AN APPARATUS FOR THE EVAPORATION OF LIQUIDS IN A TEST-TUBE.

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The following procedure and apparatus were designed primarily to permit the evaporation of foamy liquids such as urine in 200 X 20 mm. test-tubes so that ashing and subsequent precipitation of one of the constituents of the solution could be carried out in the same tube.

The procedure consists in heating the test-tube containing the liquid to be evaporated in a suitable bath maintained approximately at the boiling point of the liquid to be evaporated while a gentle current of heated air is directed into the test-tube.

Evaporation of fluids that foam and bump badly by the ordinary procedure of boiling requires a large vessel such as a 250 cc. Kjeldahl flask, and when it is desired to transfer the liquid to a small vessel such as a 200 X 20 mm. test-tube at a volume of 10 cc. or less, the procedure is at least an awkward one and not likely to be quantitative.

By the means to be described, not only is it possible to precipitate in the original tube used for evaporation and ashing, but the use of material to prevent bumping such as silica or pebbles which might introduce uncertainty into the analysis is eliminated, because the evaporating liquid does not boil. Still another advantage results from the fact that once the tube is adjusted in place, almost no further attention is required until evaporation is complete.

Compressed air is passed through a cylinder 30 cm. high packed with absorbent cotton to free it from particles of dust. This is connected to an air heater consisting of a heating coil enclosed

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Evaporation Apparatus

in a glass tube (Figs. 1 and 2). The glass tube is 1 cm. inside diameter by 20 cm. long and is fitted with a glass wool filter. The heating coil consists of 21 feet of 22 gauge nichrome resistance wire wound in a spiral. This is an ordinary laboratory heating unit for use on a 110 volt current. A cork stopper plugs the lower end of the heating apparatus. On this is mounted a piece of Pyrex tubing, 1.5 cm. in diameter and 16 cm. long, which holds the
heating coil. One section of the heating coil is straightened to pass down the interior of the Pyrex tubing on which it is mounted, and connections through the cork are made with short pieces of copper wire and binding posts. A layer of glass wool covers the cork. This keeps the lower end of the heater cool regardless of how long it is in operation. No rheostat is required. This is avoided by the simple expedient of attaching the heating unit of two heaters in series. The air temperature thus produce

\[(200-300^\circ)\text{ is sufficient for the purpose. The heating unit is conveniently raised or lowered by a rack and pinion arrangement, shown in Fig. 2. More than 100 solutions have been evaporated with two such heaters during the last 2 years and they are still giving satisfactory service.}

Usually the test-tube containing the liquid to be evaporated is heated in a bath of dilute sulfuric acid (boiling point 110–120°) when 30 or more cc. of urine are to be evaporated in each tube.
Evaporation Apparatus

With dilute solutions, or when only 10 to 20 cc. of fluid are to be evaporated at a time, an ordinary water bath at 100° does very well. Fastest evaporation occurs when the outlet of the hot air tube is about 3 cm. above the surface of the liquid to be evaporated. If the outlet for the air is adjusted about once every 10 minutes, the rate of evaporation of urine is only slightly slower than is obtained by boiling in a Kjeldahl flask. 30 cc. can usually be evaporated in 35 to 40 minutes. Even if no attention is given the tube after it is once adjusted, 30 cc. of urine will evaporate in approximately an hour. The current of air required is only sufficient to produce a cup-like depression in the surface of the liquid.

A simple apparatus suitable when only a few determinations are required can be made from laboratory materials. The air from the absorbent cotton filter is directed by means of glass tubing against the interior lower portion of a Kjeldahl flask which is fitted with a cork stopper. A second glass tube, similar to the outlet of the electrical heater, conducts the air from the Kjeldahl flask to the surface of the liquid to be evaporated. A Bunsen burner under the flask heats the air passing through. The connection between the cotton filter and the flask should be made in part with rubber tubing so that the flask will not be rigid. If it is supported somewhat loosely in a clamp on a ring stand, the distance of the outlet from the surface of the liquid can be adjusted by sliding the entire flask down as the liquid evaporates.

The objection might be raised that dried material on the sides of the test-tube in which liquids are evaporated by this process might be carried out of the tube by the current of air. This objection cannot be applied in the case of urine because it dries to a gummy mass which sticks to the sides of the glass, as do many other biological fluids. It is not likely that the gentle current of air used would cause a loss except from material that dried to a fine powder. The method has been tried out with urine, trichloroacetic acid blood filtrate, etc., in connection with the determination of calcium and magnesium. Recovery, as indicated by control analyses in which the evaporation apparatus was not used, has always been complete.
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