making his results available to us in advance of publication.

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RECEIVED DECEMBER 19, 1955

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ADSORPTION ON INORGANIC MATERIALS. I. CATION EXCHANGE PROPERTIES OF ZIRCONIUM PHOSPHATE[1]

Sir:

Precipitates obtained by mixing Zr(IV) and phosphoric acid solutions (to be called zirconium phosphate) were found to exhibit adsorptive properties for cations which apparently can be described in terms of cation exchange behavior. The materials, after precipitation and centrifugation, were dried (or fired), ground to small mesh size and screened. They were then used in small columns of the type commonly used for ion exchange experiments. Distribution coefficients D (amount per kg. adsorber/amount per l. solution) were also determined in batch equilibration experiments involving small amounts of the solids and solutions.

The zirconium phosphates showed excellent adsorptive properties for a number of cations, *e.g.*, the alkali metals, alkaline earths, Al(III), Fe(III), etc., and typical cation exchange displacement reactions. They appear to have reasonable adsorptive capacities. For example, zirconium phosphate dried at 25° can adsorb *ca.* 1 mole Cs^+ from 0.1 M CsCl solutions. This uptake decreases with firing temperature, though not seriously if the firing temperature does not exceed 200°, where uptake is still 0.7 mole of Cs^+ per kg. Although detailed rate studies have not been carried out as yet, columns prepared from these materials seem to behave qualitatively similarly to columns prepared with conventional organic cation exchange resins.

The exchange reaction appears to approach ideal behavior, at least under trace conditions (low loading). Thus log D for tracer Ce(III) is a linear function of log M HCl with slope *ca.* minus three, as expected for ideal Ce^{+++}–H^+ exchange.

Detailed studies of the selectivities have so far only been carried out for the alkali metals. For these the selectivities differ widely, permitting separations with small columns. A typical separation of Rb and Cs with a small column of room temperature dried zirconium phosphate is illustrated in Fig. 1.

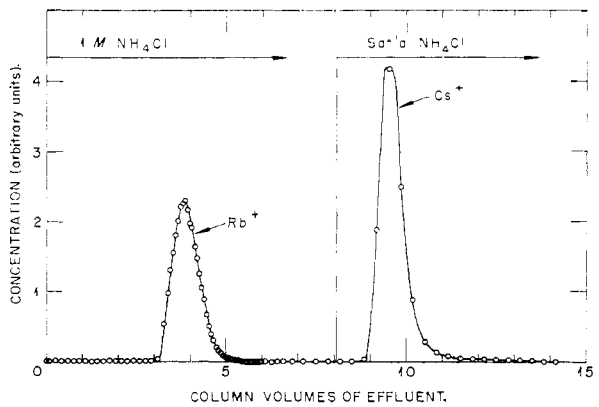

Fig. 1.—Separation of Rb^+ and Cs^+ on zirconium phosphate (0.25 cm.^{2} × 12 cm. column) (flow rate 0.8 cm./min.).

(1) This document is based on work performed for the U. S. Atomic Energy Commission at the Oak Ridge National Laboratory.

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A TETRAHYDRO-FOLIC ACID LINKED FORMIMINO TRANSFER ENZYME

Sir:

We wish to report the occurrence of a formimino (–CH=NH) transferring enzyme for formiminoglycine in extracts of *Clostridium acidi-urici* and the function of tetrahydro-folic acid in formimino transfer.

Formiminoglycine (FIG), identified by Rabinowitz and Pricer[1] as an intermediate in purine degradation by *Clostridium cylindrosporum*, has been prepared by the method of Micheel and Flitsch.[2] *Clostridium acidi-urici* cells, grown in a uric acid medium essentially as outlined by Barker and Beck,[3] were ruptured as a frozen cell paste by Hughes press.[4] After centrifugation, the "crude" extract was used or "Dowex" treated (15 minutes at 0° with 3 g. Dowex-1-Chloride/800 mg. bacterial protein) to remove cofactors.

The "crude" extract and the "Dowexed" extract when supplemented with tetrahydro-folic acid (THFA), cleave formiminoglycine as shown

$$\text{Formiminoglycine} \xrightarrow{\text{THFA}} \text{glycine} + \text{ammonia} + \text{formate} \quad (1)$$

Formiminoglycine was measured by the alkaline nitroprusside–ferricyanide method of Rabinowitz and Pricer[5] and glycine, after elution from chromatographs, by the ninhydrin method of Moore and Stein.[6] Separation and qualitative identification were achieved by chromatography on Whatman no. 1 paper with a phenol-water solvent. Formiminoglycine (R_f 0.75) and glycine (R_f 0.38) were visualized by using their respective colorimetric reagents as sprays.[7] Formiminoglycine was stable to incubation and chromatography as well as to the procedure for ammonia analysis.[8] As observed in Table I, the "crude" extract decomposed formiminoglycine beyond the glycine stage—*i.e.*, recovery of but 0.5 μM. glycine and 1.4 μM. ammonia/μM. formiminoglycine used. "Dowexed" extract did not cleave formiminoglycine but was activated by tetrahydro folic acid to give essentially

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