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XXIV. *On Iodine.* By ANDREW URE, M.D. *Professor of Chemistry, &c. &c., Glasgow.*

To Mr. Tilloch.

SIR, — THE great trouble and uncertainty attending all the processes which have been prescribed in the scientific journals for procuring this interesting elementary body, and the high price at which it is sold in Great Britain, induced me about two years ago to inquire whether an easier and cheaper mode of preparing it might not be discovered*.

As many of the Scotch soap manufacturers use scarcely any other alkaline matter for their hard soaps except kelp, it occurred to me that in some of their residuums a substance might be found, rich in iodine. Accordingly, after some investigation, I found a brown liquid of an oily consistence, from which I expected to procure what I wanted. This liquid drains from the salt, which they boil up and evaporate to dryness from their waste leys for the soda manufacturer. I instituted a series of experiments on the best mode of extracting the iodine. As these succeeded far beyond my expectation, I hope the following account of them will prove not uninteresting to the British chemist.

The specific gravity of the above liquid, as obtained at different times, is very uniformly about 1·374, water being 1·000. It converts vegetable blues to green, thus indicating free alkali. Of this the manufacturer is aware, for he returns it occasionally into his kelp leys. Its boiling point is 233° Fahr. Eight ounces apothecaries' measure require precisely one measured ounce of sulphuric acid for their neutralization. Supposing this quantity of acid combined with soda, it would indicate one part of pure soda in eleven by weight of the liquid. But the greater part of the alkali is not uncombined; for an immense quantity of sulphurous acid and a little sulphuretted hydrogen gases escape on the affusion of the sulphuric acid. One hundred grains of the liquid yield 3·8 cubic inches of gas, chiefly sulphurous acid; and sulphur is at the same time deposited. From the quantity of sulphur, one might expect a larger proportion of sulphuretted hydrogen; but the disengaged gas possesses the peculiar smell and pungency of burning sulphur, blanches the petals of the red rose, but shows hardly any action on paper dipped in saturnine solutions. In the instant of decomposition of the sulphite of soda, and hydroguretted sulphuret existing in the liquid, the nascent sulphurous acid of the former may be supposed to act on the

* The iodine sold in London is for the most part imported from Paris, as I was informed by an eminent practical chemist.

nascent sulphuretted hydrogen of the latter; their atoms of oxygen and hydrogen uniting to form water, while the sulphur of both is precipitated. I cannot in any other way account for the very copious separation of sulphur, while very little sulphuretted hydrogen appears. From the excess of sulphite present in the liquid, we have a redundant quantity of sulphurous acid evolved. From eight liquid ounces, equal by weight to eleven, 213 grains of sulphur are obtained.

The liquid saturated with the sulphuric acid has a specific gravity of 1.443, a bright yellow colour, and it does not affect the purple infusion of red cabbage. I distilled eight ounces of this in a glass retort. The stopper of the tubulated receiver was frequently blown out by the escape of incondensable gas, even after the liquid had been for a long time in ebullition. This, which was probably hydriodic acid gas, continued to be evolved to the very last. In the receiver, which had been kept very cool, a colourless and nearly transparent liquid was found. Its specific gravity was 1.054, of an acidulous and acerb taste; it reddened vegetable blues, and powerfully blackened brass. From this liquid I could extract only three or four grains of iodine, though the viscid black substance left in the retort yielded more than twenty times the quantity. We see therefore that by distillation very little hydriodic acid can be procured from the saturated liquid.

In the prosecution of my researches to ascertain the best mode of extracting the iodine, I at length discovered the causes of the anomalous results which had not a little perplexed me at first, rendering the product very uncertain. The following method was found to answer extremely well.

The brown iodic liquid of the soap-boiler was heated to about 230° Fahr.; poured into a large stone-ware bason, of which it filled nearly one-half, and was then saturated by the proper quantity of sulphuric acid, as above stated. The acid ought to be previously diluted with its own bulk of water*. On cooling the mixture, a large quantity of saline crystals is found adhering to the sides and bottom of the vessel. These are chiefly sulphate of soda, with a very little sulphate of potash, and a few beautiful oblong rhomboidal plates of hydriodate of soda. The precipitated sulphur is intermixed with these crystals.

After filtering the cold liquid through woollen cloth, I add to every twelve ounces apothecaries' measure, 1000 grains of powdered black oxide of manganese. This mixture is made in a glass globe or matrass, over the mouth of which a glass globe is

* When concentrated oil of vitriol is added, the effervescence is very violent; the liquid reddens wherever the acid falls, and a little of the purple vapour of iodine rises.

then

then inverted. The heat of a charcoal chaffer being now applied, the iodine sublimes in great abundance. To prevent the heat from acting on the globular receiver, a thin disc of wood, with a round hole in its centre, is placed over the shoulder of the matrass. As soon as one globe becomes hot, another may be substituted in its place; and thus two or three may serve in rotation to condense a very large quantity. The iodine is easily washed out by a little water. It is then drained on glass plates, and dried. From the above twelve ounces of liquid I usually obtained about 200 grains of iodine. This may be purified by a second sublimation from dry quicklime. The most convenient apparatus is that represented (Plate III. fig. 1.) It is composed of an exterior vessel *b*, containing the mixed materials, and an interior one *a*, filled with cold water. On the outside of *a*, beautiful large crystals concrete, and by lifting up *a* they may be readily detached without breaking them. If in the operation of subliming the water of *a* should become hot, it is easy to run it off with a siphon, and to fill it again with cold, or to put into it some ice. I have not seen any such apparatus described before, and I can recommend it as possessing many advantages over the subliming vessels usually employed.

If the manganese be increased much beyond the above proportion, the product of iodine is greatly lessened. If, for example, thrice the quantity be used, a furious effervescence ensues; nearly the whole mixture is thrown out of the matrass with a kind of explosive violence; and hardly any iodine is to be procured, even though the materials should have been saved by putting them into a very large vessel. On the other hand, should only one-half of the prescribed quantity of manganese be used, much hydriodic acid rises along with the iodine, and washes it perpetually down the sides of the balloon. Or, if during the successful sublimation of iodine the weight of manganese be doubled, the violet vapours instantly cease. Neither sugar nor starch restores to the mixture the power of exhaling iodic vapour.

A similar interruption of the process is occasioned by using an excess of sulphuric acid. For, if to the mixture of twelve ounces of saturated liquid, and 1000 grains manganese, an additional half-ounce measure of sulphuric acid be poured in, the violet vapour disappears, and the sublimation of iodine is finally stopped. Quicklime, added so as to saturate the excess of sulphuric acid, does not renew the process. In these two different cases, iodic acid is probably formed by the too rapid and copious supply of oxygen. For the due decomposition of hydriodic acid, the oxygen ought to be afforded merely in the quantity requisite to saturate its hydrogen.

The best subliming temperature is 232° Fahr.; though in open

vessels it readily evaporates at much lower degrees of heat; even at that of the atmosphere. When it is spread thin on a plate of glass, if the eye be brought into the same plane the violet vapour is discernible at 100°. It evaporates slowly in the open air at 50° of Fahrenheit. When put into a phial closed with a common cork, the iodine soon disappears: it combines with the substance of the cork, tingeing it brownish yellow, and rendering it friable.

240 grains of nitric acid, sp. gr. 1.490, saturate 1000 grains of the iodic liquid. Sulphurous acid is copiously exhaled as before. After filtration a bright golden-coloured liquid is obtained. On adding a little manganese to this liquid, iodine sublimes; but the quantity procurable in this way is considerably less than by sulphuric acid.

I am, &c.

Anderson's Institution, Glasgow,
August 29, 1817.

ANDREW URE.

XXV. *Theorems for determining the Values of increasing Life Annuities.* By Mr. J. B. BENWELL.

To Mr. Tilloch.

SIR, — THE following collection of theorems embraces an extension of those communicated in a previous Number of your Magazine, being applicable to the valuation of life annuities increasing by certain orders of a constant numerical ratio.

The several Life Assurance Companies established in the metropolis are occasionally in the habit of granting annuities that increase by the scale of the natural numbers as well as the multiples thereof, and which annuities may be either temporary or deferred; but, in respect I (presume) to those institutions which do not possess the proper and requisite aids (in conducting this branch of scientific research), it has been represented as a matter of much apparent doubt, whether the methods they pursue, in order to arrive at the supposed values in these and similar inquiries, be rigorously exact and unobjectionable, — a circumstance that imperiously requires elucidation, because it tends to militate against the avowed professions held out by them, of being guided by the pure and unerring principles of mathematical truth. It is very probable that the practice of granting progressive life annuities might be rendered almost as general as any other species of contingent investment; and what seems chiefly essential to the dissemination thereof, is a commodious and accurate formula for the solution of the most useful cases. But with the exception of one for finding the value of a life annuity, increasing according