

## A LABORATORY VACUUM FILM EVAPORATOR

By H. E. Watson.

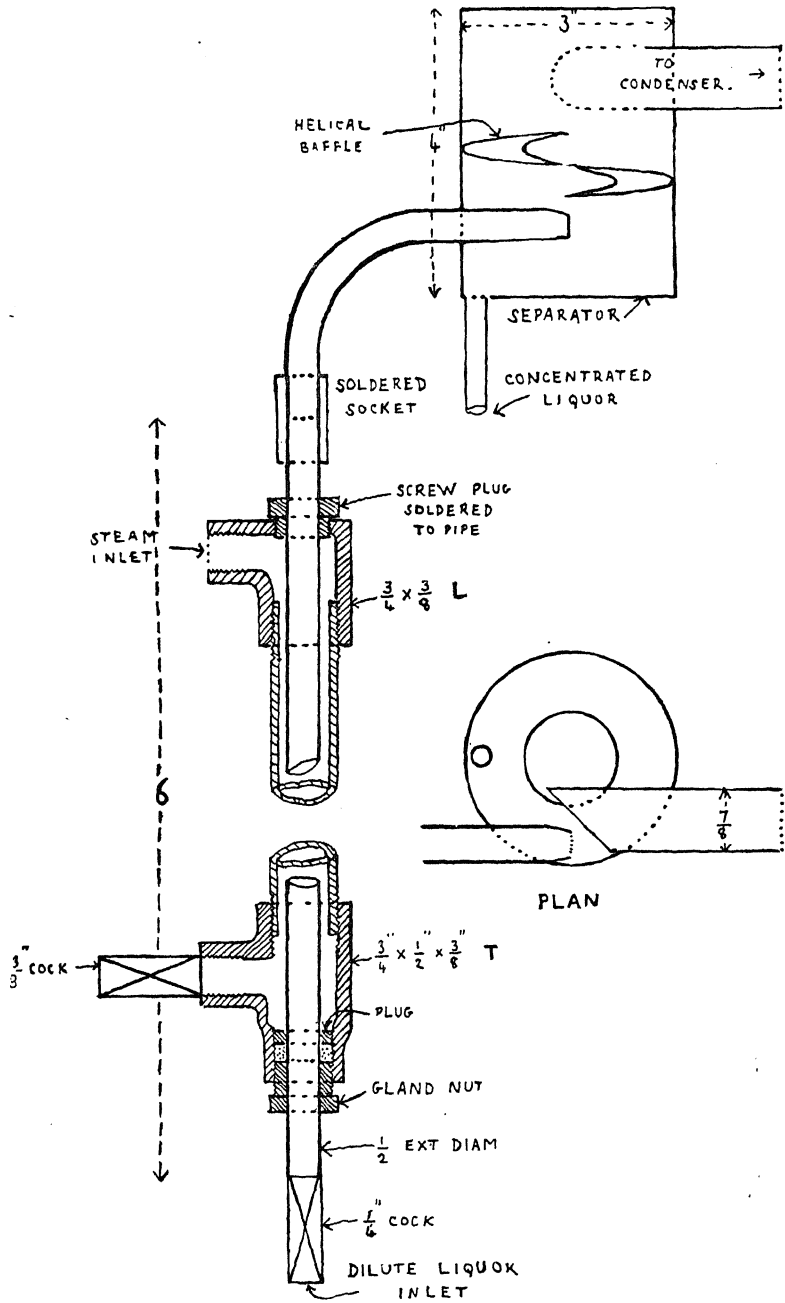
A common operation in chemical works is the concentration of large volumes of aqueous solutions under reduced pressure, and various types of plant have been constructed for this purpose. These include vacuum pans, tube evaporators and film evaporators of the climbing and falling types. Film evaporators, either in single or multiple effect, have proved themselves to be most useful and efficient for concentrating solutions of caustic soda, tannins, glue, etc.

In a chemical laboratory, where only one or two litres of liquid have to be dealt with, the usual plan is to distil in glass vessels, but no convenient type of vacuum evaporator appears to be available which is suitable for a technical chemical laboratory, where the quantities of liquid to be evaporated may amount to several gallons. Such quantities are beyond the capacity of glass apparatus, and yet too small for treatment in the "laboratory" evaporators made by the manufacturers of commercial plant. It is possible in many cases to use a small vacuum pan, but apart from the high cost, and the necessity for having several pans made of different metals, the joints of these pans when in intermittent use are apt to cause trouble, and in certain cases the prolonged contact of the solution with the hot surface affects the quality of the product.

During the course of the last few years we have had to concentrate aqueous solutions of glycerine, tartaric acid and tannins under reduced pressure and for this purpose have constructed a small apparatus of the type of the "Kestner Climbing Film Evaporator", which can be used either under atmospheric or diminished pressure.

As this evaporator has been found to be so useful in our laboratories, and is very simple to construct, a brief description of it is given in this paper.

SCALE  $4\frac{1}{2}''=1'$



LABORATORY VACUUM FILM EVAPORATOR

The evaporator consists of :—

- (a) the evaporating tube
- (b) the steam jacket
- (c) the separator

and details of the construction are shown in the figure. To facilitate the removal of the evaporating tube it is screwed into the steam jacket at the top; in the case of a copper tube a soldered joint may be used, but for a tin tube the screw is preferable.

Similarly the soldered socket at the top of the tube may be replaced by a union joint although in practice the soldered joint is almost as rapidly undone. It is convenient to have several tubes of the same size made of different metals, for example iron, copper, tin and lead, for use with different liquids.

The only separator we have used was made of tinned copper soldered together. In order to allow the liquid to run down into the exit pipe the baffle shown in the figure should not fit the outer wall tightly.

Before starting to work the evaporator, the steam exit tube of the separator is connected with a condenser and receiver. For the latter we have found a large filtering flask most suitable. The side tube of the flask is attached to a vacuum pump and a manometer. The condenser should not be too small, and the one we have used is a double surface copper condenser with  $\frac{2}{3}$  sq. feet cooling surface. This condensing area is necessitated by the high temperature of the cooling water which varies from  $25^{\circ}$  to  $30^{\circ}$ , but the size can be considerably reduced if cooler water is available.

A bottle for receiving the concentrated liquor is attached to the small tube at the bottom of the separator.

Steam is admitted at the top of the steam jacket, and ordinarily the lower cock is left open and a small quantity of steam allowed to escape when the evaporator is working. If it is desired to use steam under pressure, the lower cock is nearly closed so as to drain off the condensed water only, or a small steam trap is attached.

As the result of the reduced pressure in the apparatus the liquid to be evaporated is drawn from the containing vessel into the evaporating tube through the cock at the bottom, and by regulation of this cock a liquid of any desired concentration may be collected from the separator.

When this adjustment is once made, the evaporation proceeds continuously and without any attention beyond occasionally emptying the receiving vessels. In order to do this it is only necessary to release the vacuum, as the liquid then automatically ceases from entering the evaporating tube. When the concentration is completed, the tube is easily cleaned by admitting a small quantity of water.

When using this apparatus the same precautions should be taken as are necessary in commercial plant with regard to the presence of incrustation forming salts in the solution, as, although there is a considerable scouring action owing to the rapid passage of steam and liquid up the tube, deposits will form and retard the evaporation. Indeed on one occasion a tube was almost completely choked in a few hours by evaporating a solution of tartaric acid saturated with calcium sulphate.

The evaporative capacity of the tube shown in the figure which is six feet long and half an inch in external diameter is from two to four litres of water an hour under a pressure of 100 to 200 mm. of mercury and using steam at atmospheric pressure.

When the liquor is admitted uniformly and the evaporation proceeds at the above rate no concentrated liquor is carried over with the steam. An irregular or jerky admission of liquid to the evaporating tube leads to loss of concentrated liquor with the condensed steam.

DEPARTMENT OF GENERAL & ORGANIC CHEMISTRY,  
INDIAN INSTITUTE OF SCIENCE,  
BANGALORE.