REMARKS ON SOME POINTS IN WATER ANALYSIS.

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Read before the Society of Public Analysts, 17th November, 1880.

IN the remarks I am about to make there is, probably, little that is new to chemists frequently engaged in water analysis, and I have been induced to bring them forward chiefly in the interest of our younger members.

During the past year I have examined many samples of water which had been purposely polluted by typhoid and other stools, with, or without, the addition of urine. In the course of this work many points connected with water analysis have again strongly impressed themselves on my mind, some of which I will now lay before you.

In the first place, I would caution analysts, most strongly, against the adoption of any general standards of purity, such as are laid down by some chemists. We may, of course, find waters of such absolute purity that we can at once safely pronounce them fit for all

domestic uses, but short of this highest purity it is dangerous to rely on any general standards. The only safe standard to go by, in any individual case, is the standard of purity furnished by unpolluted waters of the district from which the sample under examination has come. This, no doubt, is difficult, perhaps impossible, to obtain in every case, but it might be within the power of our Society to furnish such standards for almost every district within the United Kingdom. Referring to the above-mentioned examinations, I may say that I was almost always able to detect, even very minute traces of pollution, if I had a sample of the unpolluted sample water for comparison. The water, chosen for the experiments, however, itself varied so much from week to week that, without such a direct comparison, even considerable amounts of pollution, comparatively speaking, would have escaped detection by the ordinary analytical methods.

Phosphoric Acid.—During the last ten years I have tested every water that has passed through my hands for phosphoric acid, but have recorded the results somewhat roughly only as, none, very minute trace, minute trace, trace, &c., &c., and I am glad to see that this question has been taken up by Hehner and others in a more definite form. The conclusions I have come to are the following:—The presence of more than traces of phosphoric acid is nearly always a sign of pollution, while the occurrence of much phosphoric acid may be taken as an all but certain sign of sewage or similar pollution, more particularly when taken in conjunction with the standard of the district. On the other hand the absence, or comparative absence, of phosphoric acid cannot be taken as proving the absence of such pollution, because phosphoric acid may have been abstracted from the water by filtration through the soil and by other means; its absence, in such cases, may thus merely prove that the soil through which the water has percolated has not yet been saturated with phosphoric acid, or that other influences causing its removal are present.

Permanganate Test.—For many years past I have applied this test to every water analysed, and I have a very high opinion of its value. I know of no test which so certainly distinguishes between unpolluted deep well waters, which often yield analytical results generally indicative of pollution, and even the purest shallow well water. Deep well waters, when really unpolluted, absorb scarcely even a trace of oxygen from permanganate, whereas even the best shallow well waters always absorb a very measurable amount. Were I to be pinned down to the use of a single test I should choose this, and I never report on a water without having applied it.

Heisch's Test.—I can speak, I am happy to say, very strongly in favour of this simple test. I have applied it recently to a number of purposely polluted waters, previously alluded to, as well as to the waters used in their preparation, and I have, in every case, been able to pick out the polluted sample even when the chemical tests had left me in very considerable doubt. The only difference in my mode of applying the test, and that first recommended by Mr. Heisch is, I believe, this: he kept his bottles exposed to the light, but at the temperature of the laboratory; I have kept them at a temperature of between 98° and 100° F. I am still continuing my examination of this test, but meanwhile would most strongly recommend its use to my fellow analysts.

Nitric Acid.—One of our leading water analysts, as is well known, entirely neglects this, in my opinion, highly important feature. Whatever may be said, and truly said, as to the innocuous character of nitrates themselves, they are, without a doubt, *mainly derived*

from nitrogenized organic, chiefly animal, matter. In deep well waters, which are above suspicion of pollution from sewage or surface drainage, the presence of nitric acid need not perhaps be taken into consideration ; but the case is widely different when we are dealing with spring, ordinary well, or river water. In all such the presence of notable quantities of nitric acid is a sure sign of previous pollution and as, at present at least, we are not able to differentiate between the various kinds of organic pollution, a water in which sewage, or similar pollution can be proved should always be rejected. In this respect the determination of the nitric acid, taken in conjunction with the standard, in this respect, of the water of the district from which the water under examination has come, is of the highest value, and will often lead us to a correct conclusion as to the character of the water. It must be remembered that the rate of oxidation (nitrification) depends on a variety of conditions and a water which at one time contains much nitric acid and little or no organic matter may, under somewhat altered conditions, contain little nitric acid and much organic matter, even though the degree of pollution has been the same in both cases.

Chlorine.—This is one of the few characteristic constituents of sewage which, when once in a water, suffers, as a rule, little or no diminution. The amount of chlorine, therefore, found in a water, when compared with the prevailing standard of the district (not with some fixed standard devised to fit all cases) is one of the very best guides towards the formation of a correct judgment.

Alkalies.—I generally content myself with obtaining a rough notion as to the amount of alkali salts present by a comparison of the total hardness of, and the total dry residue yielded by, the water. In most pure potable waters the greater part of the saline constituents consists of lime and magnesia salts, or in other words, the total hardness accounts for most of the saline constituents. In polluted water this is no longer the case, and in these the total hardness often represents but the smaller portion of their saline constituents. Here again the comparison of any special sample with the prevailing type of the district is of great value. In connexion with this, I may be permitted to draw attention to the fact, pointed out some years ago in Germany, that we may sometimes be able to detect whether the pollution found is due to animal or human urine, by estimating the relative proportions of sodium and potassium present. In human urine sodium is the predominating alkali metal, in the urine of cattle and horses potassium preponderates.

Sample Taking.—In taking a sample, from an ordinary shallow well more particularly, it is advisable to have the well pumped for some time, dry if possible, and to take the sample only after the well has partially refilled. In wells which are not very much used a very great improvement in the quality of the water often takes place while it remains in the well, and the analysis of such a sample may lead us to entirely erroneous conclusions. If expense is no consideration it would be well to take two samples of the water, one before, one after the pumping. A material difference between these two samples would, in itself, be strong evidence against the well.

Lastly.—I would ask analysts not to assume too readily that even a very bad sample of water is perfectly safe after it has been boiled. It is only necessary to remember that the controversy regarding so-called spontaneous generation, which has now been carried on for many years, is due, entirely, to the extreme difficulty of killing all living germs in the fluids experimented on. Would any advocate for spontaneous generations be listened to

for one moment if he had simply boiled his solutions in an ordinary tea kettle? I am of course far from affirming that the boiled water is not as a rule more safe than the unboiled water, but its *absolute safety* should not be taken for granted.

P.S.—Since reading the above I find that I have omitted to mention one point I wished to bring forward. The tint produced by the Nessler reagent in the ammonia distillate corresponds, at all events nearly always, with the tint produced in the standard ammonia. This is not, however, the case with the distillate containing the albuminoid ammonia. In this latter the tint produced is occasionally of a decidedly yellower tint than that produced in the standard ammonia, due, perhaps, to the presence of some compound ammonias. Much to my regret I have not, hitherto, noted this down in my laboratory book, but shall do so in future. I mention the point because other analysts may have been more careful in this respect than I have been, and if they would give us their experience it is not improbable that we may gain one more valuable guide through the tangled path of water analysis.

In reply to Dr. Blyth, Dr. Dupré said he had not tried Wanklyn's moist combustion process, but he had tried a somewhat similar one, namely, warming the water for some time with an alkaline solution of permanganate and estimating the amount of permanganate remaining, a test which had been in use in Germany for a number of years. He was not, however, so far, entirely satisfied with the test. Chiefly because he found it almost impossible to obtain an alkaline solution of permanganate which, on heating for some time, did not suffer some decomposition.

Mr. Heisch, in reply to a question from Mr. Harvey, said he always kept his sugar solutions in as bright a light as he could; it makes the growth come on much quicker. He could quite confirm what Dr. Dupré had said as to destroying germs. Boiling did not do so, and he did not find any difficulty in getting his growths almost as easily as if the water had not been boiled.

Considerable discussion then ensued with regard to the suggestion thrown out by Dr. Dupré as to the practicability of obtaining reliable standards of the various water supplies, and ultimately a committee was appointed to arrange the matter and report thereon.