elements. Three of them, by Bilecki,[1] Marshall,[2] and Hollins,[3] relate to possible modifications of "Prout's law"; that is, they point out relations analogous to, but not identical with, those assumed by Prout. Schmidt[4] and Stoney[5] discuss the connection of the atomic weights in a more purely mathematical way, and so too does Vincent.[6] The logarithmic spiral of Stoney is especially suggestive. There is also an elaborate memoir by Lord Kelvin[7] on the "weights of atoms"; and a discussion by Clarke[8] of the best method for the reduction and combination of atomic weight determinations. Ebaugh's work on the atomic weight of arsenic,[9] which was cited in the report of your committee for 1901, has appeared in full in this Journal.

INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS.

This committee, which was too large for effective working, has appointed a smaller body for action. This smaller committee, consisting of F. W. Clarke, T. E. Thorpe and Karl Seubert, has already reported, and its report has appeared in this Journal.[10] The table of atomic weights, there given, need not be repeated here.

THE DISTRIBUTION OF HYDROGEN SULPHIDE TO LABORATORY CLASSES.

BY CHARLES LATHROP PARSONS.

Received December 2, 1902.

SO MUCH has been written regarding new forms of generators for hydrogen sulphide and their use in the laboratory that one must needs approach the subject with trepidation and, at least, the semblance of an apology. There are, however, few teachers of chemistry who have not experienced the many inconveniences in the use of this most important laboratory reagent, inconveniences that are too frequently little understood by the student himself and which are generally the direct result of wasteful use. It is

1 *Chem. Ztg.*, **26**, 399.
2 *Ibid.*, **26**, 663, and *Chem. News*, **86**, 88.
3 *Chem. News*, **86**, 147.
4 *Ztschr. anorg. Chem.*, **31**, 147.
5 *Phil. Mag.* (6), **4**, 411 and 504.
6 *Ibid.*, (6), **4**, 103.
7 *Ibid.*, (6), **4**, 177 and 281.
8 *Am. Chem. J.*, **27**, 321.
9 This Journal, **24**, 489, June, 1902.
10 V. **25**, p. 1, January, 1903; and *Ztschr. angew. Chem.*, **15**, 1305.

always easy to instruct students to allow the gas to flow through the solution undergoing analysis at a rate no faster than one or two bubbles a second and always to close the outlet when not in use, but it is an impossibility to attain this result with individuals. Also the constant cleaning and replenishing of the large generators and the limited efficiency which most of them possess has led many instructors to require each student to prepare his own hydrogen sulphide as wanted rather than to depend upon a general laboratory supply. This method is to be deplored even with small classes, while with larger numbers it leads to a laboratory condition which there is no necessity to describe. The constant use in my laboratories, for several years, of the main principle of the apparatus about to be described and the almost complete removal of the difficulties I had before experienced, emboldens me to become a contributor to this already voluminous subject.

THE SYSTEM OF SUPPLY.

The usual small lead pipe of approximately 8 mm. diameter is

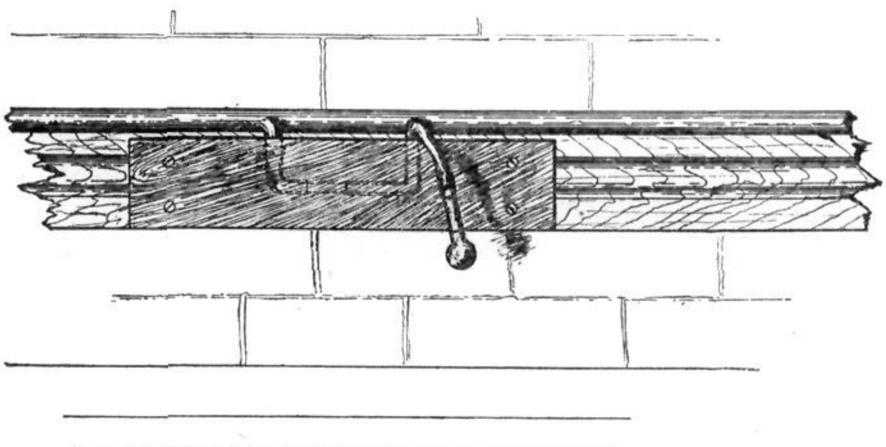

Fig. 1. Detail of outlet.

run from hood to hood where wanted and in each hood any number of short lengths of 4 mm. diameter are soldered on for outlets. The ends of these smaller outlets are then fused together and a fine opening made with a needle. To these lead outlets are attached, by means of a rubber connection, pieces of thermometer tubing bent as shown in Fig. 1 and of such a length that only a limited flow of gas can be obtained under the pressure used. In my own practice, under a pressure of 20 cm., a length of about 12 cm. is required to check the flow down to the rate of 2 bubbles a second which is fast enough for any ordinary use. The thermometer tubing is bent as shown in the figure and another short piece of rubber tubing is attached for a final outlet. This is closed with a simple glass plug, which is much to be preferred to a clamp. The whole, with the exception of the end of the rubber tube carrying the plug, is hidden from sight by a wooden block appropriately channeled on the back to receive the thermometer and lead tubing, and screwed on. The student removes the plug, inserts his own delivery tube, secures a fixed flow of gas and, as the whole system is apparently open when he removes his delivery tube, he seldom fails to insert the plug. If he does, but little harm ensues. The flow can be regulated by the length of the thermometer tubing used and the length of tubing required can easily be determined by experiment. A few centimeters variation in pressure makes but little difference in the flow. The rubber tubing connections should be made tight and permanent by slightly heating the lead and glass and they need to be renewed about once each year. There is practically no trouble arising from the stoppage of the capillary tube, only some half dozen tubes having been stopped up in an experience of five years.

THE GENERATOR.

The generator (Fig. 2) consists of three essential parts: (1) The acid container *A*. (2) The trap and holder of spent acid *B*. (3) The iron sulphide holder and gas generator proper *C*. All of these parts may be made of glass, porcelain or heavily glazed earthenware. Earthenware is much the cheapest but I have experienced much difficulty in having it made gas-tight. This is fundamental in the construction of the tower and bell *C*. By coating a common earthenware tower with asphalt paint both inside and out I have, however, obtained excellent service from the one now in use.

The acid container *A* holds approximately 10 liters of acid. It is so arranged by means of an inverted jug, or bottle, that the level is maintained constant at *h*. The inverted bottle has a shoulder blown on which, resting on the top of the containing jar, holds it in place. It is filled with 1:8 sulphuric acid or 1:4 hydrochloric acid. The hydrochloric acid is quicker in its action on the iron sulphide and for that reason only is to be preferred. The sulphuric acid, however, is cheaper, answers every purpose and no trouble whatever is experienced from the sulphate formed. The pressure is determined by the perpendicular distance between *h*

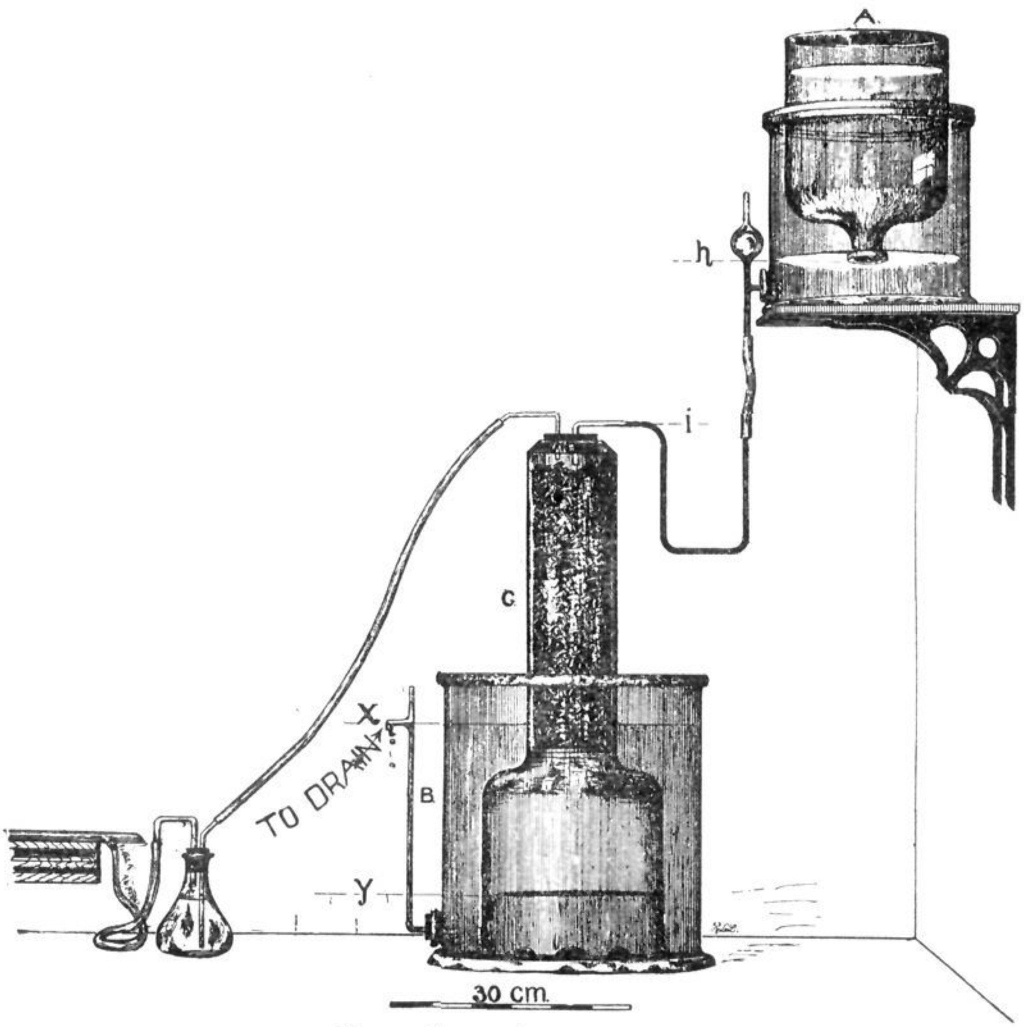

Fig. 2. Generating apparatus.

and i and is limited by the greatest adjustable distance between the equal and balancing pressure x and y. The connection between A and C is made by means of a U-shaped glass and rubber tube. It will be easily understood that any increase of pressure in C caused by the production of gas will immediately force the acid back into the arm nearest to C thus stopping the flow of acid. The variation due to this increase of pressure, while completely stopping the flow of acid, is seldom so great as a single centimeter, for the enlargement at the bottom of C takes up the excess of gas and the counterbalancing pressure x to y serves as a cushion. The entrance tube at the top of C should be about 1 cm. in diameter to avoid a slight siphon action which is caused by the short bend where it enters. The glass level outside of A serves simply to show when the acid supply in the inside container is exhausted, provided this is made of opaque material.

The holder B is 35 cm. high by 28 cm. inside diameter, and is provided with a constant level and overflow to drain. It should be covered to prevent evaporation and consequent crystallization of sulphate. The rate of diffusion of a gas through a liquid is so slow that there is practically no odor thrown off into the room from the surface of the liquid.

The tower *C* is the gas generator proper and consists of a bell jar 22 by 25 cm. as a gas holder and pressure cushion, having a few openings at the base for the free passage of liquid. To the top of the bell jar is attached a cylinder 10 cm. inside diameter and 50 cm. high having four constrictions at the base to hold a perforated plate. It is filled with iron sulphide in small lumps or broken sticks. The bell jar and cylinder are best made in one piece, but if made of glass they may be connected by means of a ground joint. This presents no advantage from the standpoint of the chemist. but does from that of the glass-blower. The acid enters the tower drop by drop and in trickling through, the iron sulphide is soon exhausted. Even with a large number of outlets in actual use the acid seldom enters other than dropwise. A small wad of glass wool should be placed on top of the iron sulphide to spread the acid and prevent the formation of channels. The exit tube should pass to a wash-bottle more for the purpose of making the rate of gas flow visible and of detecting any leak in the line when not in use than for any need of purification of the gas. It will also be apparent that when the generator is first placed in action the flow of the acid should be controlled by pressing the rubber tube with thumb and forefinger until the pressure between x and y, which balances that between h and i, has established itself.

A generator of this size will easily supply 100 outlets of the form described, even if all were in use at one time. A smaller generator is, however, not to be recommended in any case, for a considerable width and height of the iron sulphide column is essential to its proper working and to insure the almost complete neutralization of the acid. The generator can be easily shut off each night although this is never done in my own practice. A leak is at once made apparent by the gas wash-bottle and easily found with a piece of lead acetate paper.

The following advantages are claimed for this form of generator. They include all of those mentioned by Richards as desirable in his very complete article on the subject of gas generators.[1]

(1) Like the Kipp generator it is perfectly automatic so long as the gas flow is choked to less than the maximum capacity of the generator.

(2) The pressure is regulated at will and is almost constant for the height chosen. In practice it seldom varies by so much as a single centimeter.

(3) Only fresh acid comes in contact with the reacting solid.

(4) Under any normal requirements, the full capacity of the acid is obtained.

(5) The products of the reaction are automatically removed. Ferrous sulphate has never, in my experience, crystallized out in the bottom of the apparatus. Some small grains of ferrous sulphate do form in time on the iron sulphide itself but cause no trouble and can easily be removed by running a stream of water through the acid inlet for a few minutes. So far, I have never found this necessary, but it is easily accomplished and may well be done whenever the iron sulphide is renewed. Large crystals do not form.

(6) There are no stop-cocks or valves.

(7) It is easily cleaned and refilled without being taken down, simply by removing a rubber stopper.

(8) When used in connection with the economical choked supply system before outlined, it requires no attention whatever for days or even weeks at a time, depending wholly upon the amount of gas used, and then only to renew the acid, as the iron sulphide will outlast many acid supplies.

(9) If for any reason a large leak develops, the acid runs through rapidly, little iron sulphide is used up, and once the supply of acid has run through all action ceases. Of course, it does not distinguish between a small leak and a legitimate outlet.

The generator works equally well for the production and supply of carbon dioxide, the automatic action being sharper on account of the much more rapid evolution of gas. It is perhaps unnecessary to add that it may be used for the production of hydrogen or for any gas that is set free with a fair degree of rapidity, by the action of a liquid upon a solid.

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[1] *Am. Chem. J.*, **20**, 189.