ON DETERMINING THE ROTATION OF LEFT-HANDED SOLUTIONS WITH THE GERMAN (*Scheibler- Ventzke-Soleil*) INSTRUMENT.

BY GEO. S. EYSTER, PH. D.

The following plan for determining negative rotation, in the absence of an instrument graduated for left-handed solutions, occurred to me some time ago. Though seeming quite obvious, I have not seen it in print.

If we use a + quartz plate reading *n* degrees to the right (either used instead of one of the cover-glasses, or sunk in an outside recess of one of the brass caps, and secured in place by a thin metal ring and three screws) in connection with a — solution of less rotating power the reading will be N or $n\text{-}x = N = -x = (N\text{-}n)$ where $-x =$ the rotating power of the solution in degrees of the instrument. For instance:

The reading of the quartz plate is 90°.

The reading of the plate and solution is 66°, then $-x = 66° - 90 = -24°$.

Or in other words, the solution has lowered the reading from 90° to 66°; hence is left-handed and is equal in value to the difference between 90° and 66°.

It is best to use a plate reading from 80° to 100° rather than one of much less thickness, as apart from the facility it affords for using a double normal solution for inversion, the value and equality of that portion of the scale is better under control.

I have not had a good opportunity to test the method since it occurred to me, but its success, as one acquainted with the principle of the quartz compensator will readily see, is merely a matter of detail.

NOTES ON THE AMMONIA PROCESS FOR WATER ANALYSIS (ILLUSTRATED BY THE PUMP-WELL WATERS OF BROOKLYN AND NEW YORK CITIES.)

BY NELSON H. DARTON.

It is with hesitation that I add to the now almost too voluminous literature of water analysis. The investigations of which I wish to give results have revealed however considerable matter of interest, especially in regard to the volatile nitrogenous matters which for some time have been known to be a constituent of polluted potable waters. Remsen, in his report on Boston water, in 1881, called attention to them more definitely, and Marsh quite recently has shown their influence on the results obtained in the analysis of even slightly contaminated waters.

The importance of recognition of these volatile constituents which are generally lost sight of in the ordinary method of analysis, as they pass over with the free ammonia but do not affect the Nessler reagent is, however, as yet undetermined, and by investigations of its physiological action in the concentrated state upon rabbits I have been enabled to draw conclusions which I trust will not be without value in judging the character of a potable water, as the sequel will show.

It was also very desirable to investigate its association with the other ingredients generally present in contaminated waters ; to what extent these relations change by allowing the waters to stand, and of the microscopic growths present in the waters examined ; consequently the research was extended to include all these data as completely as the facilities in my laboratory would allow, and are given in the tables.

The waters selected for the investigations were known to be polluted with sewage and decomposing vegetable matter, and highly charged with these volatile nitrogenous matters of which I wished more particularly to investigate the characteristics. These were the well waters of Brooklyn, more familiarly known as "pump waters." There are about three hundred of these wells and their pumps, most of them less than a hundred feet in depth, that yield a plentiful supply of cool, clear water even in the dry seasons. The sources of supply of these wells, or in other terms their water-sheds, are almost exclusively from water infiltering through the cobble-paved streets and backyards of houses, then through gravel and sand, finally collecting in impervious depressions, generally of clay, underlying the city. The area drained to each pump is quite extensive, as Brooklyn is built upon the slopes of numerous hills. So far as I can find, there was no system followed in locating the pumps ; they are more abundant in the lower and older wards of the city, now populated by the poorer classes, and having with few exceptions the highest death rates of any portion.

The sources of pollution of these waters are numerous. The principal one is by infiltration—first through the filthy streets, covered with animal excreta and decomposing vegetable matter, then through the soil and subsoil, saturated with accumulated decayed and slowly putrefying matter, whose only source of elimination is by these waters—much of this finds its way to the sea, but no small proportion of it is raised in the pumps. Another source of pollution which I am led to believe is a very considerable one, is from the loosely built sewers and carelessly-joined drainage pipes from the houses. Then, again, from the loosely-floored stables, manure pits, corner cesspools and closets in many of the backyards a great amount of sewage drains into the ground and adds to the pollution. There is naturally little or no opportunity for purification of these waters by aeration.

Three of the few remaining pumps in New York city were included in the investigation for comparison. These wells are similarly polluted to those of Brooklyn.

Thirteen wells were indiscriminately selected, numbered in the table from Nos. 75 to 88, and including the three New York City wells.

The analyses were made at three intervals, first on the same day that they were drawn ; second, after standing forty-eight hours, and third, after six days. During these intervals they were kept in bottles but half-filled and loosely stoppered.

The results were obtained as follows :

Residue.—50 cc. evaporated, dried for three hours at 100° and weighed.

Loss on ignition.—The above residue was ignited for twenty minutes, cooled and weighed. Carbonic acid water was not added.

Chlorine—Titration on 50 cc.

Nitrites.—According to Preusse and Tiemann's description of the application of Griess' test (metadiamido benzol.)

In these and other colorimetric examination the colors obtained were compared with those produced in solutions of known strength of the constituent sought.

Nitrates.—By the zinc-copper-couple as described by Thorpe.

Oxygen required.—By the moist combustion method of Wauklyn half the quantities prescribed by him being taken.

Ammonia, free and albuminoid, by Wanklyn's method. To obtain permanganate solution free from ammonia the following process was followed : Freshly fused potassa was allowed to cool out of contact with the air in an exhausted bell glass ; this and the proper amount of permanganate were dissolved in sufficient absolutely ammonia free water, readily obtained by redistilling Ridgewood water with the proper precautions. The solution thus made was boiled in a distilling flask with a mark on its neck whereunto it held half a litre of water at 100° c.; it was connected with a condenser, and when 10 cc. of distillate was found to be free from ammonia, the flask was filled with pure boiling water and poured into thoroughly cleansed, small hot bottles of about 100 cc. capacity, for which it was used. Frequent tests of this method revealed not even a trace of ammonia, even when distilling from a half litre and collecting the first 10 cc. of distillate.

For measuring this solution a pipett of the form that I proposed before the Society some time ago* but with a three foot length of rubber tubing and two strong pinchcocks. Upon it were two marks, one at 10 cc. capacity, the other on the stem at 1 cc.

In every instance 100 cc. of the water was taken and the distillation conducted in 250 cc. in distilling flasks of German glass.

Precautions were taken against the disturbing influence of ammonia in the air of the laboratory by placing dishes of dilute hydrochloric acid in the niche which was devoted exclusively to the water analyses. This did not, however, appear to be necessary.

In the estimation of the volatile nitrogenous matters 100 cc. of the water were diluted, and every 10cc. of distillate diluted to 20 cc. and then divided into two portions, one of which was Nesslerized directly and confirmed the free ammonia found in the first distillation, and the remaining portion placed in a 35 cc. distilling flask joined to a miniature but effective condenser, some water and 1 cc. of the permanganate mixture added and redistilled—the 1st 10 cc. of distillate always contained all the NH_3 and was Nesslerized, the difference between this and the first result being equivalent to the ammonia from the volatile nitrogenous matters. In order to determine some of its characteristics, if possible, all the waters examined were concentrated from five litres to 50 cc. This we readily accomplished by distilling at first in half litres and collecting each first 100 cc. distillate, these were mixed and the litre obtained distilled in two portions, each first 100 cc. of distillate being likewise collected ; to this a calculated amount ofphosphoric acid was added to hold back the free ammonia, 50 cc. was then distilled off and after redistillation was found to be quite free from ammonia. After filtration through asbestos felting 1 cc. distilled with sufficient permanganate mixture and the ammonia Nesslerized, showed that about

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* This journal. III.—12.

two-thirds of the NH_3 of the volatile nitrogenous matter had been secured and all other bodies, both chemical and organized, had been left behind.

A number of fine young rabbits were selected and sufficient amounts of these concentrations were injected under their skin with the effects detailed after each table. This it was expected would confirm a suspicion that I had long entertained that these matters were deleterious to the animal economy, and is, I think, fully justified by the results obtained.

Microscopic examinations were made of the sediments from the waters which were generally very slight; and the various forms of life found, so far as I could identify them, are detailed after the tables. In order to separate and examine the Bacilli, Micrococci and similar organisms, two methods of separation or rather concentration were tried, the first by adding osmic acid and allowing that which had been killed by its action to deposit; and the other by developing in a film of gelatine; both of these methods were found to yield quite satisfactory results, but preference was given to the latter on account of its larger yield. Before covering with the film a small amount of Cohn's developing liquor was added to the water. The dissolved gases were determined by the usual method of distillation and absorption by potash and pyrogallate of potassa. It may be well here to recall the significance of the relations of the proportions of the gases dissolved in water and their change upon standing. Water, under the most favorable conditions of purity and at 15° c., will dissolve 6.3 cc. of oxygen and 11.7 cc. of nitrogen, and the relation is only disturbed to any great extent by putrefaction of matter held in solution and also by the action of femrents.

At about the time that the research was commenced Dr. A. R. Leeds in a preliminary, and as yet unpublished communication to the N. Y. Academy of Sciences, called attention to a new actinic method for determining putrescible organic matter in potable waters, which, in a number of trials he had found to yield extremely satisfactory results. Consequently it was thought desirable to include an investigation of the value of this new method

The details of the process were orally communicated to me, and were quite closely followed. One hundred cc. of the water is mixed with the same amount of decimonnal silver solution preferable the nitrate; the mixture in a closed bottle is exposed to light as long as it is acted upon, and the decomposition has been completed, the putrescible organic matter having been oxidized at the expense of the silver, which precipitates as metal. All is then poured through a Gooch filter, and this and the bottle washed with ammonia to dissolve haloid salts. The silver adhering to the inside of the bottle and that on the filter is then dissolved in nitric acid and determined as may be convenient ; its weight in millegrammes multiplied by 10 equal parts per million, and by the ratio of 108:16 equal oxygen required.

This process has so far yielded the most satisfactory of results, and promises to be a convenient, applicable and accurate method for the analysis of potable waters, if not alone, at least with the ammonia process, and when appreciable amounts of sulphides are absent.

The location of the wells and results of the physical and physiological examinations of the waters were as follows : The effects on rabbits here spoken of are the effects produced by the subcutaneous injection of a small portion of the concentrated nitrogenous matter obtained as described.

No. 75. Corner of Johnson and Lawrence streets.

Appearance in 2 ft. tube, bright and clear. Sediment slight. Microscopical examination of sediment : Sand, fibrous vegetable matter, a cypris, diatoms, and a few yellow algae.

The concentrated volatile nitrogenous matter injected under the skin of a rabbit caused violent diarrhœa, with vomiting and death in about an hour.

No. 76. Near corner Myrtle avenue and Lawrence street.

Bright and clear. Sediment considerable, containing much sand, also, *confervae*, *desmids*, *oscillatorae*, *palmaceae*, and *volvox*, two varieties of *amoeba* a *chilodon*, an *auginuillata fluviatalis* and numerous diatoms.

The effect of the concentrated nitrogenous matter on a rabbit was essentially the same as with No. 75, but more intense.

No. 77. Corner of Bridge and Tillary streets.

Bright and clear. Sediment small, containing sand, fibrous vegetable matter, some diatoms and a few dead *chaetonotii*. Injection of the nitrogenous matter under the skin of a rabbit produced a slight transitory diarrhœa.

No. 78. Corner Sumner avenue and Bainbridge street.

Strong odor of brewery swill, develops that of H_2S on standing. Sediment abundant, dark colored, containing numerous algae and animalculæ. The effect on a rabbit was to produce diarrhœa, cramps, vomiting and death. A similar effect, though not so rapidly fatal, was produced on a cat.

No. 79. Corner Johnson and Bridge streets.

Water clear and bright. Sediment small and containing scarcely anything worthy of mention. Effect on a rabbit similar to that of the previous one.

No. 80. Corner Chapel Place and Bridge street.

140 feet deep. No sediment. Effect on a rabbit slight transitory diarrhœa.

No. 81. Near corner of Irving Place and Fulton avenue.

Clear and bright. Sediment slight, consisting of sand, *diatoms*, *algae*, several *cypri*, *chilodons* and *amœbæ*. Effect on a rabbit, violent diarrhœa followed by slow recovery.

No. 82. Corner Bridge and Nassau streets.

Water clear. Sediment large, containing sand, algae and monads. The bacteria obtained by filming when injected under the skin of a rabbit caused diarrhœa and death. The same effect was produced by the concentrated nitrogenous matter.

No. 83. Corner Fulton avenue and Carleton.

Water clear. Sediment inconsiderable. In this water the proportion of total ammonia was much less than the sum of the five and albuminoid together. It probably contained some substances oxidized by the permanganate to nitrates. The tests were duplicated with the same results.

No. 84. Corner Duffield and Johnson streets.

Water clear. Sediment moderate, containing sand, numerous *diatoms*, *chilodons*, etc. Effect on a rabbit, violent diarrhœa, etc. Death in two days.

Some of this concentrated nitrogenous matter was also injected under my own skin. The effects were similar. Diarrhœa was produced in two hours, and continued for two days.

No. 85. Hanover Place near Fulton street.

Water clear. No perceptible sediment. Effect on a rabbit, intermittent diarrhœa lasting for about a week. The effect on my assistant was to produce a tendency to diarrhœa lasting four days.

No. 86. New York City, corner Thames and Church streets.

Water clear. Slight odor of acetylene, which soon disappeared. Contained no volatile nitrogenous matter. Effects on a rabbit nil.

No. 87. New York City, corner Dey and Greenwich streets.

Water clear. Much sediment. Both the sediment and the volatile nitrogenous matter produced violent diarrhœa, and vomiting, with rabbits, which in the case of the sediment terminated in death.

No. 88. Corner Church and Cedar streets.

Similar to the last. Sediment contained vorticella and microstoma. The volatile nitrogenous matter injected under my own skin produced diarrhœa and vomiting from which I took a week to recover.

To determine whether the above results were exclusively due to the volatile nitrogenous matters and whether they existed in the water as such, or were formed during distillation, further experiments were tried from time to time during the research. That these volatile nitrogenous matters preëxisted in the waters was, I thought, very probable. To ascertain this the waters were, after being filtered through asbestos plugs (in all other respects they were as when drawn from the wells), injected in considerable quantity under the skins of rabbits. Symptoms were produced very similar to those induced by the concentrated waters, and the distillates from the concentrated waters which had been found not to contain or develop the volatile nitrogenous matters. Well No. 86 greatly polluted, otherwise produced not the slightest discernable effect upon the animal's health, and when the free ammonia was allowed to accumulate in another portion and concentrated till it became two parts per million, on injection it produced exactly similar results.

In order to determine the effect of the less volatile portion of a water, some of that which had been filtered through the asbestos plugs of our other experiment, was distilled at a very low pressure at a temperature of about 84° C., as previous experiments had shown that all the readily volatile matters of this water were easily separated from it by heat, applied if for even a short time. That which remained and was injected in the rabbit produced little or no discernable effect. While in this and the first injectings, bacterial matter might have been implicated, the latter experiment would have failed on account of their sterilization by the heat applied. Yet the volatile matters, in which in every instance I am sure there were no bacteria present, produced more or less violent diarrhœa, with the exception, I might again mention, of that from well No. 77, which, although when concentrated, contained 7 parts per million, an amount equal to that in many of the others, produced no diarrhœa in the rabbit into which it had been injected. The only manner by which I can account for this is by assuming that the term "volatile nitrogenous matters" is a very elastic one, and includes both virulent and harmless amine compounds. Of the former, those of phenol, toluol, etc., and of the latter, ethyl, etc. This is a part of the subject, however, that I trust to be enabled to further elucidate, while it suffices in the present communication to show that the volatile nitrogenous matters accompanying the other pollutants in a sewage contaminated water probably are injurious to health, and that in an examination of a water to determine its potability, their presence and amount should not be lost sight of.

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ABSTRACTS.

Abstracts from the *Journal of the London Chemical Society:* *E. Waller, Ph.D.*

On the Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal Gas. By Lewis T. Wright. (Vol. XLIII. p. 267.)

Experiments with an absorption apparatus of the Frankland-Ward type showed that a manganese peroxide bullet introduced some gases with it mechanically, unless previously submitted to the action of a stream of coal gas for some hours, after which it removed a small amount of gas mechanically. Copper sulphate dried at 150° absorbed some gas mechanically. Copper phosphate moistened with syrupy phosphoric acid gave tolerably good results.

In experiments with absorption tubes, the amount absorbed being weighed, cupric sulphate was found to be objectionable for the following reasons: The sulphuric acid set free reacts with the hydrocarbons in the gas,—sulphurous acid will always form (whether the sulphate has been dried as recommended by Fresenius for four hours at 150°-160° or not.) The reagent also is not very sensitive to small amounts of H_2S. Ferric and manganic oxides are not sufficiently sensitive. Mercuric oxide steadily loses weight in a current of pure coal gas. Cupric phosphate was the most satisfactory. It was prepared by dissolving 2 lbs. Na_2HPO_4 (crystals?) in 1 gal-