NOTE ON THE DIRECT OXIDATION OF ORGANIC MATTER IN WATER.

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A great difference of opinion has existed among the authorities upon the question of oxidation of organic matter in potable waters.

For instance: Tidy says "I am led to the inevitable conclusion that the oxidation of the organic matter in sewage when mixed with unpolluted water and allowed a certain flow, proceeds with extreme rapidity, and that it is impossible to say how short a distance such a mixture need flow, under favorable conditions before the sewage matter becomes thoroughly oxidized. It is certain to my mind that there is no river in the United Kingdom but what is many times longer than is required to effect the destruction of the sewage by oxidation."

He also says: "It was further evident that the last traces of organic matter were the most difficult to oxidize."

The following is a description of the apparatus which he employed in the experiments which led to the conclusion above quoted.

It consisted of a series of 20 troughs, each 10 ft. long and constructed of two pieces of wood joined together at a right angle and lined with glass. Each trough was so placed that it had a fall of one inch, the water from one trough being discharged into a second placed under, but a few inches distant from it. The fall of this second trough was in the opposite direction to the first, the second trough allowing the water to fall in like manner into a third placed under it, the fall of which was in the same direction as the first and so on and on. By this arrangement a constant flow

*The following was presented by Mr. Hine as a graduation thesis for the degree of B. S., at the Rensselaer Polytechnic Institute in June, 1892. The work is entirely his own, and was undertaken at my suggestion and under my observation.—W. P. MASON.

of the water to be experimented upon was obtained through the 20 troughs. At the top of the apparatus a cistern was placed of sufficient size to hold the entire bulk of the water to be employed.

From the cistern a constant flow of the water through the troughs was maintained. A second cistern of similar size was placed at the bottom of the apparatus, so that all the water from the last trough of the series was delivered therein. The water from the lower cistern was continually pumped by a small force pump into the one above.

As opposed to Tidy's conclusions, Frankland states:

"I should say that it is simply impossible that the oxidizing power acting on sewage running in mixture with water over a distance of any length, is sufficient to remove its noxious quality. I presume that the sewage could only come in contact with oxygen from the oxygen contained in the water and also from the oxygen on the surface of the water, and we are aware that ordinary oxygen does not exercise any rapid oxidizing power on organic matter. We know that to destroy organic matter the most powerful oxidizing agents are required. We must boil it with nitric and chloric acid and the most perfect chemical reagents. To think to get rid of organic matter by exposure to the air for a short time is absurd."

One of Frankland's experiments was as follows: A bottle containing an equal volume of peaty water and air was securely tied to a wooden cradle which was fastened to the connecting rod of a horizontal steam engine making 100 strokes per minute and was thus shaken. Frankland afterwards analyzed the air in the bottle, and from lack of CO_2 therein concluded absence of oxidation.

It was with a view of obtaining more light upon this subject, from analysis of the water itself, that the following experiments were undertaken.

The method of shaking, by fastening to the connecting rod of an engine, was similar to that of Frankland, and the water experimented upon was in each case analyzed before and after shaking. In the first six (6) experiments a tin can of 4000 c.c. capacity was used, but glass stoppered bottles of like capacity were afterwards substituted therefor.

Varying amounts of sewerage were placed in the bottles, water added until the dilution reached 3,000 c.c., the mixture was then thoroughly stirred and 1,500 c.c. were taken out and analyzed. The bottle containing the remaining 1,500 c.c. was then securely fastened to the connecting rod of a horizontal steam engine of 10 in. stroke, running at a speed of 75 revolutions per minute, so that in an hour the water was subjected to 9,000 violent concussions and traveled 1.25 miles.

The lengths of time during which the waters were thus lashed into spray varied from 18 to 60 hours. The mean temperature of the water during the shaking was 30° C.

An examination of the results shows that the amount of oxidation which took place during the agitation of the water was very trifling, a finding entirely in accordance with Prof. Leed's observations of the water of the Niagara river before and after passing Niagara Falls. Direct oxidation does not seem to be a factor of any considerable importance in the purification of polluted water.

FREE AMMONIA.

	Before Shaking.	After shaking.	Hours Shaken.
1	.145	.180	18
2	.130	.140	18
3	.420	.450	42
4	.310	.350	18
5	.205	.410	40
6	.205	.195	42
7	.840	1.145	42
8	.345	.410	18
9	.220	.395	18
10	.185	.115	18
11	.550	.115	18
12	.045	.105	13
13	.085	.125	21
14	.060	.100	23
15	.040	.155	60
16	.060	.035	18
17	.035	.110	18
18	.030	.105	21

FREE AMMONIA.

	Before Shak-og.	After Shaking	Hours Shaken.
19	.050	.120	52
20	.105	.130	22
21	.075	.140	19
22	.080	.110	24
23	.080	.125	42
24	.085	.145	42

ALBUMINOID AMMONIA.

	Before Shaking.	After Shaking.	Hours Shaken.
1	.355	.370	18
2	.285	.300	18
3	.455	.400	42
4	.550	.570	18
5	.440	.080	40
6	.180	.115	42
7	.690	.560	42
8	.215	.325	18
9	.410	.440	18
10	.750	.845	18
11	.435	.440	18
12	.490	.440	13
13	.335	.325	21
14	.330	.270	23
15	.345	.300	60
16	.355	.355	18
17	.300	.250	18
18	.270	.320	21
19	.285	.285	52
20	.285	.210	22
21	.255	.225	19
22	.285	.240	24
23	.275	.245	42
24	.290	.250	42

REQUIRED OXYGEN.

	Before Shaking.	After Shaking.	Hours Shaken.
1	4.25	4.75	18
2	3.35	4.35	18
3	4.15	4.25	42
4	4.70	4.15	18
5	4.95	1.85	40
6	2.80	2.40	42
7	5.00	3.90	42
8	3.50	3.10	18
9	2.50	2.75	18
10	9.05	7.90	18
11	4.60	3.80	18
12	4.20	3.60	13
13	3.10	2.95	21
14	2.90	2.65	23
15	3.60	2.65	60
16	3.50	3.50	18
17	3 00	2.70	18
18	2.85	2.60	21
19	2.80	2.40	52
20	2.65	2.35	22
21	3.75	2.80	19
22	3.40	3.55	24
23	3.30	3.15	42
24	3.10	3.40	42

NITROGEN IN NITRITES.

	Before Shaking.	After Shaking.	Hours Shaken.
1	.001	.007	18
2	.012	.018	18
3	.012	.037	42
4	.012	.011	18
5	.007	.036	40
6	.003	trace.	42
7	.003	.001	42
8	.004	.005	18
9	.005	.005	18
10	trace.	.001	18
11	trace.	.001	18
12	.005	.004	13
13	.004	.008	21
14	.007	.008	23
15	.007	.002	60

NITROGEN IN NITRITES.

	Before Shaking.	After Shaking.	Hours Shaken.
16	.004	.010	18
17	.003	trace.	18
18	trace.	trace.	21
19	trace.	trace.	52
20	.001	.001	22
21	.003	.003	19
22	.004	.005	24
23	.004	.004	42
24	.010	.010	42

NITROGEN IN NITRATES

	Before. Shaking.	After Shaking.	Hours Shaken.
1	1.28	1.25	18
2	1.117	1.284	18
3	1.126	1.188	42
4	1.144	1.100	18
5	1.139	1.223	40
6	1.073	1.136	42
7	0.932	0.220	42
8	0.752	0.695	18
9	1.179	1.148	18
10	1.690	1.306	18
11	1.014	1.042	18
12	1.000	1.584	13
13	1.056	1.210	21
14	1.091	1.144	23
15	1.196	1.359	60
16	1.179	1.245	18
17	1.025	1.135	18
18	1.293	1.262	21
19	0.836	1.038	52
20	1.139	1.117	22
21	1.342	1.372	19
22	1.073	1.223	24
23	1.425	1.474	42
24	1.509	1.544	42