PRACTICAL APPLICATION OF THE "SALTPETER METHOD" FOR DETERMINING THE STRENGTH OF SEWAGES.*

By Arthur Lederer,
Chemist and Bacteriologist, The Sanitary District of Chicago.

SINCE the publication of the saltpeter method of determining the biochemical oxygen demand of sewages and polluted waters, I have made a number of observations which throw more light on the reliability and practicability of the method. I have also simplified the procedure so as to make it more adaptable to working conditions. At the present time the operation of the sewage-testing stations of the Sanitary District is entirely controlled by this method. It has also been employed in sanitary surveys of polluted streams.

The method is based upon the biochemical consumption of saltpeter oxygen by a sewage during an incubation period of ten days at 20° C. The initial minus the residual available oxygen expressed as parts per million oxygen indicates the biochemical oxygen demand. The original procedure consisted in the addition of varying quantities of saltpeter to the sewage in stoppered bottles, either with or without the addition of methylene blue. If no coloring matter was present, the "septization" of the sediment served as the index of the oxidation. The residual nitrite-nitrate oxygen was determined in the bottle in which the sediment did not turn septic after ten days' incubation. This method of employing varying quantities of saltpeter is necessary of course in preliminary tests when one deals with a sewage of unknown strength. There is, however, no additional labor involved, since only one bottle is selected for the final analysis. The other bottles are discarded. Once the approximate maximum strength of a certain sewage is established, a definite excess of saltpeter can be employed, thus reducing the number of bottles to one. I have found on various occasions that a reasonable excess of saltpeter does not result in an increased oxygen consumption. In this respect the method is vastly superior to all of the methods involving fresh water dilutions, such as required in the Modified English Incubation Test, accepted as a provisional procedure for the "Standard Methods of Water Analysis." It is true that in any dilution method, only free oxygen determinations are required which are much simpler than nitrate-nitrite determinations, from the analytical standpoint. However, the precautions and amount of preliminary work required in a dilution test such as the English incubation test are great and emphasize the difficulties of obtaining comparable results with such a test.

In order to have comparable results with the English Incubation Test, it is absolutely essential to prepare a dilution which is just sufficient to insure stability. The saltpeter method was originally developed on this basis. Various dilutions were made of the sewage with fresh water and methylene blue was added as an indicator. The dilution, just sufficient to retain the color, expressed in parts per million of oxygen, gave the same result as when an equivalent of saltpeter of oxygen was added to the undiluted sewage. The saltpeter solution was prepared on the basis of five oxygen atoms being released from two sodium nitrate molecules. It is obviously wrong to prepare *ad libitum* any kind of sewage-water mixture and compare the free-oxygen consumption thus obtained with the saltpeter-oxygen consumption. Matters are still worse if a dilution is incubated at one temperature and the saltpeter sewage at another. An intelligent comparison can only be drawn by adhering to the procedure indicated above. That a serious error can occur in comparing the free-oxygen consumption with the saltpeter-oxygen consumption, if the proper required concentration is not adhered to, was impressed on me during the co-operative work on the Modified English Incubation Test. In a number of the series of experiments I worked out the saltpeter-oxygen consumptions, as well as the free-oxygen consumptions in the various concentrations. Such a comparison is recorded in the following Table I., the results being expressed in parts per million.

Table I.—Free-Oxygen Consumptions in Various Concentrations Compared to Saltpeter-Oxygen Consumptions at 20° C.

Serial No.	Time of incubation in days.	Fresh water oxygen demand, P. P. M. Original concentration of sewage in per cent. 1.0	1.5	2.0	2.5	3.0	4.0	5.0	Saltpeter oxygen demand P. P. M.
1	1	60	27	..	..	20	..	..	38
	5	180	113	..	..	97	..	..	71
	10	230	146	..	..	120	..	..	81
	..	(26)	(26)	..	..	(43)	..	..	..
2	1	50	33	..	..	33	..	..	18
	5	130	100	..	..	67	..	..	57
	10	180	126	..	..	90	..	..	81
	..	(20)	(22)	..	..	(31)	..	..	..
3	1	20	..	15	..	..	20	..	19
	5	150	..	90	..	..	75	..	78
	10	190	..	135	..	..	92	..	86
	..	(22)	..	(32)	..	..	(44)	..	..
4	1	50	..	40	..	..	32	..	—
	5	140	..	95	..	..	75	..	63
	10	210	..	135	..	..	98	..	80
	..	(24)	..	(31)	..	..	(45)	..	..
5	1	50	..	..	32	..	..	22	32
	5	110	..	..	84	..	..	66	66
	10	120	..	..	92	..	..	88	75
	..	(14)	..	..	(27)	..	..	(53)	..
6	1	30	..	..	24	..	..	22	30
	5	100	..	..	68	..	..	64	60
	10	140	..	..	100	..	..	—	71
	..	(16)	..	..	(30)	..	..	..	..
7	1	70	..	..	32	..	..	32	24
	5	150	..	..	96	..	..	60	52
	10	180	..	..	104	..	..	76	66
	..	(20)	..	..	(30)	..	..	(45)	..
8	1	50	..	..	28	..	..	26	23
	5	130	..	..	96	..	..	80	66
	10	150	..	..	116	..	..	98	78
	..	(17)	..	..	(34)	..	..	(58)	..
9	1	70	..	..	36	..	..	36	27
	5	190	..	..	112	..	..	100	67
	10	240	..	..	124	..	..	100	89
	..	(28)	..	..	(36)	..	..	(65)	..

The figures in parenthesis indicate the percentage of oxygen absorbed by the sewage after ten days' incubation. The influence of concentration upon oxygen absorption is strikingly illustrated in the table. However, when the per cent. of oxygen absorbed by the sewage approaches 50 or

*Read before the Laboratory Section, American Public Health Association, Jacksonville, Fla., December, 1914.