

to the high school, but has, rather, a thorough dislike of the subject acquired through bad teaching. When this is true the high-school teacher must take the pupil as he is and not as he is supposed to be. He must re-dress the old facts and bring them out clothed and in their right relations. When we have reached the strictly "new" era the necessity for this elementary work in the high school will be done away, and the broad reaches of a world-wide, beautifully true science will be laid open to the student of our high schools and academies.

THE PURIFICATION OF MERCURY.

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Many methods have been proposed for the purification of mercury in the "wet way," that is, by using acids and oxidizing mixtures, such as nitric acid, a mixture of nitric and sulphuric acids, and especially a mixture of sulphuric acid and potassium dichromate.

The impure mercury is shaken up with these reagents, or it is allowed to fall in a fine stream through a long column of the reagent. But with these reagents, none of the metals which are below hydrogen in the voltaic series can be removed unless some mercury is in solution. When mercury is dissolved in the reagent, however, all metals down to mercury in the series can be removed, except gold, silver, potassium, etc. As these "noble" metals are seldom found in mercury, the wet way is useful. The best reagent is a solution of some mercury salt, and a nitric acid solution of mercury nitrate of medium strength answers all purposes. A large jar partially filled with this solution serves as a receptacle for all "dirty" mercury. The mercury to be purified is brought into a separatory funnel (Squibb's form with a glass stopcock and stopper is best), and covered with a freshly prepared solution of mercury nitrate and nitric acid. After the mer-

cury has been shaken vigorously with this solution for about five minutes, it is run into another separatory funnel, and the solution is poured into the dirty mercury jar. The mercury is now shaken with a little water two or three times to remove the acid, and finally dried by allowing it to pass through a pin hole in the apex of a folded filter paper. This leaves the mercury very bright and ready for all ordinary uses.

It is, however, often desirable to distil mercury, and this can be done easily with ordinary laboratory apparatus, using no better vacuum than can be obtained with an ordinary Sprengel aspirator or filter pump. A and R (Fig. 1,) represent two ordi-

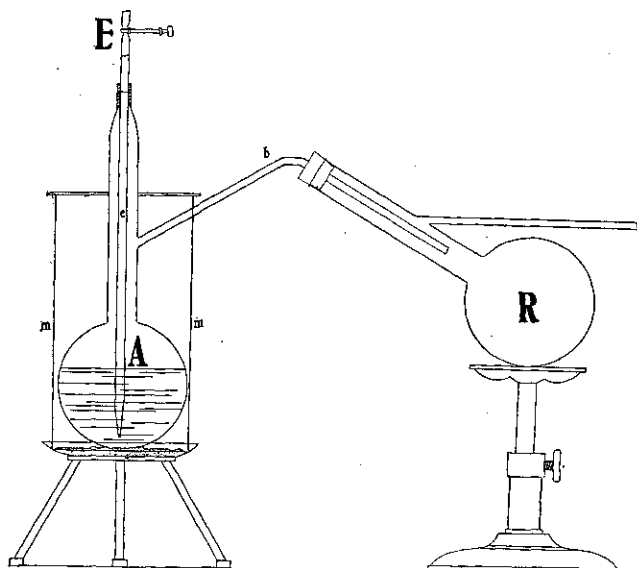


Fig. 1

nary distilling flasks of about half a liter capacity. The side tube of the flask A is bent first up and then down, and, if necessary, a short piece of tubing is fused on to this side tube to make it 30 to 40 cms. long, so that it extends well into the neck of the receiving flask R. The connection with R is made air-tight by means of a rubber stopper, or, better still, with a cork and sealing wax. The side tube from the neck of the receiving flask R is

joined to an ordinary Sprengel aspirator which gives a vacuum of from 20 to 30 mm. of mercury.

If one attempt to distil mercury under atmospheric pressure or in anything less than the best vacuum obtainable by a mercury pump, the mercury bumps and spurts beyond all control. But if gas bubbles are allowed to pass slowly through the mercury, it boils gently under any pressure, and in an ordinary Sprengel aspirator vacuum at about 210°C . This use of gas bubbles to prevent bumping in liquids being distilled under reduced pressure is quite common in Organic Chemistry manipulations.

To introduce the air bubbles, a piece of common tubing of rather thick wall and 6 to 8 mm. in diameter is drawn out to a fine capillary at one end—about one mm. in external diameter and 10 to 20 mm. in length. This capillary end extends down into the mercury in A, and the upper end of this tube *e* bears a piece of rubber tubing with a pinch cock to regulate the admission of air. The joint between A and this tube can be made air tight with a minimum exposure of rubber or cork, if the neck of A be drawn down so that it just slips over the tube *e*, the joint being closed with a piece of rubber tubing. If the neck of A is rather long and the mantle with asbestos cover described below is used, this joint never becomes noticeably warm.

The flask A stands in a sand bath on a tripod and is surrounded by a mantle *m m*, made from a large beaker, the bottom of which is cut off with a "cracking coal," and a slit cut down from the top for the side tube *b*. The top of this mantle is closed by means of an asbestos board cover.

The mercury is placed in A and the end of the capillary part of the tube *e* pushed down nearly to the bottom of the flask. The aspirator will soon reduce the pressure to about 25 mm. of mercury, if the joints are tight. Then by slowly opening the pinch cock, a slow stream of bubbles is allowed to break up through the mercury. A Bunsen burner serves as a source of heat, as a temperature of only a little over 200°C . is needed under the diminished pressure. The distillation can proceed quite rapidly without any danger of spurting, and when once in operation, the apparatus requires no attention whatever. One can safely allow

all the mercury to distil over, as the flask will not break and the last portion is quite as good as any. My results showed the absence of foreign metals in any part of the distillate (and it was possible by the method used to detect, for example, one part of zinc in 100,000,000 parts of mercury).

If any metallic oxides are present, they are liable to be mechanically carried over, and form a coat or covering on the mercury, but no *metal* except the mercury goes over. The oxides, if present, are easily removed by filtering through a pin-hole in the apex of a folded filter paper.

This apparatus is readily constructed from material found in most laboratories. It has a far greater capacity than the Weinhold mercury still; it distils more rapidly and possesses the decided advantage of distilling all the mercury, whether a few grams or kilograms.

In distilling from an iron still at atmospheric pressure, the bumping and spurting leaves one in doubt as to the purity of the distillate. This difficulty could be easily obviated by forcing a slow stream of air from any compressor, or hydrogen from a generator through the boiling mercury.

Pumice stone, pieces of porous plaster, hollow tetrahedrons made of platinum foil, etc., are often used to prevent bumping. They owe their efficacy to the little air bubbles which are liberated from them and tend to restore the equilibrium between a liquid and its vapor. The liquid in the interior where it is not in contact with the vapor becomes superheated; a bubble of an indifferent gas, brought into the liquid, acts as a vacuum to the vapor, and as soon as the vapor forms in contact with the superheated liquid, the system is out of equilibrium, and there is a rapid evolution of vapor while equilibrium is restored. The return to the equilibrium temperature is often so rapid as to cause explosive effects. The gas bubbles prevent superheating, and the liquid boils quietly at the equilibrium or boiling temperature.

Porous substances, after a time, lose the gas on their surfaces or in their interstices, and so become ineffective. A slow stream of bubbles of an indifferent gas is generally more effective. If working under diminished pressure, one uses the pressure of the

atmosphere to force the gas through the boiling liquid, and at atmospheric pressure, one can employ a gas from a gasometer, gas cylinder or generator, according to the nature of the gas to be used.

A DEMONSTRATION OF THE WEIGHT OF A LITER OF CARBON DIOXIDE.

BY C. E. LINEBARGER.

There are comparatively few quantitative experiments which are adapted for performance on the lecture table, as they require more care and attention to insure good results than can usually be given during the lecture. And yet the desirability of giving some quantitative work in the lecture room can hardly be questioned. A fundamental demonstration is the determination of the weight of a liter of a gas, and in schools where the laboratory work is purely qualitative, such a demonstration becomes almost peremptory. Carbon dioxide is a gas well suited for such purposes. The methods which have been in vogue are, however, rather unsuitable for demonstration, although they may be made to yield satisfactory results in the laboratory as an individual experiment. The method described in this paper permits of the weighing of a liter of carbon dioxide with a satisfactory degree of accuracy, and in a reasonably short time, and further does not demand any protracted or delicate manipulation. If the class is familiar with the reduction of gas volumes to standard conditions, the demonstration from start to finish ought not to take more than half an hour, and the actual manipulation of the apparatus, apart from the weighings and measurement of the volume of the gas, does not require five minutes.

Recently there have been placed upon the market steel capsules* filled under considerable pressure with carbon dioxide.

* Their trade name is "Sparklets."