THE USE OF O-CLOR BENZENE
IN SEWAGE TREATMENT

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STATEMENT OF PROBLEM

The purpose of this study is twofold:

1. To determine the desirability of using O-Clor-Benzene in the control of odors by preventing the production of hydrogen sulfide in sewage.

2. To determine the effect of varying amounts of O-Clor-Benzene on the rate of digestion of sewage sludge.

DISCUSSION OF PROBLEM

The problem at hand is an attempt to find some use for O-Clor-Benzene, commercially known as Cloroben, in the treatment of sewage. O-Clor-Benzene is an obnoxious by-product of most large chemical plants. Because of its properties, manufacturers are not allowed to just "dump" it, and for that reason a market for O-Clor-Benzene is trying to be created. It already has some value as a fly exterminator, but because of its penetrating odor, its market is very limited. The question then resolves itself into: Just what can be done with O-Clor-Benzene?

In England the use of O-Clor-Benzene to control the filter fly has been tried and satisfactory results have been obtained. If this be the case, then perhaps there is a possibility that O_Clor-Benzene may be used in certain types of mosquito control growth in ponds and lakes as well as fly control.

Because of the fact that O-Clor-Benzene is a by-product, any literature concerning its origin or its commercial life is at a premium. However, during the summer of 1934, W. Rudolfs of Plainfield, New Jersey, did considerable experimenting with it as it would be directly related to sewage treatment. His experiments were not intended to be exhaustive, but only sufficient to show the merits and demerits of O-Clor-Benzene.

From the start the fact must be borne in mind that, unless Cloroben is distributed throughout the testing samples, no satisfactory results can be obtained. Good contract between the particles can be obtained by thirty minutes aeration or a rapid mix using a ten per cent Cloroben solution in alcohol.

The first phase he considered was the effect of O-Clor-Benzene on coagulation, odor control, settlebility, and bacterial reduction of sewage.

The treatment in this case was made by the addition of an alcoholic solution of O-Clor-Benzene to sewage for the purpose of obtaining a more rapid and finer dispersion of O-Clor-Benzene. This was deemed necessary because any reaction between the water in-soluble O-Clor-Benzene and sewage particles would be solely a surface action. From a practical point of view this means of obtaining proper dispersion is impossible for two reasons; first, the cost is too great; and second, because of the fact that alcohol is unstable in sewage. However, by the use of a domestic sewage the B. O. D. was raised from 300 ppm. to over 400 ppm.

The addition of an alcoholic solution of 500 ppm. of O-Clor-Benzene caused a reduction in total bacterial count of 99.95%; 99% of the gas forming organisms; and 99.99% of the B-Cozi. A further reduction in amount of

O-Clor-Benzene; namely, 10 ppm., had no toxic effect on the normal bacterial population.

The odor of the sewage was changed with as small an addition as 10 ppm. This change lasted for five days. The original sewage odor then returned, but it was not nearly so intense as the control. If the addition added was to be 500 ppm., its strong odor was still prevalent even after thirty days.

O-Clor-Benzene was found to have no effect on turbity and settleable solids after a four-hour contact period.

When just plain sewage is allowed to stand we find a marked change in the anaerobic digestion of sewage after thirty days. The digestion is rapid and the acidity decreases until the pH is below the favorable environment for bacterial decomposition causing foul odors to emanate from the mixture and little or no coagulation of solids. If, however, Cloroben is added, anaerobic digestion proceeds at a much slower rate. The rate being set by the amount of O-Clor-Benzene that is added. With the addition of 500 ppm. anaerobic digestion is prevented.

In considering the effect of Cloroben on the settling rate of activated sludge, it has been found that the rate is increased in the initial stage; that it decreases as time goes on and is practically lost after three hours. If the activated sludge is in good condition to begin with, there would be no point in treating it.

One of the most important phases of this subject is O-Clor-Benzene's effect on aerobic decomposition in respect to suspended solids, oxygen consumed, B. O. D., and nitrification; and to determine the effect of larger quantities of Cloroben on retarding or the inhibitation of these activities. Any reduction in suspended solids is negligible no matter what quantity of the chemical is added. In oxygen consumed tests samples treated with 200 ppm. to 500 ppm. show marked increases (5% to 35%). This indicates that Cloroben does have an inhibitory effect on aerobic organisms. The effect is lost, however, on prolonged digestion.

By increasing the quantities of O-Clor-Benzene, a slight inhibitory effect can be realized. The maximum reduction for 500 ppm. is about 17% which persists from five to fifteen days.

Nitrite formation is very active upon the addition of small additions (0 to 200 ppm.) of Cloroben in the early stages, but plays out as time progresses (twenty days). With the addition of larger amounts (500 ppm.) that activity is inhibited until the twentieth day when it is extremely active.

If Cloroben is to break into the sewage treatment program, it will be used as a substitute in most cases for chlorine. For that reason it is interesting to note just what a comparison of the two chemicals will indicate. An experiment on the comparative effect of chlorine and O-Clor-Benzene on the prevention of hydrogen sulfide production has been carried on and with interesting results. As far as possible the experiment was conducted to more or less duplicate what normally occurs in a sewer. That is, the treatment with O-Clor-Benzene and chlorine was made after one hour of detention by "re-seeding", or the addition of organisms capable of reducing sulfates to hydrogen sulfide which normally are present in the film surrounding a sewer pipe.

It was found that Cloroben treatment of 5 ppm. had a slightly greater initial effect in the reduction of sulfide production which remained for a longer period than did the same amount of chlorine. This advantage was lost, however, when the amount of chemical added was increased to 10 ppm. and 15 ppm. at which points they rode at practically even terms. Any increase in the dosage above those points was found to have little or no effect on the O-Clor-Benzene sulfide reduction while an increase in chlorine treatments decreased the sulfides produced in direct proportion. The sulfides produced amounted to 1/2 to 1/3 as that produced by the control indicating a fairly persistent retardation.

Thus for rapid flowing small sewerage systems chlorine treatment from 33.3 % to 100% of the chlorine demand appears to be as effective as equivalent weights of O-Clor-Benzene, and treatment to 200% of chlorine demand is somewhat more effective than Cloroben whereas over longer periods of contract O-Clor-Benzene appears more effective.

METHOD OF PROCEEDURE

Part I. Fresh samples of a typical domestic sewage (3.0082 ppm H_2S) obtained from the East Lansing sewage plant were used. Six three-liter samples were used; (1) Control, (2) 10 ppm. of O-Clor-Benzene, (3) 20 ppm., (4) 30 ppm., (5) 40 ppm., (6) 50 ppm. These samples were tested daily over a period of seven days for the production of hydrogen sulfide. At the end of the period of experimentation the other properties, namely, odor and appearance were also noted and the results recorded. Two such analyses were made.

The method of testing the samples for H_2S was as follows:

1. Pipette 10 ml of standard iodine (.025 n) solution into a 400 ml Erlenmeyer flask.
2. Add about 1 gm of pottassium iodine crystals to flask.
3. From 3 liter sample pipette 200 ml sewage into flask.
4. Titrate with .025 N standard sodium.thiosulfate using starch solution as the indicator.

Calculations:

10 - S = #ml of sodium thiosulfate used

10 - D = #ml of distilled water used

$$\text{ppm. of } H_2S = \frac{(S - D) \times 426}{\#\text{ of ml of sample}}$$

Part II. Six #10 cans were suspended at different points in the settling channels of the East Lansing sewage plant for a period of one week. The samples were then collected and intimately mixed in a large container. Four portions of two liters each were removed and placed in stoppered bottles so hooked up as to capture and record the production of any gases.

This experiment was allowed to run for a period of four weeks with readings on the production of gases recorded daily.

Data - Part I

Trial I

Fresh Sewage 3.088 ppm. H_2S

	1 day	2 day	3 day	5 day	6 day	7 day
control	1.704	3.515	6.688	5.645	5.645	4.367
10 ppm.	1.704	2.556	5.432	2.806	2.728	4.783
20 ppm.	1.384	3.621	1.971	1.555	2.875	2.237
30 ppm.	1.598	2.172	2.232	2.130	1.917	2.769
40 ppm.	1.598	2.620	2.232	1.598	1.661	2.876
50 ppm.	1.704	2.875	2.232	2.343	1.704	1.917

Trial II

Fresh Sewage 2.982 ppm. H_2S

	1 day	2 day	3 day	4 day	5 day	6 day	7 day
control	2.875	3.285	4.575	4.620	3.725	3.834	2.449
10 ppm.	3.725	3.085	3.725	3.680	3.085	3.514	3.834
20 ppm.	3.300	2.130	2.555	1.855	0.960	1.065	1.176
30 ppm.	2.770	2.445	2.555	2.490	1.855	1.278	1.490
40 ppm.	3.085	2.660	1.811	1.980	1.340	1.278	1.490
50 ppm.	2.770	2.875	2.555	2.335	1.490	1.065	1.490

Data - Part II

Production of Gases

Typical of Sewerage

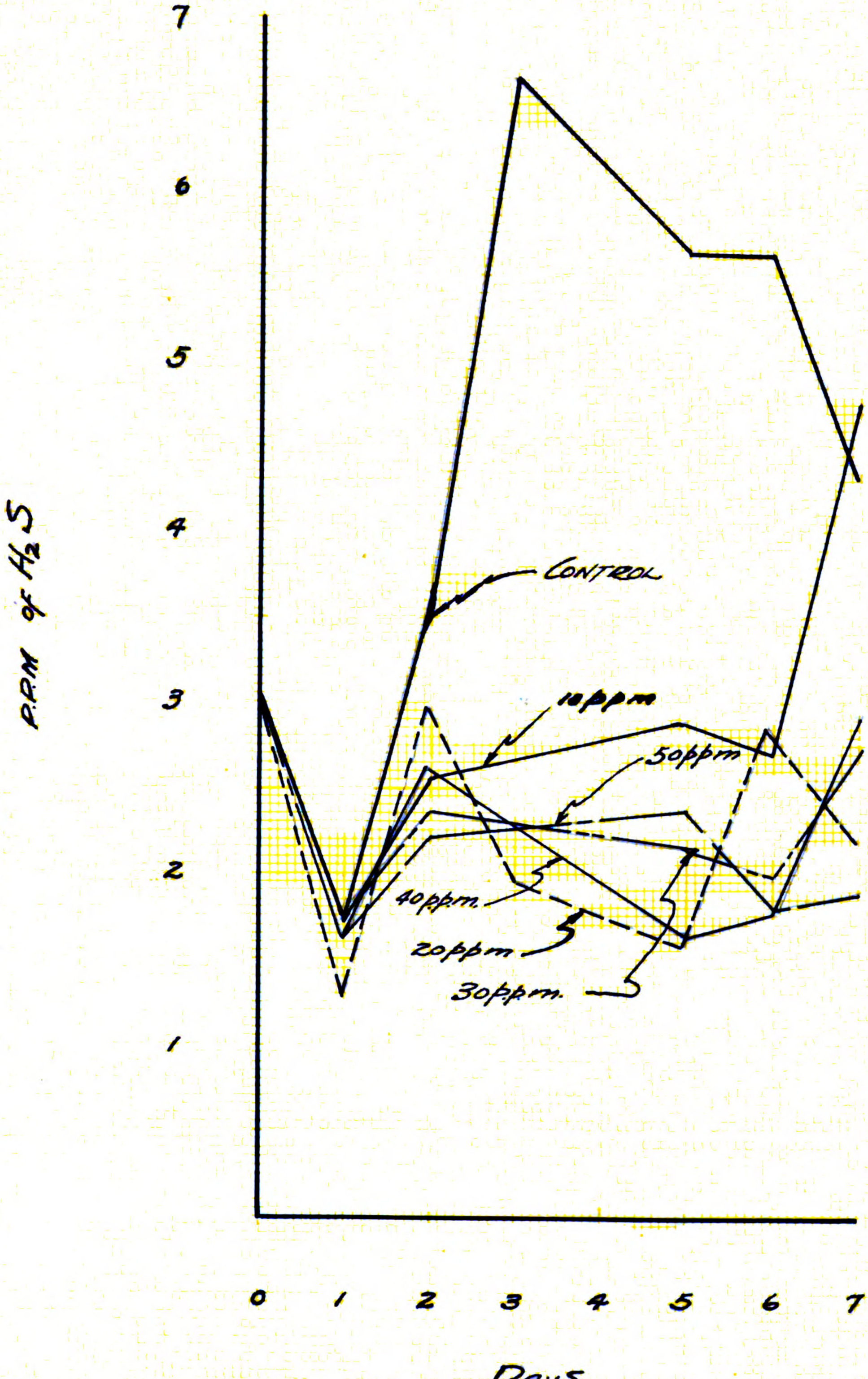
Chiefly C_4H_4 and $C\ O_2$

	Control	100 ppm.	250ppm.	500 ppm.
First Week				
1	0	0	0	0
2	400	200	200	40
3	1600	800	740	110
4	2170	1240	1020	130
5	2900	1660	1200	140
6	3900	2360	1540	140
Second Week				
1	4420	2760	1800	140
2	5060	3960	2440	140
3	6100	4780	2580	160
4	6560	5380	2810	200
5	7240	5860	3070	200
6	8340	7580	3850	220

Production of Gases - Continued

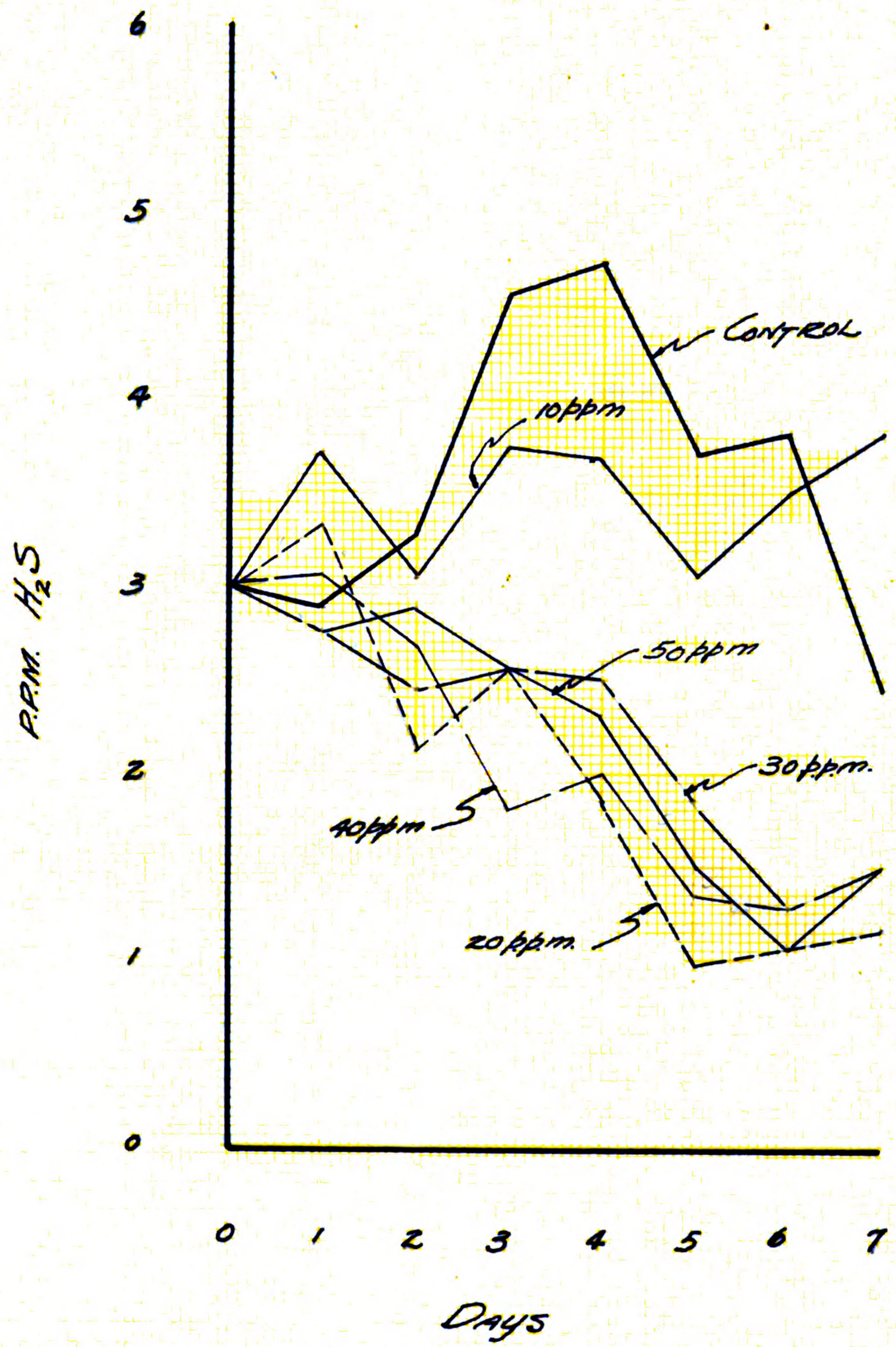
	Control	100 ppm.	250 ppm.	500 ppm.
Third week				
1	8340	7580	3850	220
2	8620	7960	4130	230
3	9320	9080	4930	240
4	9620	9540	5530	240
5	9920	9920	5950	240
6	10,100	10,220	6370	240
Fourth week				
1	10,250	10,480	6740	240
2	10,440	10,810	7250	260
3	10,760	11,150	7930	260
4	10,940	11,370	8330	260
5	11,000	11,410	8770	260
6	11,080	11,440	9190	260

TRIAL I
of H_2S PRODUCTION

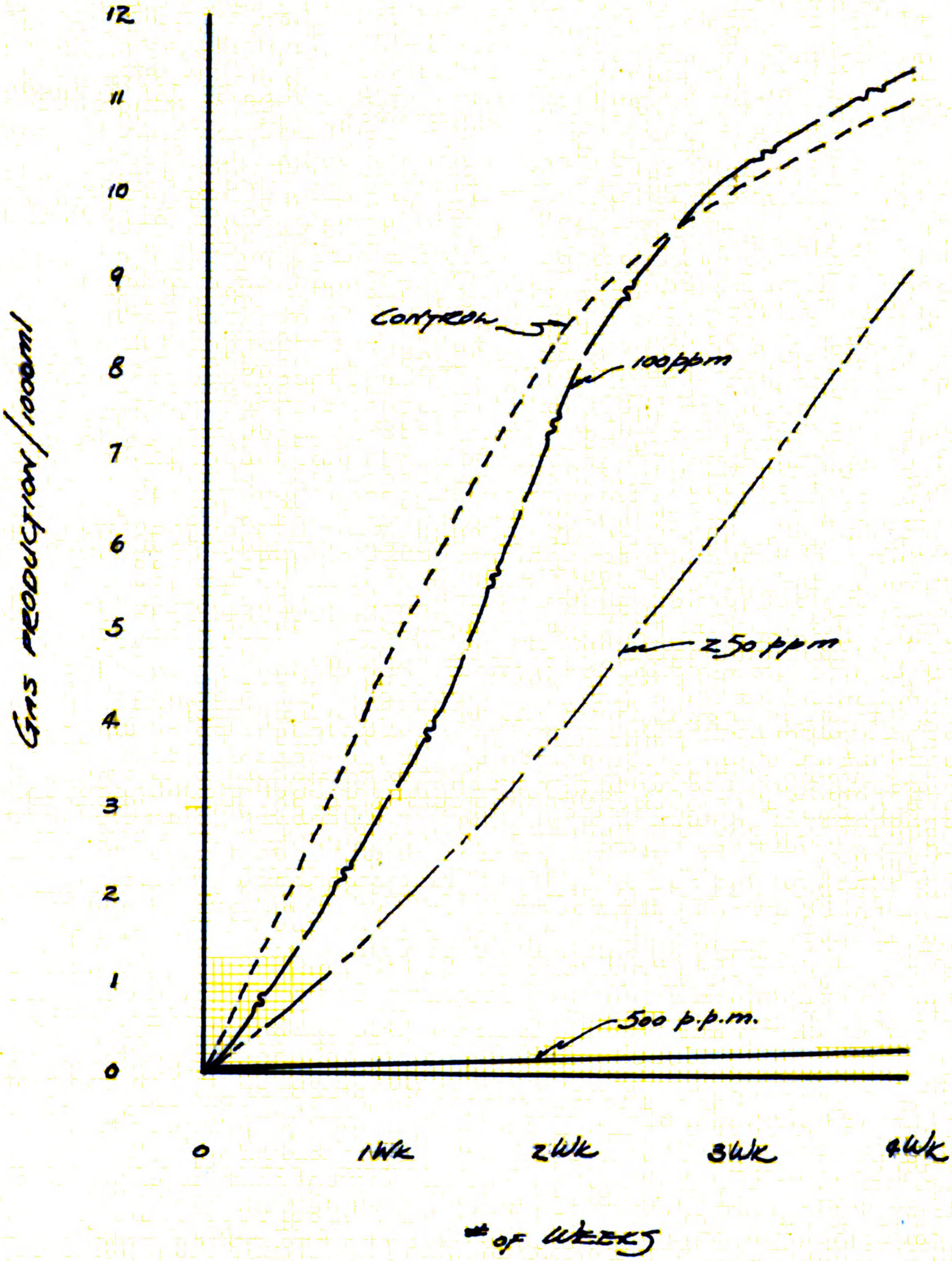


TRIAL II

H_2S PRODUCTION



PRODUCTION OF GAS
C_4H_4 & CO_2



DISCUSSION OF DATA

A fresh sample of East Lansing sewerage was found to contain about 3 ppm. of H_2S. In running sulfide tests on the day following collection a considerable reduction in the sulfide content was found. This reduction was due to the presence of combined sulfides. From that time on the control sulfide content was steadily increased, the enrichment being due to the reducing of inorganic sulfates. In a region where calcium and iron are present in greater quantities a change such as this will be even more marked.

A similar procedure was evident in the 10 ppm. sample, but in the other samples O-Clor-Benzene left the sulfides in a combined state. This was due to the sterilization of the samples by Cloroben. From this it is obvious that organisms appearing in the sewage are not resistant to dosages of O-Clor-Benzene greater than 20 ppm. This is not true of organisms present in sludge. It was found there that dosages up to 250 ppm. could be resisted. They do, however, fall victim to dosages of 500 ppm.

Cloroben does remove the typical odor of sewage in samples greater than 30 ppm. in the sewage and 300 ppm. in the sludge. In the place of sewage odor we have the penetrating odor of O-Clor-Benzene, and it is a question of tastes as to which of these two is the least desirable.

Another observation that can be made is that aproximately equal retardation in sulfide production is obtained in samples containing 20-50 ppm. of O-Clor-Benzene. The sulfides produced in those samples amounted to 1/2 to 1/4 of the amount obtained from the control which does indicate a fairly persistent retardation.

The digestion of the sludge which was inhibited at a dosage of 500 ppm. does not mean very much so far as sewage treatment is concerned. Before any significance can be attached to the results, it must be decided whether a stunted digestion is worth while. A prolonged storage of sludge may be desired before disposal. If such be the case, O-Clor-Benzene in a quantity great enough to produce 500 ppm. could be added.

GENERAL CONCLUSIONS

From Part I.

1. O-Clor-Benzene is effective in holding down the production of H S for a period of six to seven days in dosages greater than 10 ppm.

2. It was found that somewhere between the dosages of 10 ppm. and 20 ppm. was the line of demarcation where O-Clor-Benzene has a sterilizing effect on sewerage. A black sludgy percipitate was present in the 10 ppm. sample but absent in the 20 ppm. sample.

In the control, 10 ppm. and 20 ppm., only the clear liquer persisted while in 30 ppm., 40 ppm., 50 ppm., the colloidal material remained in suspension. This would indicate a growth of organisms able to remove any colloidal material present.

3. In the control, 10 ppm., 20 ppm., and 30 ppm. samples, there was present the sewerage odor in varying degrees. It was very strong in control and dwindled down to merely a trace at 30 ppm.

From Part II.

1. It was found the O-Clor-Benzene present in amounts greater than 250 ppm. prevented the digestion of sewage for a period of four weeks.

The sample containing 250 ppm. was held back considerably for four weeks, but at the end of that time it was throwing off the effect of O-Clor-Benzene at a fairly rapid rate. One hundred ppm. is retarded only in a small degree throwing off all effects in seventeen days. Five hundred ppm. may be termed an outer limit, inhibiting any digestion what-so-ever.

The differences in the amounts of gas collected in the control and 100 ppm. sample may be contributed to an experimental error. An error was made in setting up the control the first day which would compensate for any marked difference.

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