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Biological treatment of wastewater for irrigation

Ali M.A .Morsi[1] and Miloud A. Daloub[2]
(1&2) Chemistry Department, Faculty of education, Al-Gabel AlGharbi Univ., Libya
1-profmorsi@yahoo.co.uk
2- mdaloub@yahoo.com

ABSTRACT

Wide variety of microorganisms may occur in wastewater which cause many diseases for human and animals. Wastewater is one of the main factors that effect on the environmental population. Biochemical treatment of wastewater becomes one of the important resources for irrigation.

In determining the optimum solutions for the advanced treatment of wastewater for irrigation, the recent technology for water applies its comprehensive know-how of biochemical processes. In the present study the wastewater was mixed with Liquid life micro organism (LLMO), to minimize sludge processing costs as well as decreasing the level of BOD, TSS, TDS, Oil and Fats in the treated wastewater. The results indicated that LLMO product systems have been successfully used to decrease sludge production, reduces the mass of solids generated per pound of BOD removed. The quality of the treated wastewater was improved and became suitable for irrigation of non edible crops. On the other hand, reduced sludge blanket means more retention time, better effluent, and reduced potential odors.

Key words: Biological treatment, wastewater, Long life microorganism (LLMO), Mixed Liquor Suspended Solids (MLSS).

INTRODUCTION

The basic premise behind sludge production is that the greater the rate at which colloidal and particulate material are solublized; converted to low molecular weight compounds, the lower waste sludge will be.

Hence Bacteria are surrounded by a cell wall that restricts the passage of macromolecules. When bacteria consume and degrade substrate, about 0.3 grams of new cells are formed for every gram substrate consumed [(5)]This is how sludge is digested aerobically. It is converted to C02 and water, plus new bacteria cells [(6)]. This reduction of solid mass can only happen when the sludge actually gets inside the bacteria. If the sludge does not get inside the bacteria, it gets trapped in the flock and gets removed by settling along with the rest of the flock. It then builds up as sludge in a lagoon, or gets wasted in activated sludge. Many bacteria are capable of producing enzymes that solubilize colloids and particulates and convert them into low molecular weight compounds that bacteria can consume [(7)]. The enzymes are broadly referred to as extracellular enzymes. However, even though many different bacteria can make enzymes, they do not make these enzymes at a high rate in real systems.

Bacteria are capable of a wide variety of functions and under different conditions may be growing and reproducing, conserving nutrients, or dying off from starvation. Bacteria will perform those functions that help them grow and reproduce at a rapid rate. In natural competition for food, bacteria that can grow faster will survive; slow growers will be crowded out. When bacteria make exoenzymes, they grow and reproduce more slowly. If there is plenty of soluble food available, the bacteria do not generally make these exoenzymes.

However, some bacteria make extracellular enzymes regardless of the amount of soluble food available, and some of these bacteria will exist in a typical wastewater treatment plant (WWTP). These bacteria reproduce slowly and remain in very low population levels. On the other hand, when bacteria are making exoenzymes, they are diverting pools of energy and material into exoenzyme production rather than into bacterial growth and reproduction[(8,9,10)].

Long life microorganism (LLMO) products are recirculated in a loop where their travel from aeration tank to the clarifier, with the return activated sludge (RAS), and back to the head of the aeration tank. That means that they circulate between environments of alternatively high and low soluble BOD [(11,12,13)]_

The aim of this work is to apply LLMO for the treatment of the wastewater. Also, to investigate the required environmental conditions, the ideal starter nutrients and the right temperature, aeration, reaction time which are needed to force the bacteria to produce the enzymes needed for reducing sludge and making bacteria which are indigenous to the wastewater treatment plant do their job more easily and completely.

MATERIALS AND METHODS

Materials:

The material consist from the following :

a) Chemical composition; NH_4Cl, K_2HP0_4, $MgS0_4$ and Sodium acetate
b) Bacterial Composition (LLMO); *Bacillus subtillis, Bacillus amyloliquefaciens, Bacillus lichenformis, Celluomonas sp., Cellulomonas biazatea, Pseudomonas stutzeri, Pseudomonas denitrificans* and *Rhodopseudomonas palustris*.
c) Wastewater; Collected from the influent of the wastewater station
d) Sterilized bottles.

Mixture of bacterial species is considered to provide optimum treatment efficiency. Automatic Bacterial Injection (ABI) delivery system was used. Ratio of the materials vary to properly formulate according to the application. Weather and nature of contamination; toxic waste, industrial wastewater, grease and fat solubilization, saline solutions ... etc.

The addition of LLMO product to the treatment system and the retention time; average hydraulic retention, can be calculated by dividing the volume of the aeration tanks in service by the average daily flow, which calculated from the following equation:

LLMO/month =(BOD load factor) x (time factor) x (flow factor/ 0.172)

Where,

BOD load factor and time factor can be determined from Tables (1&2)

Flow factor is the average daily flow of the plant in million gallon per day (MGD).

Table (I)

Influent BOD (PPM)	Less than 175	175 to 350	350 to 1000	1000 to 2500	more than 2500
BOD load factor	I	2	3	4	5

Table {2)

Detention time (hrs)	Less than 6	6 to 12	12 to 20	20 to 36	More than 36
Time factor	1.333	1.16	1.00	0.85	0.70

However, for the best results, LLMO should be used with an automatic bacterial injection (ABI) delivery system (Fig 1).The automatic bacterial injection (ABI) system consists of a continuous reactor for on-site growth of LLMO bacteria. The reactor contains a continuous duty aerator with a fine bubble diffuser and a water heater to retain an optimum temperature for bacterial growth. The activated bacteria are discharged to the wastewater via gravity discharge (Fig. 1).

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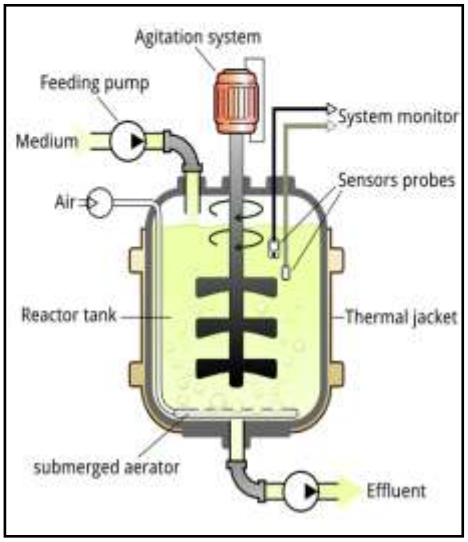

Fig. 1. Automatic bacterial injection (ABI) delivery system

Analysis

The work was carried out according to the purcellsinch plant have design criteria; Table (3) and to follow the progress of the trial will be monitored by analysis the following parameters:

1- Dissolved oxygen levels; analysis was carried out daily
2- Mixed liquor suspended solids; analysis was carried out daily
3- Microscopic sludge quality examination; analysis was carried out weekly
4- Sludge settle ability

Table 3. Purcellsinch plant criteria

Parameter	Design capacity
Inlet flow	2932m^3/hr
Biochemical daily load	6.459 Kg BOD/day
Required BOD	effluent 20mg/l
Required suspended solids	30 mg/l
pH of plant	6-10
pH in Effluent	6.5-8.5
dissolved oxygen required for	0.5-2.0 mg/100

RESULTS AND DISCUSSION

This work was carried out by using LLMO for wastewater treatment to reduce the activated sludge. LLMO liquid has the ability to produce large quantities of various extracellular enzymes. These enzymes allow the bacteria to convert particulate and colloidal matter into low molecular weight compounds which can easily absorbed by the bacteria. The conversion of these products by the bacteria to carbon dioxide and water is the basis for sludge reduction [15].

The activated sludge consists of particulate, colloidal and soluble organic matter. The soluble substrate is removed by bacterial action, while colloidal and particulate matter cannot be consumed by the micro-organism. The morphology of the bacterial membrane, which is semi permeable, allows the passage of soluble organic molecules into the cell as a food source. Bacteria break down this organic matter into carbon dioxide and water which reduces the amount of excess sludge produced.

A specific oxygen uptake rate test was carried out to see how efficient the bacterial flocks were at taking up the oxygen made available to them, the results obtained were given in Table (4).

Table 4. Oxygen uptake by bacterial flocks.

Time elapsed (min)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DO (rng/l)	4.0	2.74	2.48	2.21	1.98	1.77	1.74	1.44	1.20	1.01	0.84	0.69	0.57	0.47	0.36	0.28

Oxygen uptake rate= 11.84 mg/I/hr
Specific oxygen uptake rate= 2.36 mg/h/g

A series of samples were examined and the data were obtained in Figures (2-9).

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Fig. 1. LLMO result After 15 days

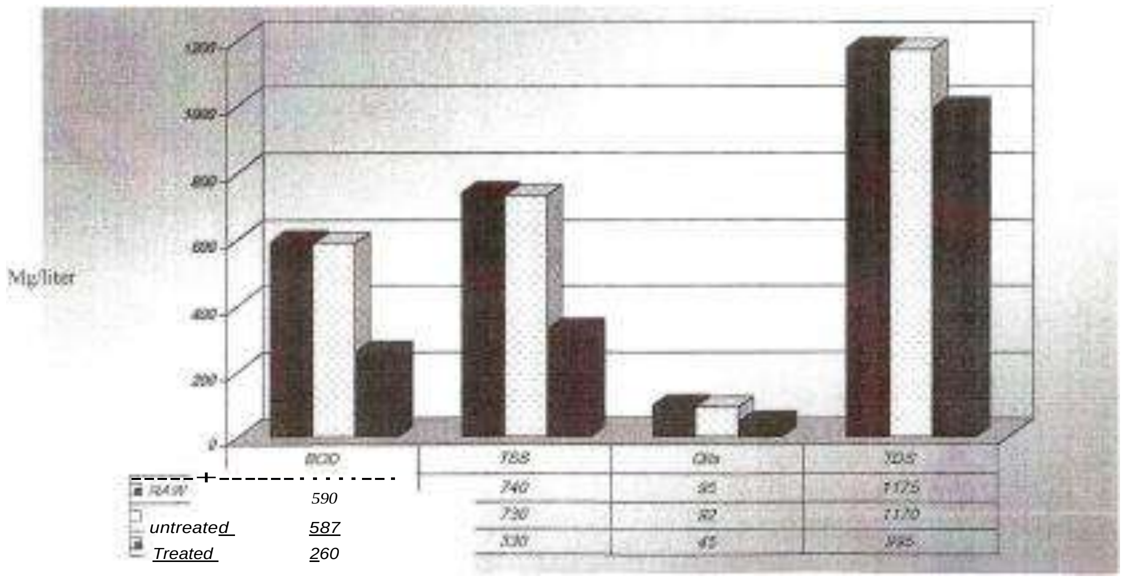

Fig. 2. LLMO improvement After 30 days

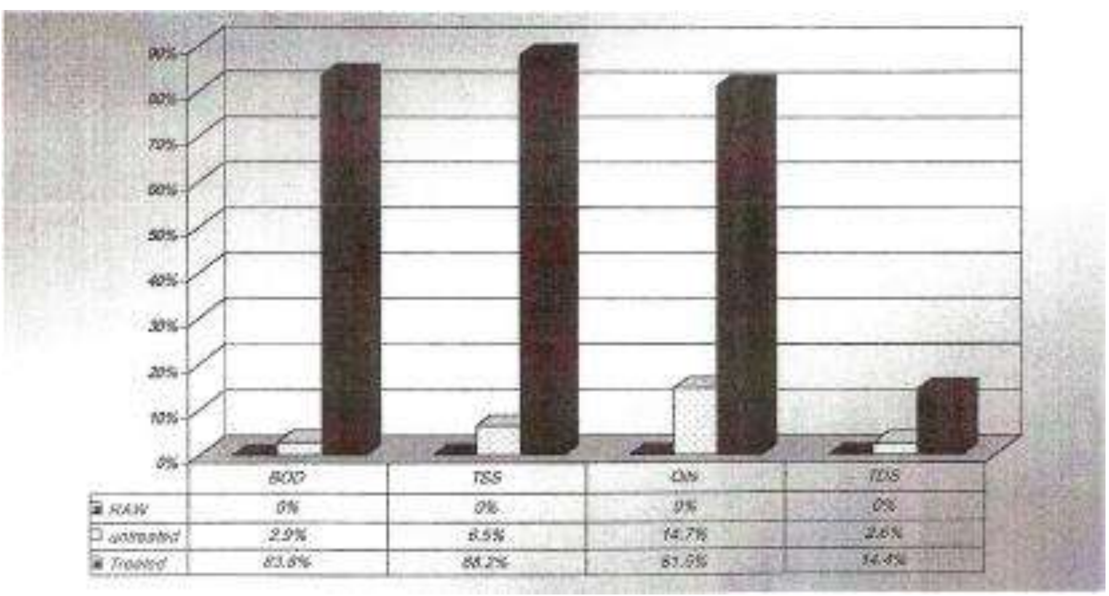

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Fig. 3. LLMO result on TDS (Mg/Liter)

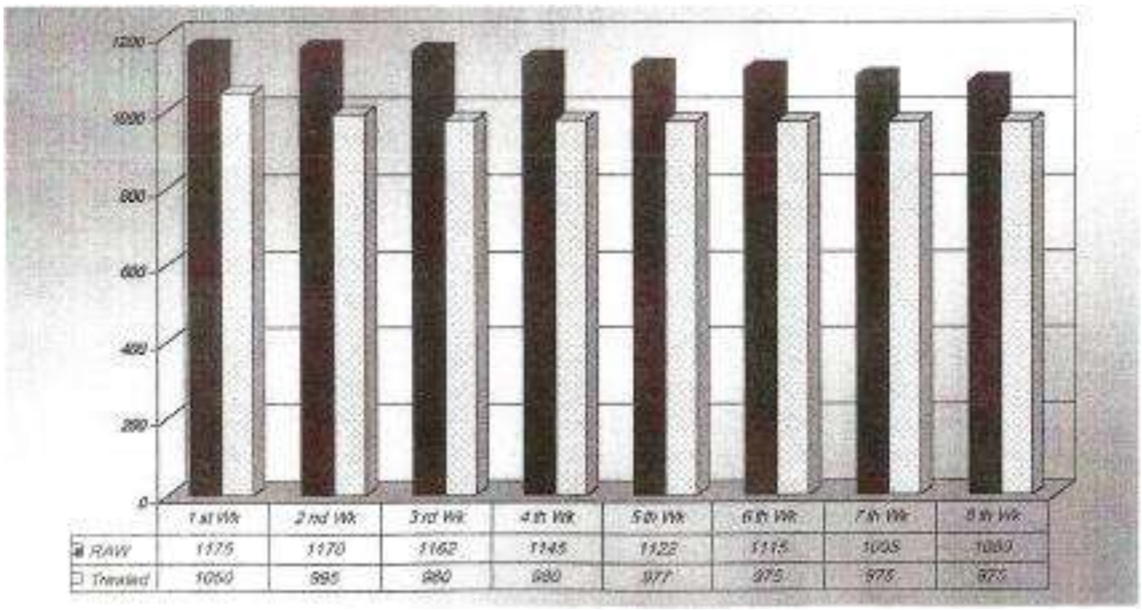

Fig. 4. LLMO result on BOD (mg/liter)

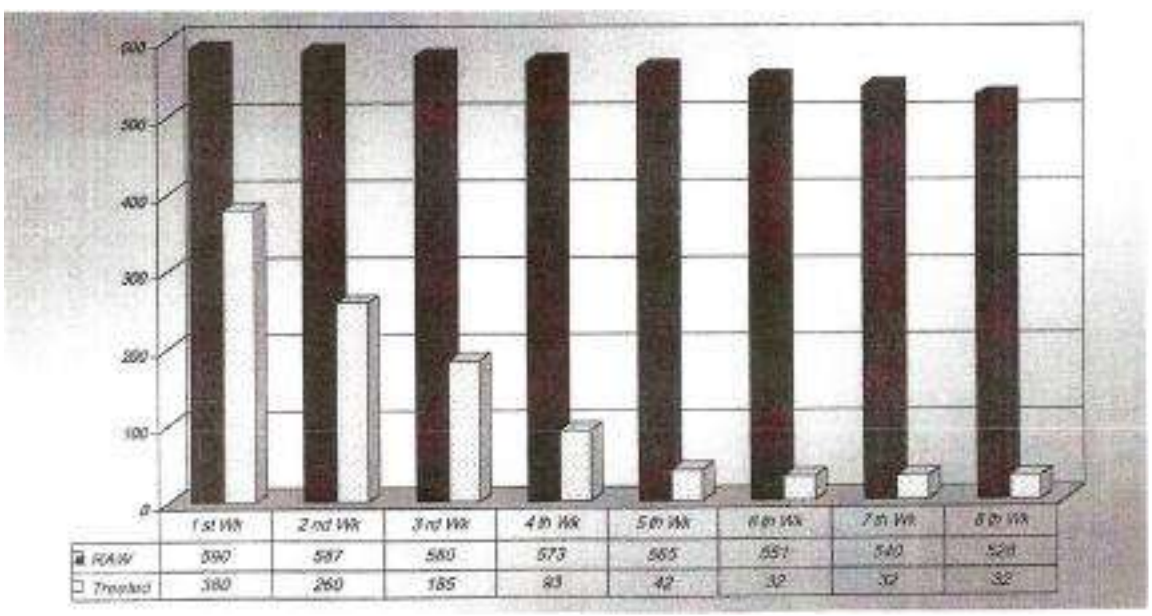

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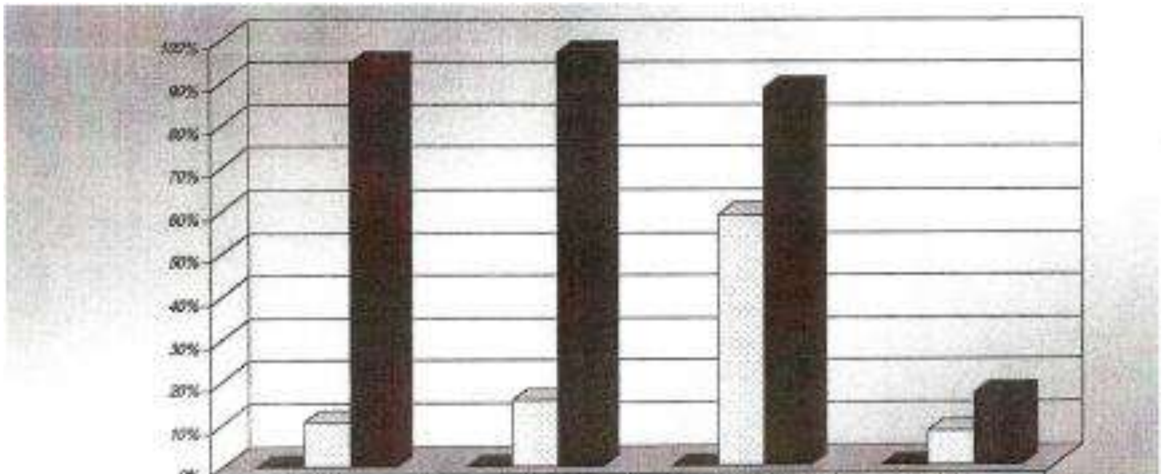
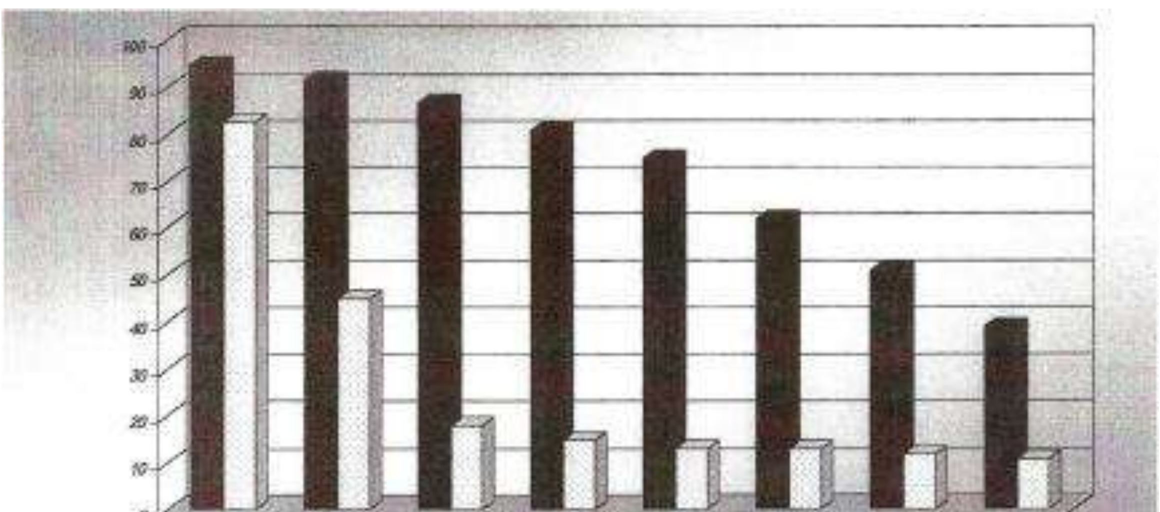
Fig. 6. LLMO improvement After 8 weeks



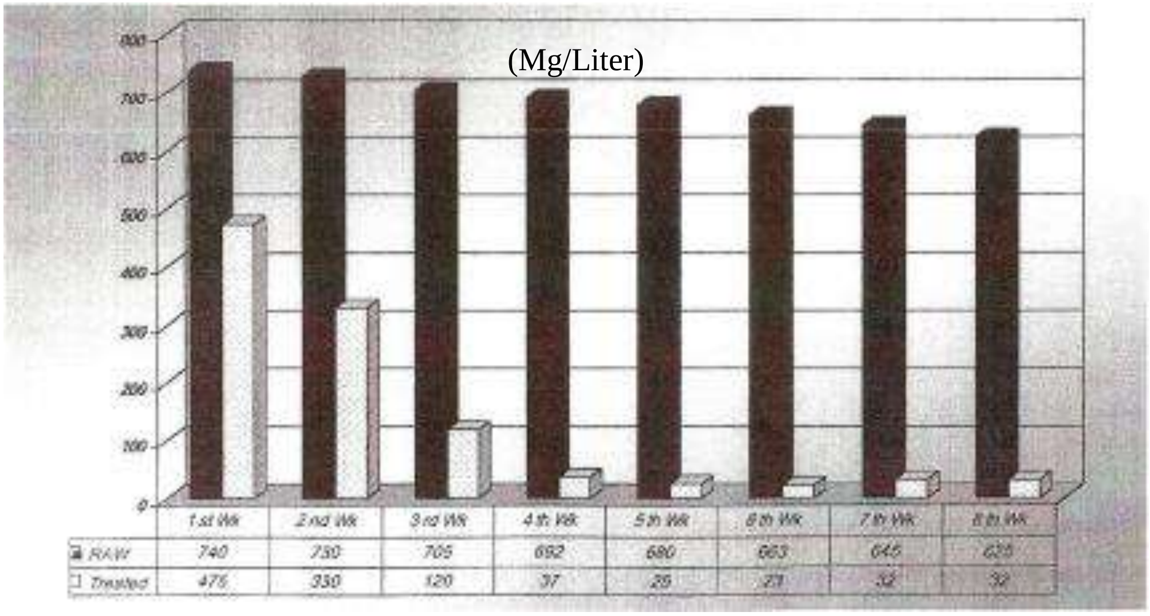
	BOD	TSS	Oils	TDS
Raw	0%	0%	0%	0%
Untreated %	10.50%	15.90%	58.90%	8.10%
TrtN1fed %	94.60%	96.90%	88.40%	17.00%

Fig. 7. LLMO result on Oil & Fat (Mg/Liter)



	1 st Wk	2 nd Wk	3 rd Wk	4 th Wk	5 th Wk	6 th Wk	7 th Wk	8 th Wk
RAW	95	92	87	81	75	62	51	39
Treated	83	45	18	15	13	13	12	11

Fig. 8. LLMO result on TSS



The results indicated that LLMO reduced sludge successfully for the first eight weeks of the trial. Dissolved oxygen levels were much improved on both occasions giving rise to a good quality activated sludge and better microbe populations . During each trial the mixed liquor suspended solids (MLSS) values in each basin were extremely stable and observed to be decreased significantly. This characteristic of the product would be immensely important to any plant wishing to quickly reduce an overloaded aeration basin or oxidation ditch.

Another advantage noted while using LLMO was the ability of the sludge to recover from breakdowns or shock loads. On many instances during the trial the sludge dewatering machine at the plant broke down leading to a build up of sludge in the system. It was noted that the sludge levels stabilized rapidly once the plant was fully operational again.

Overall, the data obtained can be seen as a success which regards to the following:

- The mixed liquor suspended solids were reduced by as much as 18 to 20%.
- The dissolved oxygen levels showed definite signs of improvement.

As a result the activated sludge microbial population improved leading to the production of better quality final effluent and filtered sludge. Ability of sludge to recover after a shock load event or after a breakdown at the plant was seen to be quality improved during the investigation.

Even the operated and designed wastewater treatments plants have problems and limitations. These challenges range from operational inconveniences, such as excessive grease build up in sewer lines, to more significant problems as inability to meat discharge permit requirements. However, LLMO offers solutions to common wastewater treatment problems where it :

1- improves nitrification; reduced nitrification process start up time and improves overall nitrification efficiency.
2- improves effluent BOD and SS; typical uses are rapid start up of new treatment facilities, quicker recovery from shack loads and improves removal performance on overloaded or undersized plants.
3- lower sludge production, waste activated sludge reduced up to 60% compared to a plant's historical sludge production rate.
4- reduces grease build up; biologically degrades grease and fat without causing problem in treatment plant.

LLMO is a breakthrough product for odor control, it prevents formation of sulfide odors, breakdown other odorous compounds and digest organic solids without resorting to harsh or toxic chemicals, hence LLMO bacteria attack organic solids and keep slurry more pump able which saves hours of maintenance work. On the other hand LLMO is a liquid suspension of non-toxic, non-pathogenic, naturally occurring bacteria with superior odor control capabilities and not genetically engineering in any way.

Finally, the results showed that the quality of the treated wastewater was improved and can be suitable for irrigation of non edible crops.

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