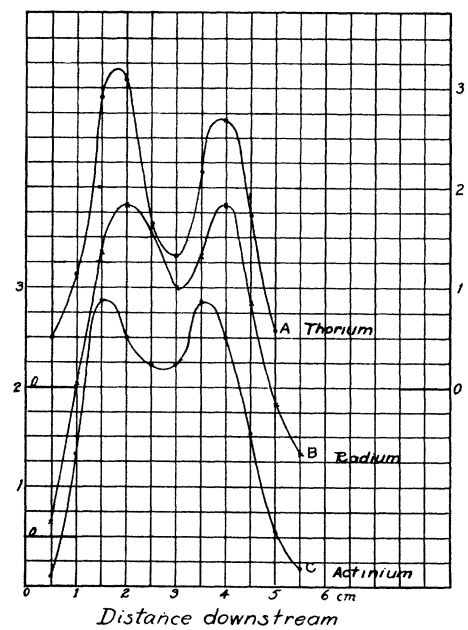

Fig. 3.

solution. The air and emanation then passed into the chamber *D*, 185 cm long and 36 cm in diameter, so large that the emanation passed through it slowly, thus permitting the formation of a greater amount of active deposit. From this chamber the active deposit ions passed into the part of the apparatus described above. The time of exposure was one hour, and the air velocity was of the order of 10 meters a second.

The results obtained are given by curve A, Fig. 3, where the down stream distances are plotted as abscissas and the ionization currents as ordinates in arbitrary units. Curve C is for the active deposit of actinium. It is thus seen that there are two active bodies in thorium active deposit and that these have the same mobility as those of the actinium active deposit.

Results in the Case of Radium Active Deposit

The equilibrium quantity of emanation from a solution of about 3 mg of radium was collected in a test tube by displacement of mercury and

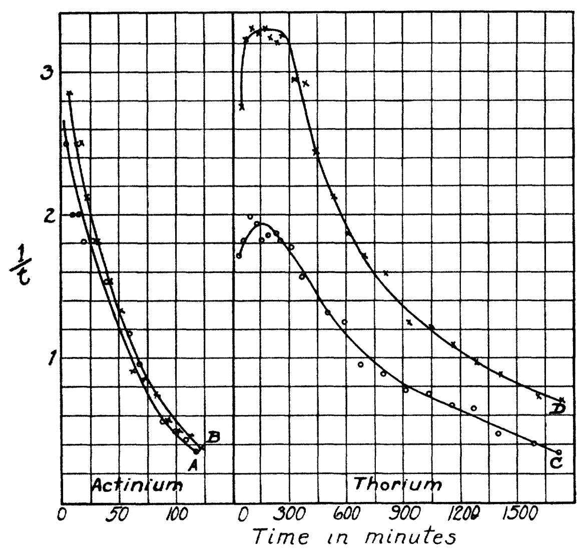

Fig. 4.

was admitted to the chamber D, Fig. 1. A length of exposure sufficient for the chamber to be emptied of the air containing the emanation was used. This interval was of the order of ten minutes. The difference of potential between the plates AB and the air velocity were the same as in the case of thorium. The results are given by curve B, Fig. 3. It is thus seen that in the case of the radium active deposit also there are two positive bodies, the same as in the case of actinium and thorium, and that their mobility values are correspondingly the same.

In Fig. 4 the decay curves for the two bodies in actinium and thorium active despoits are given. Curve A is for the more rapid of the two ions in the case of actinium and curve B is for the slower.

Curves C and D are, correspondingly, the decay curves in the case of thorium.

The half value periods deducible from these curves show that both bodies were B products at time of measurement.

Discussion of Results

In considering the nature of the two bodies, the question arises as to whether originally one came down as an A product and the other as a B product. It is, however, quite clear that this is not the case. If it were so then, owing to the short life of the A product in both the actinium and thorium series, the amount of the A product deposited should be much less. The curves in Fig. 3, however, show that about equal amounts of both are deposited.

It was also thought for a time that one of the active bodies was atomic and the other molecular in size, and that the ion of atomic size, having the greater mobility, would come down sooner. The fact, however, that an ion one atom large has the same mobility in air as an ion one polyatomic molecule large, as shown by the work on argon,[2] precludes this interpretation. The remaining alternative is that one is singly charged and the other doubly charged. An attempt to determine this by means of a magnetic field is under way. Thus far, it has not been found possible to overcome the difficulties encountered.

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Physical Laboratory,
University of Minnesota,
July 1, 1925.

[2] Erikson, Phys. Rev. **25**, p. 890 (1925).