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Application of Adsorption Barrier Technique in the Ring Oven Method: Rapid Separation of Acid Dyes with Magnesium and Aluminum Hydroxide Zone Papers

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The ring oven method\(^1\) has been used widely for the micro-analysis of inorganic and organic substances. The only limitation of this method is that thermolabile samples such as enzymes are not analyzed. In 1970, Weisz and Abe\(^2\) attempted an interesting approach to this problem and demonstrated that an "adsorption barrier" in the ring oven method could be substituted for the "temperature barrier". The method was based on the use of an insoluble hydroxide as the adsorption zone, which was produced on a filter paper with the aid of a ring furnace. The samples were washed into the zone by means of a suitable solvent without employing the ring furnace itself.

The purpose of the present work is to define how much the adsorption barrier technique can extend the usefulness of the ring oven method and to obtain some information about adsorption of dyes by metal hydroxides. On the basis of these results, a widely applicable procedure for the separation of acid dyes has been developed.

Experimental

Reagents

Solutions of dyes. 0.05% aqueous solutions were prepared from commercially available dyes, which were employed without further purification. These dyes and some metal indicators chosen for this study are as follows.


Triphenylmethane Dyes: Cyanol FF (C. I. 43535), Cyanol Silk Blue B (C. I. 44080), Erioglaucin A (C. I. 42090), Acid Magenta (C. I. 42685), Thymol Blue, Xylenol Orange, Pyrocatechol Violet.

Others: Indigo Carmine (C. I. 73015), Murexide (C. I. 56085), Litmus.

Solutions of Mg$^{2+}$, Be$^{2+}$, Al$^{3+}$, Cd$^{2+}$, Pb$^{2+}$, Y$^{3+}$, La$^{3+}$, Bi$^{3+}$ and Th$^{4+}$ ions (10 mg/ml of each ion). Chlorides or nitrates were dissolved in distilled water.

**Apparatus**

Toyo No. 53 chromatographic filter paper, 55 mm in diameter, and Toyo's ring oven apparatus were used.

**Preparation of Adsorption Barrier Zone Paper**

3 μl of an ion solution was added to the center of a piece of filter paper and washed to the ring zone (22 mm in diameter) with 0.1 N hydrochloric acid. The filter paper was removed from the ring furnace and bathed in 0.4 N sodium hydroxide or in 2 N ammonia, rinsed with water and dried.

**Procedure**

The dye sample drop (3 μl) was spotted on the center of the adsorption barrier zone paper and washed with water. A sharply developed ring-shaped zone of dye was observed when it was adsorbed. The amounts of dye adsorbed on metal hydroxide zone was determined using the same technique as described in a previous paper.

**Results and Discussion**

**Hydroxide as an Adsorbent**

In order to obtain the most suitable adsorbent, a number of insoluble hydroxides were examined. From the comparison of the adsorption behavior of acid dyes under similar conditions, it was found that aluminum and beryllium hydroxides had the largest