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DECONTAMINATION OF XENON FROM RADON

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ORNL-793
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CHEMISTRY DIVISION

DECONTAMINATION OF XENON FROM RADON

H. Zeldes and A. R. Brosi

Date Issued
AUG 14 1950

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ABSTRACT

The feasibility of rapidly decontaminating liter amounts of xenon from radon by factors of at least 10^6 using a simple gas chromatography technique has been demonstrated. The separation has been achieved in a single pass through a small synthetic hydroxyapatite column with high recovery. A method is also indicated for quantitatively recovering the xenon in a given sample in decontaminated form.

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DECONTAMINATION OF XENON FROM RADON

H. Zeldes and A. R. Brosi

Introduction

In connection with work being done at the Argonne National Laboratory it has become desirable to decontaminate liter quantities of xenon from radon by factors of at least 10^6. This problem is a natural extension of the work on separation of radioactive gases described in ORNL-685. Using the charcoal column and helium elution technique described in that report a thousand-fold decontamination factor was obtained in preliminary experiments.

Although an adequate process could be evolved for a charcoal column operated with the elution technique, it was felt that "break-through" operation would be much simpler for routine separations. With elution-type operation large volumes of a carrier gas must be passed through the column before xenon appears in the effluent gas stream. Since the use of carrier gas is avoided in break-through operation, much less time is required for the purification. Also, the separation of xenon from carrier gas is avoided.

Since a synthetic hydroxyapatite column was found to have about ten times as many theoretical plates per unit length as the coconut charcoal column, this material was used in the experiments described below. The use of this material was suggested by Dr. P. H. Emmett on the basis of pore size distribution.

The work described below is a demonstration of the feasibility of quantitatively decontaminating liter amounts of xenon from radon with simple equipment. Undoubtedly a wide variety of adsorbents and column operating techniques could be used to accomplish the required separation. These possibilities have not been explored since the aim was to determine feasibility rather than to develop a process.

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Experimental

A glass U-tube was filled with 13.3 grams of 100-120 mesh size synthetic hydroxy-apatite[1]. This adsorbent was prepared for use by evacuation at 520° C for one hour. In addition to removing adsorbed gases this treatment removes water and alters the pore size distribution and specific surface of the adsorbent. The adsorbent bed was 50 cm long and had a cross sectional area of 0.5 cm^2. The void volume of the column was 20 cc.

The pressure and flow control equipment were the same as described in ORNL-685. The proportional counter detector described there was replaced by an anthracene scintillation counter which would detect Rn alpha particles.

In each constant temperature run the evacuated column was initially equilibrated with xenon at a pressure of one atmosphere. Immediately after injecting xenon and radon tracers, xenon flow was started at a rate of 10 cc/min. measured at 25° and 1 atmosphere.

Figures 1 and 2 are plots of activity in the detector cell, in arbitrary units, as a function of the volume of xenon passed through the column at two temperatures, -78° C. and -98° C., respectively. The complete radon activity peak is not shown because it is distorted by the radon decay products deposited in the detector cell.

Discussion

The xenon data shown in figures 1 and 2 have been analyzed by the method of Mayer and Tompkins[2] for the number of theoretical plates in the column. The

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(1) This material was furnished by Dr. E. F. Barrett of the Mellon Institute of Industrial Research, Pittsburgh, Pa.

(2) S. W. Mayer and E. R. Tompkins, J. A. C. S., 69, 2866 (1947).

radon data were not used for a theoretical plate analysis because the shape of the activity curve is affected by the growth and decay of radon daughters in the detector cell. The analysis shows that there were 365 plates in the column when operated at -78° C and 560 plates when operated at -98° C.

Using the normal probability distribution function approximation (described by Mayer and Tompkins) for the shape of an elution peak, the fraction of radon eluted has been computed as a function of the effluent xenon volume. The useful volume of xenon which could be flowed through the column before 10^{-6} of the radon was eluted was found to be 1030 cc at -98° C and 440 cc at -78° C. These volumes are known to be conservative because of the nature of the approximation. The experimental conditions also lead to conservative estimates of these volumes because all of the radon tracer was added at the start of xenon flow instead of being homogeneously mixed with the xenon. The volumes of xenon which can be passed through the head of the column before the effluent gas attains a residual radon content of 10^{-9} as well as 10^{-6} are shown on the figures.

If the column at -98° C were initially filled with a light gas such as helium and 1390 cc of xenon were flowed onto the column, 1030 cc or about 75% of the initial volume could be recovered in properly decontaminated form and 360 cc would be left on the column. If 100% recovery of a given sample were desirable, 1030 cc could be flowed onto the column followed by 360 cc of ordinary xenon. The ordinary xenon could also be replaced by another gas less highly adsorbed than radon but more highly adsorbed than xenon.

With operation at -78° C the fraction recoverable is also about 75% even though the number of theoretical plates is less than at -98° C. This result is a consequence of the more favorable ratio of xenon and radon elution peak positions.

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If a larger volume of identically decontaminated xenon is desired, the cross sectional area of the column should be increased in proportion to the increase in volume. The flow rate should also be proportionately increased since the number of theoretical plates will decrease with low flow rates.

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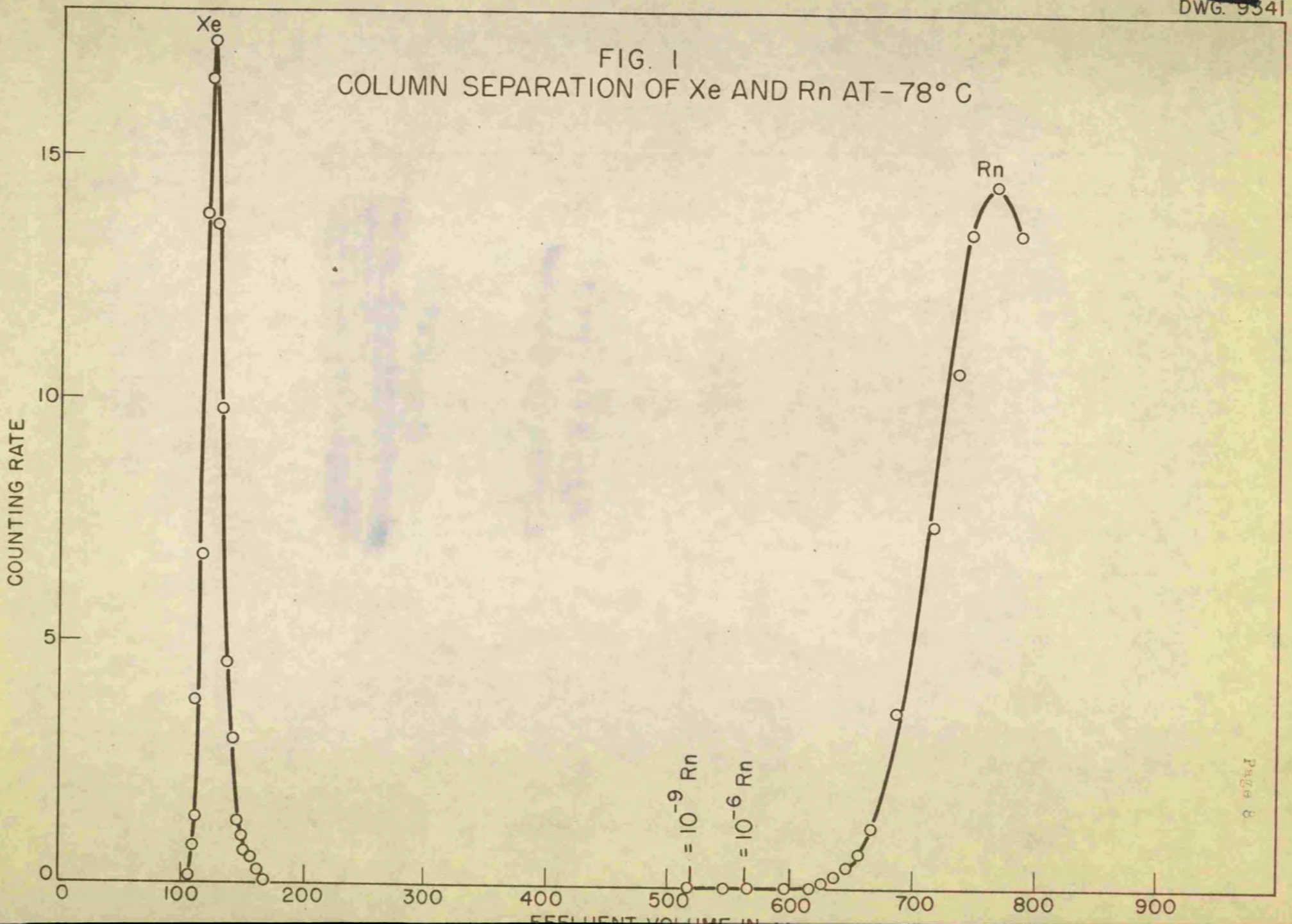
DWG. 9341

FIG. 1
COLUMN SEPARATION OF Xe AND Rn AT -78° C



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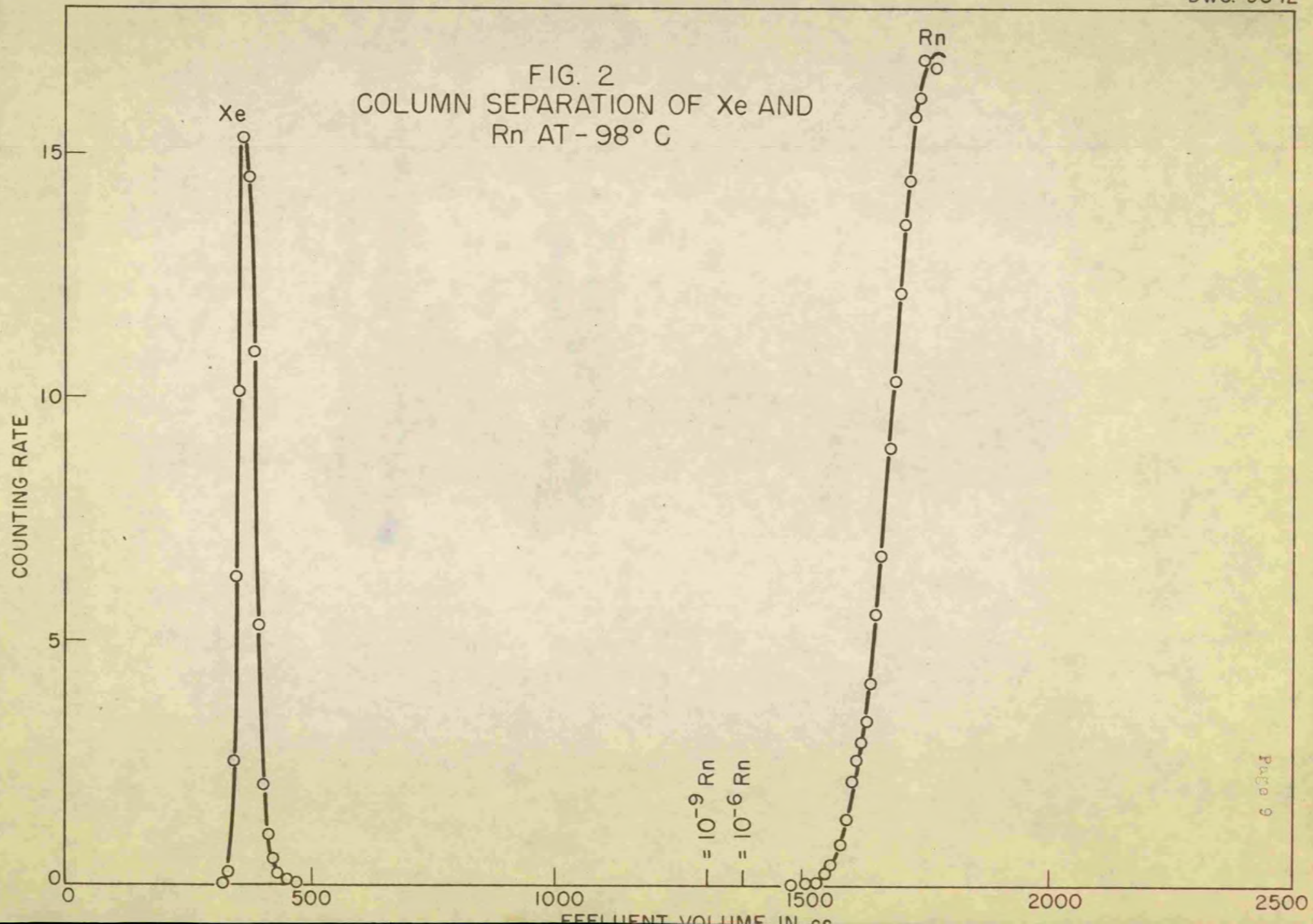

FIG. 2
COLUMN SEPARATION OF Xe AND Rn AT - 98° C