A Chemical Investigation of the Water of Salt Creek.

A THESIS
Presented to the Faculty of the College of Science,
UNIVERSITY OF ILLINOIS.
For the Attainment of the Degree of Bachelor of Science in Chemistry.

BY

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JUNE, 1895.
Introduction:—

As pure water never occurs in nature, the influence of natural water on the health of the consumers, together with its widespread use in the arts has stimulated study of the same as it occurs in different forms.

The quality of different samples of naturally occurring water depends entirely upon the impurities they contain. If the water in a surface water and comes in contact with a stratum composed principally of carbonates as the Trenton lime stone strata, it will dissolve a considerable amount of the lime and hold it in solution, as a consequence the water will be hard. Again if the waters falls in a thickly populated community where source
of contamination from sewage and other objectionable refuse matter are found, the water will take up from this disease germs and organic matter, thus becoming so polluted, that it will be rendered unfit for domestic use.

Water contained in creeks and ponds which are located in a forest region is apt to be somewhat changed in quality by the influence of decomposing vegetable organic matter, such waters almost invariably contain various kinds of growing plants, which exert a great influence in purifying the water.

Water which receives additions from tile drains will be modified to an appreciable extent by the various salts dissolved out of the drained area.
Since water is subject to great variation in purity, and as surface water obviously exerts an important influence upon the water of shallow wells, we have made, from time to time, analyses of the water of Salt Creek, with the idea of finding out the average condition of the water so that a comparison may be made between it and the well water of the surrounding country. Also particular attention was paid, as the season progressed, to the character, quality and quantities of impurities contained in the water.

No attempt has been made to establish standards of composition for surface water in general, as this obviously is impossible, except for very limited areas, on account of the fact that the geological conditions of different land areas vary.
as well as the sources of contamination from the drainage. The rapidity of the current of different streams varies, also the exposure to the influence of light and air.

The samples of water analyzed were taken from the same point in Salt Creek; a map of which is given, # represents the point where the collections were made.

Salt Creek begins about one mile to the north of Urbana, where it is joined to a canal from the north; This canal is something like twelve miles in length and receives the water of a large tract of low farm land, which is drained by means of tile; However, this year the rain fall was so light that no precipiable
quantity of water was received by the creek from this source and consequently it need not be taken into consideration.

The creek in its winding course must be about one mile and a half long from where the canal joins it, to where it flows into Crystal Lake.

It runs through considerable timber land and low pasture land; along the course of the stream on the banks were at least six dead horses exposed to all the changes of the weather. A number of drains from the farm land empty into the stream, but this year they did not deliver any water. The water in the creek bed was very low during most of the time that the analyses were made, although in the spring when the ice thawed, it raised considerably at the point where the sample was taken.
collected, so that for a few weeks the surrounding low land was flooded with water.

Collecting Samples: Ground glass stopped bottles were used to collect the samples. The bottle was immersed two feet below the surface of the stream and completely filled; as a precaution it was emptied and refilled three times, the fourth bottle full being securely corked. Because of the unstable character of nitrogen, as contained in its various forms, these determinations were made directly after collection. When it was possible and when they were delayed, the samples were placed in a cool dark cupboard to prevent the effects of light and heat on the impurities of the water.
Order of Determinations:—

The nitrites and the nitrates were determined first. Next the Free ammonia determination was commenced, while this was in progress, the quantity of chlorine and degree of hardness was determined. As soon as the per cent of Free ammonia was found, the Aluminoid ammonia determination was started, during its progress the Total Solids determination was commenced. The next day the determination of nitrates was completed. The oxygen consumed was next determined, and the Total solids and Volatile matter were determined last.

Methods Employed:—

I'm determining the
nitrates present, the Aluminium process with slight modification was employed. The process depends upon the reduction of the nitrates, by the action of the Aluminium in alkaline sol. The nitrogen present in the form of nitrates is obtained and estimated in the form of free ammonia. By this process no nitrates were found to be present. It was thought that possibly by taking a larger quantity of water to make the determination, nitrates might be detected accordingly five hundred cc. of a sample was reduced in volume to fifty cc. and the determination made, but even by this determination no appreciable quantity of nitrates were found, and the faint test that was given may have been due to the presence of nitric acid and ammonia fumes that were present in
the laboratory. To detect nitrite, naphthylamine hydrochloride and sulphamido acid together
with a few drops of hydrochloric acid were
used. No nitrite were found.

**Free and Abs. ammonia Determination.**

For these
determinations, five hundred cc. of the sample
was taken after the bottle had been shaken
to insure a fair sample.
The apparatus (page ) was thoroughly
steamed with ammonia free water until the
distillate gave no reaction with Nessler’s Solution
the five hundred cc. sample was then in-
troduced into a litre flask which was con-
connected with the Stock tin tube of a Liebig con-
denser, by means of a safety distilling bulb,
Rapidly the distillation, without spitting, was continued until two hundred and fifty c.c. of distillate was collected in fifty c.c. Nessler tubes and comparison made as usual with the standard tubes, the amount of free ammonia in each was ascertained and a record made of the same.

For the estimation of the albuminoid ammonia present, the part of the sample remaining in the flask, is distilled with an alkaline solution of permanganate and the process continued as in free ammonia.

The chlorine determination was made as usual by the volumetric method. A very weak standard solution of silver nitrate was used and potassic chromate served as an indicator.
Hardness Determination.

The last soap solution
and table representing the degree of hardness,
as recommended by Dr. Clark was used in
making the hardness determinations.

Oxygen Consumed.

The oxygen consumed was
determined by finding out just how much of a
standard solution of permanganate was
necessary to oxidize the organic matter held
in solution in the sample of water.

Numerous objections are urged against the
Forehammer process, one of the most im-
portant of which is that "its indications are
only comparative and not absolute." It is also
held that "Comparisons are only true when the organic matter compared is substantially identical in composition. This objection of course would apply only to those cases where the samples were obtained from different surroundings and conditions. In such cases it is obvious that since animal organic matter might be contained in one sample whereas vegetable organic matter might be in the other, the effect of the oxidizing agent would not be the same in each case, and consequently comparisons of the results would not give a correct idea of the ratio of organic matter contained in the samples.

It is reasonable to suppose, that, since the samples of water examined were all collected at the same place
in the same creek—they all have been subjected to about the same modifying influences and consequently they would contain almost exactly the same kind of organic matter. This supposition is substantiated by the results of Dr. Pity, who has made periodic examination of the waters of various streams. He found that there is a remarkable parallelism in the examination of water from the same source between the proportion of organic carbon and of oxygen abstracted from the permanganate. If it is true, that the organic contained in the different samples examined did not vary in composition appreciably, then we may look upon the results obtained with some degree of reliance.
Total Solids and Volatile matter Determination.

In these determinations five hundred c.c. of the sample was evaporated in each of two platinum dishes. The dishes with contents were dried at 185°C. The volatile matter was driven off by heat just below full redness. The residue in most of the analyses was white, although it was colored brownish in a few instances by the presence of iron.

The following table shows the results of the analyses, in parts per million, together with the date of Collection and temperature of the air on the corresponding date.
Results expressed in parts per million.

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Samples 5, 6, 7, 8, 9, & 10 were collected when the
water was very high. It had overflowed the low
land at the point where the collections were made.

This is perhaps an explanation of the low
amount of free ammonia in these samples.

It should be noted that in the determination of
chlorine, the first four determinations are a little
higher than they should be, for in the titration
a deeper tint was taken for the end reaction
than for the succeeding determinations.

In making the above analyses, account was
kept of the mean daily temperature and the
moisture that fell either as rain or snow;
to see what bearing it had on the quality
of the water.
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Rain fall is marked R and snow, given as melted snow in inches.
Signification of Results.

Nitrogen in its various forms gives an entirely indirect indication. Its signification consists in the fact that it indicates the previous condition of the water. The organic matter contained decomposes, its nitrogen is set free as ammonia and this by fermentation and nitrification becomes converted into nitrites and nitrates. This so-called nitrification takes place under the influence of microbes, the habitat of which does not extend more than a few feet below the surface of the soil. The use of water that has been contaminated with nitrogenous organic matter is held to be dangerous by some authorities on account of the fact, that the decomposition of nitrogenous organic matter is generally thought about.
by microorganisms, the products of which are very analogous to organic bases or alkaloids. They are generally present in minute amounts. Some authorities hold that even in minute amounts they are very active in their physiological effect. Other authorities say that the evidence which connects disease with polluted water is purely circumstantial, and the amount of organic matter, even in water classified as dangerous, is so small, that as pointed out by Professor Mallet “it furnishes important evidence against any chemical theory of the production of disease from this source.” Professor Mallet in drawing attention to two particular waters says if the whole of the organic carbon and nitrogen found in them, existed as strychnine, it would be necessary to drink about half a gallon of
the water at once, in order to swallow an average medicinal dose of the alkaloid. Notwithstanding, there was no doubt of the highly dangerous character of the two samples referred to.

Chlorine is present in water always in combination, generally as sooty chloride, which in itself is not so objectionable, but a knowledge of its presence is valuable, for it is the one sure indication of previous contamination by sewage or equally objectionable matter. In the vicinity of salt deposits, and the sea a large per cent. of chlorine is not to be looked upon as being objectionable, but in other places it is a good indication of contamination by animal excreta (Chumman
mine contains 5000 parts per million.

From the examination of water from wells in the immediate vicinity, results have been obtained for the per cent of chlorine. I found that the University well contained from 12 to 15 parts chlorine per million, water from a well on John St. near the university contained 13 parts per million and from the results of analysis of the water of Illinois river at Havana it has been found to contain from 2.5 to 37.8 parts chlorine per million. I examined a well south of Urbana and it contained over two hundred parts chlorine per million, this of course was due to pollution. The average per cent of chlorine in the creek water is 8.15 parts per million. This includes the average
of results obtained from Jan 31 to May 23.

Hardness of water is generally due to the presence of salts of calcium and magnesium. In regard to the significance of the presence of these salts in water, opinion is very divided. Some authorities consider the presence of a certain proportion of the salts desirable as furnishing the materials necessary for bone formation, others say that when they are present in more than moderate amounts, they cause calcareous concretions in the system. Others regard their presence or absence as immaterial from a hygienic standpoint. Magnesian waters are very generally credited with the power of causing phosphate calculi and gout; also the influence of lime and magnesian salts are based upon
very unsatisfactory evidence.

The following table shows the average of the analyses, together with the highest and lowest figures obtained during the period of examination which covered the time between Jan 31 and May 23.

| Samples were all taken from same place | Gilboa | amm. | amm. | amm. | Nileta | C. Epy. | S.P.B. | Moll. M. | Moll. | Breed | Results expressed
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</tbody>
</table>
To judge the quality of this water from the analyses, it would be impossible to do otherwise than to condemn its use for domestic purposes. The actual amounts of organic nitrogenous matter found as indicated by the albuminoid ammonia, and oxygen consumed together with the high per cent. of free ammonia would be sufficient data for the condemning of the use for domestic purposes. According to Frankland a water containing more than 3 parts of organic nitrogen per million is unfit for domestic purposes, and as the albuminoid ammonia in this water reached at times as high as .425 parts per million, this would also of itself reflect seriously upon the use of the water. There can be little doubt but that most of the organic matter in the water was
of vegetable origin. True, there were the bodies of six horses on the bank some distance from
the stream but they had not been very complete
ly acted upon by the change in weather
(neither had much rain fallen) to wash the
products of decomposition into the stream
and the water near where they were was very
low in the bed of the stream, that being sev-
eral places further down the stream where
the creek was dried up, consequently they
did not have much influence upon the
quality of the water.

From the results obtained by Thomas M. Brown,
M.D., in his investigation as to the influence
of organic matter contained in the soil at
successive depths, upon the quality of the water
It appears that the amount of ammonia and that of organic matter (as indicated by the oxygen consumed) taken up by the water from the soils at different depths, decreased with the increase of depth. If this be true, it would seem to account in a small measure for the high per cent of ammonia contained in the samples of creek water examined.

For the water in the creek comes mostly in contact with the upper layers of soil and a great deal of vegetable matter finds its way into the stream, it being surrounded by wooded land where a great deal of vegetable organic matter decays upon the ground.

The amount of chlorine present in the water may not be considered as high and would
not reflect seriously on the use of the water. In all probability the chlorine should not be considered much, if any above the amount that would naturally be washed out of the air and soil by rain. While the chlorine is not above the per cent of chlorine found in the well water of the immediate vicinity yet it must be looked upon as being higher in regard to surface water than the per cents contained in the neighboring well water as given above under the head of significance of chlorine.

The absence of nitrates and nitrites is favorable, in as much, as it does not indicate previous contamination, neither however, does their absence indicate that the water is not
It was after the ice melted. This may be explained on the basis that, during the year when the creek is not covered over it receives constantly more or less organic matter from various sources. In the winter the organic matter which has been collected keeps on decomposing and ammoniac is formed. The stream being protected by layer of ice from the action of atmosphere, prevents the oxidation of the ammonia to nitrite and nitrate also prevents escape of ammonia, consequent by it is higher in winter. Now the amount avoid ammonia constantly decreases and no additional of fresh organic matter are received by the stream. Therefore the amount of ammoniac ammonia is higher in summer than in winter.
contaminated, for under favorable conditions nitrates and nitrate may not be formed, or being formed they will be reduced. It may be said, in spite of the above facts, that, the nitrogen in form of free and albuminoid ammonia, together with the chlorine and the general appearance of the water, also the fact that the appearance of the total solids after driving off volatile matter, was somewhat indicative of fatty matter. The water is entirely unfit for domestic use.

Conclusions:—The results of the analyses show the per cent. of free ammonia to be considerably higher in the winter when the creek was covered over by a thick sheet of ice than
It is also well to note the decrease in the amount of free ammonia at the time of high water after the rain fall in the spring. There was no much free ammonia in the water. If rinsed, and chilled, we might say the free ammonia contained.

There is also an absence of nitrite and nitrate, as well as considerable fluctuation in the amount of chlorine and oxygen consumed.

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