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A STUDY IN THE BIOLOGICAL TREATMENT OF THE DOMESTIC AND LOCAL INDUSTRIAL SEWAGES

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SUMMARY

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Total sewage of the middle-sized town in our country having different local industries of various complexity may contain a large scale of harmful materials for the environmnt and aquatic life.

Waste waters derived out from such a town is treated bfore theu take their ways to the streams and rivers. High percentage of organic wastes was removed from the total town waste waters by the microbial activity of activated sludge.

Organisms of activated sludge were adapted in such a way to help in these waste removals. Some selected bacterial species were organized for this purpose.

The time and the dilution factors were counted for, to give the best results.

The method of chemical oxygeen demand COD was used as a measurement for the degree of purification. It is possible to get even better results by the treatment of the final outflow and more adaptation of the bacterial microflora of activated sludge.

INTRODUCTION

The applied method in this research for the treatment of waste waters of the town is the activated sludge method. Since it is necessary to follow any process for the protection of the environment it was suggested to try the microbial effect of the activated sludge on the removal of the various wastes from the town sewage. Some workers demonstrated the efficiency of this method for the treatment of medium to large sized wastes (1) and for the removal of chemical oxygen demand (2). Some chemical radicals like chloride causes poor flooculation of organisms of activated sludge when present in the waste water in concentrations above their normal averages (1). This led to remarkable reduction in chemical oxygen demand.

The essential biological conditions must be available for the activated sludge processes (3).

Time and the weak concentration of the waste waters are important requirement factors to let the sludge to give better results (4).

The activated sludge process is an aerobic operation requiring an oxygen residual of at least 0.5 mg/1. (5). Oxygen is the primary limiting factor, its demand is a direct function of the biological phenomena. The removal of any substrate by the organisms of activated sludge is commonly measured as the decrease in chemical oxygen demand (COD) of the waste water. COD test is a non-specific test which can be used for wastes of either known or unknown compositions (6).

The microorganisms which have an important role in the process of activated sludge are floc-forming saprophytes (7), predatores and some undesirable organisms (8).

The materials which have to be removed from the waste water undergo biodegradation. This mechanism is performed

by the microflora of the activated sludge. The rate of biodegradation is affected by the physiological condition of the sludge (10).

The aim of this work is to direct the sanitary and environmental authorities to a simpler and less costing method in the field of sewage treatment.

MATERIALS AND METHODS

The activated sludge was formed in the laboratory by following a double series of sludge production and mixing the two collections at the ratio of 50 to 50 by volume.

One litre of the total waste water of the town of Sulaimanyah was aerated for three days. the resulted light suspension was then centrifuged, decanted and collected. One ml. of the last suspension was spread on each of twenty plates with a basal experimental medium according to standard method (1972).

Plates were incubated at room temperature for two days. The growing colonies were isolated on slants of the same medium. All the grown colonies were inoculated into one 1 litre of a medium modified by us with ingredients:

KH_2PO_4	3 g
K_2HPO_4	7 g
$(NH_4)_2SO_4$	1 g
CH_3COONA	4 g
$Mg\ SO_4$	0.1 g
Tap water	1000 ml.

Organisms were sufficiently aerated in the medium for three days. After the formation of bacterial flocs, the suspension was centrifuged and flocs were collected and transferred to the sludge apparatus.

A second series of sluddge producing works was made by inoculating of pure cultures of the bacterial groups Pseudomonas, Achromobacter, Alcalligenes, Enterobacter and Protus into the bacterial floc producing medium no.1. Aeration continued for three days. Flocs were then collected and transferred to a sludge apparatus and fed with waste water of the total city normal sewage.

Two ml. of the colloidal precipetate of $Fe(OH)_3$ and five ml. of that of $Al(OH)_3$ were added.

The development of the final sludge was controlled by the addition of the first sludge to the second sludge at a constant daily rate and equal portions for six days. At the end of the 10th day, the adapted sludge was collected, washed and standed-by for work. The sludge was divided into two equal parts, one for the proveeding of the experiments and the other for control.

Technical steps were followed as described in the Standard Method (1972).

Microscopic preparations, relative numbers of the free cells, settability activated sludge at periods of 10.30 and 60 minutes, were all examined.

Chemical oxygen demand (COD) was measured according to standard method (1972).

EXPERIMENTAL WORKS

Three series of experiments were derived on total town waste water in three main parts as described by Gaudy (6).

Part 1. (Deals with thw synthetic sewage)
Part II (Deals with the diluted sewage)
Part III (Deals with the feeding processes).

COD valus of the crude sewage, and its dilutions, synthetic sewage, treated sewage and the effluent were determined at starting point (To. = time zero), 3rd day T3. and 6th day T6. and the data for the treated sewages were compared with those of the crude sewage and the controls.

RESULTS

Macro and microscopic examination of the activated sludge showed that it had a light reddish-yellow color and regular flocs with some little air gaps at the beginning (To). Some protozoa were observed.

After the addition of the substrate and at the third day T3 and sixth day T6, the color of the sludge became darker, the homogenous flocs were destroyed and the architecture of the cell masses was changed. More air intervals appeared, and the number of the protozoa was reduced.

The flock forming organisms were slender short rods. Some cells were curved. Cell aggregations were settlable after standing for several hours. Some free swimming cells remained suspended and unsettled in the clear supernatant.

In case of the sewage modification to adapt the activated sludge the increased amount of the added raw materials generally resulted in decreased settability of the sludge. That means under the action of increased con-centrations of total substrates in the waste water, the activated sludge needs more time to give good purification results.

Table (1) represents the ability of adapted activated sludge operating on a modified sewage to which different amounts of raw chemicals were added. Whereas Fig (1) represents the settlability of sludge acting on four different forms of waste water and a control at six day of the experiment.

Viabler counts were ranging from 70-120 x 10^{5} (Table II). This range was obtained when repeatedly inocula-tions were made on standard medium. There were no statistically sifnificant differences between the viable counts of the diluted supernatant of the control and that of the experimental sludge.

The dry mass of a sludge used as control and on operating sludge was between 48 mg and 67 mg. (Table IV).

Dilution of the sewage had a decreasing effect on the dry mass valuesd of the activated sludge. Feeding the system with fresh sewage made the dry mass values more stable.

Table 1. Settability of adapted activated sludge at starting point, one day T-1 and two days T-2 of the experiment at time periods 10.30 and t0 min.

Control adapted sludge	Imhoff Funnel Graduation			
	The days of experiments			
	Minutes	T-0	T-1	T-2
Control	10 30 60	100 85 66	100 84 64	100 84 62
0.1 g/l centrifuge concentrated raw sewage	10 30 60	88 80 66	87 71 50	84 62 31
0.3 g/l centrifuge concentrated raw sewage	10 30 60	100 84 67	91 75 63	90 75 60
0.5 g/l centrifuge concentrated raw sewage	10 30 60	100 91 70	94 77 79	94 79 83

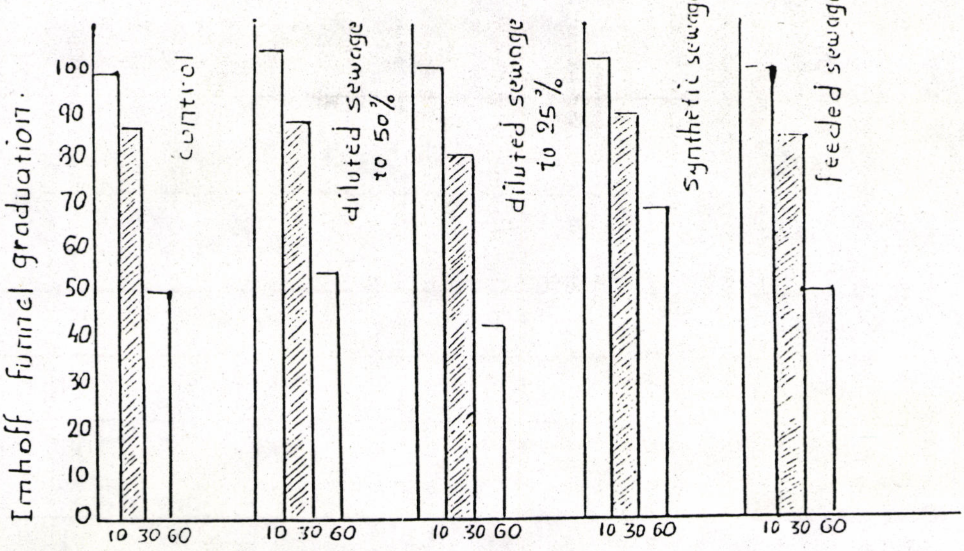

Fig. 1. Settability of activated sludge acting on a sewage under 4 different conditions and a control, measured after 6 days of starting the experiment.

Table 2. Viable count for activated sludge by which a control sewage was treated as well as foud different forms of the sewage.

Control and modified sewages	Viable count multiplied by 10^5		
	Starting time T-0	3rd day T-3	6th day T-6
Control	112	115	110
Synthetic sewage	109	101	90
Diluted sewage to 50%	105	103	105
Diluted sewage to 25%	111	91	73
Feeded sewage	101	88	89

Table 3. COD values of crudge sewage as such, Treated by activated sludge without feeding by fresh sewage, diluted and treated with feeding at starting point T0, after 3 days T3 and after 6 days T6.

Control and modified sewage	Chemical Oxygen Demand COD in mg O_2/1			COD reduced to
	Starting T-0	third T-1	sixth T-2	
Control I Crude sewage as such	1920	1880	1850	-
Control II Treated sewage without feed	1900	1000	640	33%
Synthetic sewage	1960	1000	520	26.5%
Sewage diluted to 50%	1000	840	680	68%
Sewage diluted to 25%	620	500	480	77.4%
Treated and feeded sewage	1920	1180	540	27%

Table 4. Dry mass calculated per one ml of the control activated sludge and an activated sludge acting on four different forms of waste water, at starting point, third and sixth day.

Control and Modified sewages	Dry mass per one ml. of the activated sludge		
	T-0	T-3	T-6
Control	64	67	67
Synthetic sewage	65	63	62
Diluted sewage to 50%	61	60	53
Diluted sewage to 25%	65	58	48
Treated and Feeded sewage	63	64	64

Total nitrogen content of the activated sludges was between 300 and 420 mg per litre.

COD values gave a clear picture about the purification property of the waste water by a combined adapted activated sludge.

In case of synthetic sewage the rate of organic substance removal was the highest. Suitable dilution of the sewage encouraged the microflora of the activated sludge to act in a good manner. Further dilution disturbs the balance of the sludge function and makes it less effective.

Table (III) represents the COD values of crude sewage as such, treated by activated sludge, diluted and treated with feeding at T-0, T-3 and T-6.

DISCUSSION

When the treated waste water is from an unknown origin, the presence of heavy metal ions may be expected. The adaptation of the bacteria to treat poisonous ions like Hg^{+2} is possible by their preexposure to these ions (11). The COD value of the total city sewage was high enough to support the growth of sludge organisms, which means high enough content of the organic materials.

Direct viable counting of metal-resistant bacteria 9DVCMR) has been found to be luseful in both enumerating and diferentiating bacteria and the test of their metabolic actdivity (12, 13). Experiments were carried out at room temperature regardless the divergency of heat degree which causes no significant effect between 30 C. and 55 C generally (14). The addition of 2-5 ml. of iron and alominum hydroxides to the inoculated waste water accelerated the production of the sludge.

In known household wastes there are various substances, which, when disposed improperly, are hazardous to the public health (15). The mixed activated sludge-liquor certainly contains diverse bacterial groups in the identification of which we are interested here, like Dimethyl Disulfide-Forming bacteria (16), and coliform bacteria in relation to the media for their recovery (17).

At the end of sixty days the biological nature and the microbial structure of the sludge were changed, the homogenous architecture of the flocs was crushed due to the chemical effect of the organic substances.

The degree of purification of the sewage was changing according to the nature of the pollution and the degradability of the substance.

When COD removal is high, bacteriological analysis showed that the relative proportions of the bacteria able to use the organics of the sewage as the carbon source was high also.

When the purification degree was low, the relative number of those bacteria was lowa too, which proves that the adaptation processes of microorganisms in aquatic microbial communities play a role in certain substrate removal and in the efficiency of biodegradation (18).

COD values and the the total organic content of the control sample without sludge were not changed very much. The slight depression in COD within six days was the result of some microbial polution from the environment.

COD values of the control sample were reduced to about 33% according to the biological action of the modified sludge although in the limited volume.

The total wastes treated in this work were regarded to be form unknown origin.

COD value of the synthetic sewage mixed with the combined sludge was dropped to about 26.5% of the original value dring six days due to the fact that sludge microflora was properly adapted by the same materials which form the total substrate components of the synthetic sewage.

In diluted to 50% sludge, COD value was depressed by the sludge to about 68%; this is due to the dilution especially when the time factor is not accounted for.

COD of the sewage diluted to 25% was less activly removed, the value depressed to 77.4% which can be explained by the fact that the nutritional requirement of the sludge was not fully supported by diluted sewage.

COD value of the ordinary sewage exposed to the action of the combined modified activated sludge fed with fresh sewage at a constant rate of 2.5 litre per day, was depressed during six days to about 27%. This was due to the well valanced system and functional correlation of the sewageactivated sludge combination.

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دراسة عن المعالجة البايولوجية لمياه مجاري المدن المختلطة

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الخلاصــــة

قد تحتوي مياه المجاري لمدينة متوسطة الحجم من مدن بلادنا على العديد من المواد الضاره بالبيئة وبالحياة المائية فيفضل التقدم الهائل الذي يكتنفنا من كل جانب تحوي مدننا صناعات ومعامل لقوائم من السلع والمواد وبدرجات متباينة من التعقيم التكنولوجي. يضاف الى هذه المياه الخارجة من المناطق السكنية والحاوية بدورها على العديد من العناصر والمركبات الضارة. ينبغي تخليص مياه المجاري من هذه المواد الضاره ومعالجتها قبل ان تجد طريقها الى الجداول وبالتالي الى انهارنا.

يمكن تسخير الكائنات المجهرية في التفكك البايولوجي لتلك المواد وتخليص مياه الفضلات منها بدرجة كبيرة من خلال طريقة تعريضها لفعل الرواسب البكتيرية المنشطة. أمكن ازالة نسبة مئوية عالية من المواد الضاره ومنها السموم والتي ترجع الى اصول غير معروفة من مياه مجاري المدن بفعل النشاط الجرثومي لكائنات الرواسب المنشطة.

لقد امكن تطوير كائنات الرواتب المجهرية هذه بطريقة كانت معها قادرة على ازالة المواد الضارة بدرجات عالية. لقد نظمت اجناس منتقاة من البكتريا لهذا الغرض.

أخذت عوامل الوقت والتخفيف بالحسبان للحصول على نتائج افضل أعتمد على قياس الحاجة الكيميائية للاوكسجين للوقف على درجة تنقية تلك المياه من فضلاتها السامة من قبل كائنات الرواسب المنشطة البكتيرية. من الممكن الحصول على نتائج ربما أفضل بأعادة تعريض المياه المعالجة لفعل كائنات الرواسب النشطة وبأجراء التعويد البايولوجي لهذه الجراثيم لتعمل على معالجة المواد الضاره وتطويل فترات التعرض لها.