SEWAGE TREATMENT OPERATORS MANUAL

FOR THE CARIBBEAN REGION

DECEMBER 1998

TABLE OF CONTENTS

1.0 GENERAL INTRODUCTION

Sewage has been identified as one of the most significant pollutants affecting the environment of the Wider Caribbean Region. Studies carried out by PAHO/CEHI indicated that only 10 % of the sewage generated in the Central American and Caribbean island countries is properly treated. 66% of the plants surveyed were poorly maintained and only 59 % were regularly monitored. Of further significance was the condition of package plants, 75% of which do not meet the standards largely because of inefficient and inappropriate operation.

Training in the operation and maintenance of sewage treatment plants has therefore been identified as one area of need in the thrust to strengthen management of the sewerage sector in the region.

1.1 OBJECTIVE OF THE MANUAL

- To give an overview of wastewater characteristics and treatment technologies

- To provide information about aerobic biological treatment.

- To provide guidelines on operational requirements and monitoring programs for:

    a. Activated Sludge Process,
    b. Rotating Biological Contact
    c. Stabilization Ponds.

- To provide trouble shooting methods for common problems.

.

2.0 INTRODUCTION TO WASTEWATER TREATMENT

2.1 WHAT IS WASTEWATER?

Wastewater is classified according to the source, namely:

- Storm Water
- Domestic Wastewater (sewage)
- Industrial Wastewater

Storm water

Storm water is the runoff which occurs after a heavy shower of rain. It often runs across paved surfaces and roadways and may enter sewers through manholes which are a part of the road drainage. Storm water is also carried off in gullies. Where storm water enters sewers leading to treatment plants it can affect the load of the plant in terms of volume and quality.

Domestic Wastewater

Domestic wastewater includes wastewater generated from household activity and therefore involves laundry, kitchen, bathroom and toilets. All forms of waterborne pathogens can be found in domestic wastewater, and these represent a substantial health hazard. A pathogen is an organism which can cause disease. Domestic wastewater is mainly biodegradable in that it does not leave any harmful residues in the environment. However, the discharge of this waste into the environment in many locations exceeds the natural regeneration and dispersal capacity of the receiving area, thus creating harmful buildup of pathogens and unpleasant odours and aesthetics.

" A pathogen is an organism which can cause disease."

Industrial Wastewater

Industrial wastewater includes discharges from industrial establishments. This effluent may be toxic and may contain any or a combination of heavy metals, various toxic substances, oil and fat, suspended solids, etc., the colour is varied colour and it may have degrees of turbid.

In many countries, toxic industrial effluent is discharged into the nearest water body and often without adequate treatment.

2.2 WHAT DOES THE WASTEWATER CONTAIN?

The characteristics of wastewater or effluent will vary according to the nature and intensity of the relevant activity. The substances which may occur include:

- Substances causing oxygen consumption
- Organic substances such as decomposing matter
- Nitrogen containing substances such as ammonia,
- Sulphur compounds
- Substances causing eutrophication such as nitrates and phosphates
- Hazardous substances which are biodegradable including ammonia (NH_3) nitrous oxide (NO_2), etc.
- Hazardous Substances which are NOT biodegradable such as heavy metals, xenobiotics, etc.
- Substances which lead to direct toxic effects such as heavy metals (lead, mercury) etc and certain chemical componds (eg. cyanide, pesticides)

2.3 HOW DO WE SELECT TREATMENT TECHNOLOGIES ?

“ A sewage treatment plant is designed to protect health.”

TO THE OPERATOR

A sewage treatment plant is a technical installation designed to remove pollutants from wastewater and so protect the health of the environment into which the wastewater is being discharged.

There are many types of technology which can be applied to sewage treatment and therefore the type of treatment plant selected is dependent on a number of factors.

“ A sewage treatment plant is a technical installation.”

The basic principle underlying the selection of treatment technologies is that discharge at any location must be carried out in such a manner, and with such quality that:

- it does not constitute a hazard to the health of the community,
- it does not create conditions which are unsightly thus destroying aesthetics
- it does not give rise to offensive odours
- the ecology of the area is protected. (plant and animal life)

2.4 MINIMUM INFORMATION

Information

The minimum information required for selecting the technology appropriate to the

What type of waste water is generated?

Why it is generated?

Is it hazardous?

Can the volume of wastewater be reduced?

What are the characteristics of wastewater?

circumstance includes:

Standards

2.5 WHAT STANDARDS MUST THE EFFLUENT MEET ?

The effluent produced for discharge should seek to meet environmental standards as follows:

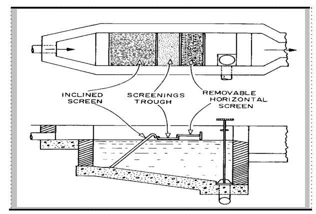
- local - standards of the regulatory agency.
- International - standards set by international bodies.
- ISO 14000 standards - certification standards.

2.6 PLANT LOCATION AND SOURCE OF WASTEWATER IS IMPORTANT

Location

The Environmental Setting within which the treatment is required must be considered viz:

- Are you in a city/ town or rural area?
- Are you near the coast or near the river?
- Are ground water levels (water table) high? Is the overlying soil/rock permeable?
- Can the receiving water bodies (river/lake/sea) assimilate the incoming treated discharge?
- Will the discharge of wastewater add to other problems?



2.7 WHAT ARE THE TREATMENT PROCESSES?

Treatment is classified according to the process and the quality of effluent which is expected to be produced.

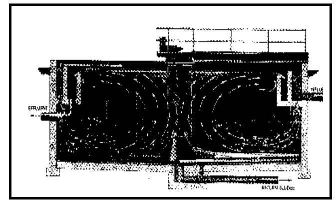
When wastewater enters a treatment plant in a range of material needs to be removed before treatment can begin.

A. Pre treatment

These treatments seek to remove coarse materials. Leaves, benches, garbage, string, rags are among the larger objects which need to be removed so as not to cause damage to the pumping equipment in the plant. Screening, grit removal, Shredding are the common methods used and devices involved include:

Rack and Screen: Generally involves parallel bars placed at an angle so as to allow liquid to pass through and trash to remain. The trash is raked off and there may be equipment to grind it for further processing in the plant.

Grit chambers: The speed of wastewater flow is reduced here so that heavier materials such as sand and gravel will settle out. This material is called grit.

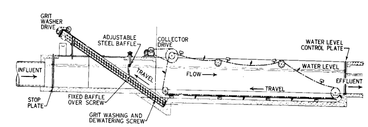


In older plants the long narrow grit channels have to be cleaned either manually (shovelling) or mechanically. The grit removed MUST be buried to prevent odour problems. Grit is removed from the system so as not to damage equipment or take up space.

Shredding: A machine called a communitor will further shred material still in the wastewater. It is usually placed after the grit chamber.

B. ***Primary Treatment***

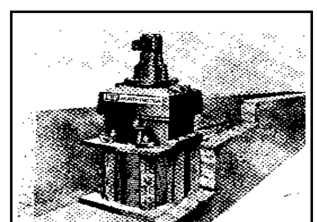
" Settling process uses simple gravity



These treatments seek to remove more than 50% solid and floating matter from the wastewater. The wastewater moves into a large settling tank where slow movement of water causes solids to settle out. Through simple gravity.

This tank is called a primary clarifier or sedimentation tank because settling helps to make the water clearer, the settled organic and inorganic solids is called *primary sludge.*

This process takes about 1 or 2 hours which is called detention time 40% -60% suspended solids are removed. Material which is lighter than wastewater and floats instead of sinks is called *SCUM* and this skimmed off and handled. Usually rotating blades push the scum to a collection point. Settled primary sludge must be collected and some tanks have rotating scrapers which push the sludge to a central point for removal.

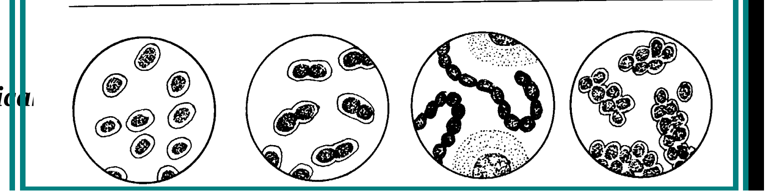


Aerobic treatment involves oxygen.

C. Secondary Treatment

From the primary tank the water moves to secondary treatment which aims to remove the non- settled solids . The unit operation selected to achieve this condition involves a biological process which uses aerobic and facultative bacteria. *Aerobic* is the term used to describe a process which involves oxygen. Secondary treatment can remove about 90% of

Biologica



Microbiology

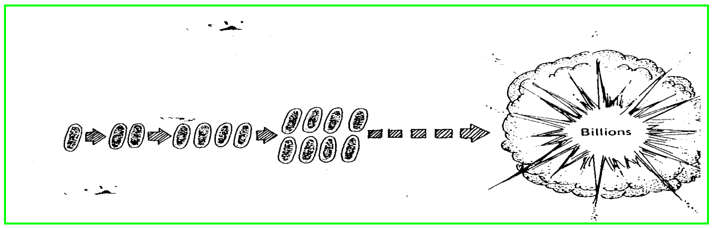
Microbe

the organic material in wastewater.

Anaerobes

Facultative

To Understand biological treatment we need to understand the terms microbiology, microbe, bacteria, aerobe, and anaerobe



Microbiology is the term used to describe that portion of biological science which includes the smallest organism. This microorganism is called a ***microbe*** and may be either plant or animal The degradation of the organic pollution load in wastewater depends upon the action of microorganisms which are present in the treatment process or the receiving water.

Bacteria

Microorganisms are commonly called ***bacteria***, but they also include protozoa, fungi, rotifer and higher organisms.

Bacteria are the most important and most abundant group of microorganisms in biological sewage treatment processes. They can be classified as: ***aerobes*** (if the oxygen is present in the solution), ***anaerobes facultative bacteria*** (if the oxygen is absent from the solution). Which can operate with or without oxygen. Both anaerobic and facultative decomposition produces undesirable odours.

Aerobic decomposition does not produce foul odours and results in a cleaner product.

Bacteria will multiply rapidly

Successful biological treatment depends on developing and maintaining an appropriate active microbial population in the treatment system. This population can be present in the system as either :

a. suspended growth - as occurs in the activated sludge process

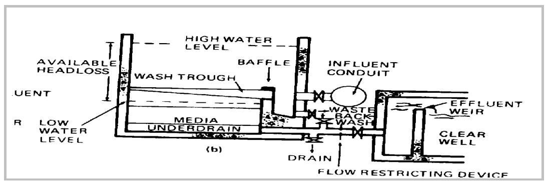
or

b. a fixed film attached to biological filter processes.

The most popular treatment units in the Wider Caribbean Region are:

- Rotating Biological Contact
- Stabilization ponds

Activated Sludge

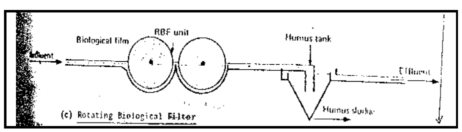


D. Tertiary treatment

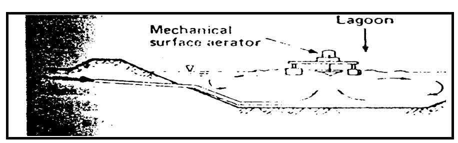
Tertiary treatment is required to achieve higher quality effluent. The appropriate unit operation will depend on the specific requirements for effluent treatment. If pathogenic and bacterial indicator organisms remain in the wastewater a chemical process should be selected.

Tertiary treatment produces higher quality effluent.

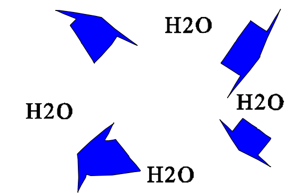
If significant quantities of nutrients, inorganic salts and/or organic waste remain and could interfere with final disposal quality then additional treatment would be required. Such a process is described as Advanced Wastewater Treatment



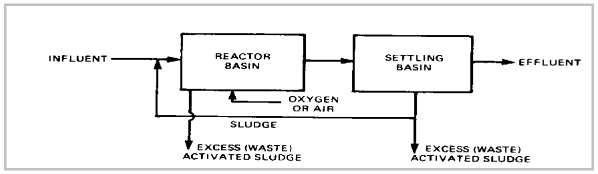
(A.W.T.) and may involve some forms of tertiary treatment.



Units used involve the use of :



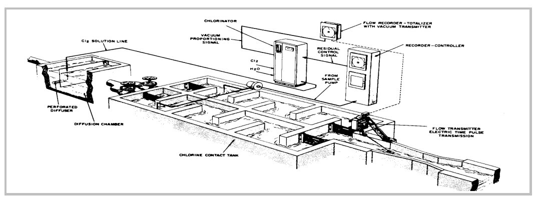
- Filtration
- Disinfection
- Nutrient removal



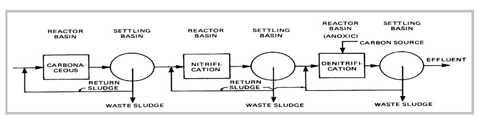
- Removal of Dissolved Organics
- Desalting , etc

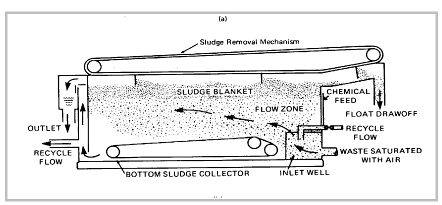
3.0 ACTIVATED SLUDGE

The quality of effluent from those treatment units allow for recycling, thus contributing to a reduction in the overall unit cost of operating the treatment plant.



3.1 WHAT IS IT?





<u>Activated sludge is</u> the term used to describe <u>wastewater</u> which is<u> mixed with air</u> for a period of time <u>to produce a brown floc</u> which consists of billions of mcroorganisms and other material. The suspended and dissolved material found in the wastewaer provide food (BOD) for the

microorganisms. These microorganisms are aerobic , that is they require oxygen in order to function.

The activated sludge process is therefore an aerobic, biological process which uses microorganisms to produce an acceptable effluent quality. This is achieved by providing the environment necessary to enable the microorganisms to remove most of the solids from the wastewater as it passes through the process.

3.2 HOW DOES IT WORK?

Four basic systems make up the activated sludge process:

Design and operation of the activated sludge therefore involve the following considerations:

Diffused Air provides dissolved oxygen

A. Aeration system

1. Aeration Tank (Reactor)

The aeration or reactor basin tank receives wastewate from primary. Proper design of capacity and dimensions of the tank involves estimation of volume and characteristics of wastewater to be treated.

1. The wastewater enters the reactor basin where microbiological floc particles are brought into contact with the organic components of the wastewater. Contents of the reactor basin are referred to as **mixed liquor suspended solids (MLSS)** or **mixed liquor volatile suspended solids (MLVSS)**. This liquor consists for the most part of microorganisms as well as inert (inactive) and non-biodegradable suspended matter.

Aeration is provided by either **diffused air** or **mechanical systems**. These systems provide dissolved oxygen and enables mixing of wastewater with mixed liquor in the aeration tank.

Fine bubble diffusers

2. Diffused air systems are the most common types. They consist of a blower and a pipe distribution system(diffusers) that is used to bubble air into the mixed liquor. Numerous diffusers are generally located near the bottom of the aeration tank so as to maximise contact time of air bubbles and mixed liquor.

Diffusers produce either fine or coarse bubbles. **Fine bubble diffusers**

consist of nylon/dacron socks or saran wrapped tubes. They tend to clog easily and therefore require higher maintenance.

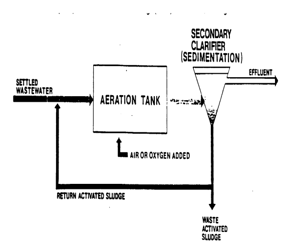
Coarse bubble diffusers consist of pipes into which holes are drilled or plates mounted on pipes. They have lower costs and maintenance requirements.

3. Mechanical Aeration is either by surface or turbine systems, but surface systems are more commonly used. The surface system either floats or is mounted on supports in the aeration tank.

B. Sedimentation Tank (Secondary Clarifier).

The sedimentation tank or secondary clarifier receives the mixed liquor which flows from the aeration tank. In this tank the velocity of flow is reduced and the mixed liquor is separated from the treated wastewater and settles by gravity on the bottom. Settling occurs most effectively when there is the best balance between the microorganisms in the mixed liquor and the organic material in the wastewater.

The main objective of the clarifier is to settle solids. This settling is the most difficult part of the process to control, as conditions must favour particles adhering to each other, becoming heavier and then settling out. This is called *flocculation.* The sludge collected (settled out) is called secondary or activated sludge. This sludge contains millions of active bacteria and can be used again.



C. Return Activated Sludge

The solids secondary sludge which settle out in a concentrated form in the sedimentation tank are then recycled back to the reactor basin. Where it is again mixed with incoming wastewater and air to assist the breakdown of material.

D. Waste (Excess) Activated Sludge

Sludge is continually produced by the "Activated Sludge Process" and the excess sludge must be disposed of in an acceptable manner according to set standards. This process is called sludge wasted and the amount returned is extremely important to the efficiency of the process.

3.3 OPERATIONAL REQUIREMENTS

Prevention maintenance is critical to trouble free operations and reduced maintenance. Every item of operating equipment requires frequent attention. Lubrication is particularly important. A good preventive maintenance program helps to improve process performance through longer helps to improve process more dependable equipment life.

"Preventive maintenance is important to trouble free operations".

The key to successful operation is understanding the system and knowing how to assess its performance. A check list allows the operator:

Lubrication is important.

- To become familiar with the ***process***
- To identify problems or potential problems. For example, it is an equipment or a process problem?
- To classify and evaluate performance.

3.4 THERE ARE TO VARIATIONS THE ACTIVATED SLUDGE PROCESS

Modifications to the process are made in the aeration tanks that is - the process reactors. These variations can be made either through the process design or in the operational characteristics of the system. The variations result in different efficiencies and apply to different circumstances. These are illustrated in Table 3.1

1. Extended Aeration
2. Contact Stabilization

Table 3.1 Operational Characteristics of Activated Sludge process

Process Modification	**BOD Removal Efficiency (%)**	**Application**
Conventional	85-95	Low-strength domestic wastes
Complete-mix	85-95	general application, resistant to shock loads, surface aerators

Step-aeration	85-95	general application to wide range of waste
High Rate	60-75	Intermediate degree of treatment where higher dilution is available in receiving
Contact Stabilisation	80-90	Expansion of existing system package plants flexible
Extended aeration	75-95	Small communities, package plants, flexible, surface aerators
Kraus process	85-95	Low-nitrogen, high-strength wastes
Pure-oxygen system	95-95	General application, use where limited volume is available, use near economical source of oxygen, turbine or surface aerators.

Find Out :

- What pieces of equipment are in the process?
- How they are connected?
- What is each piece expected to do?

Draw a simple diagram of your system using the diagram above as a guide

In operating the activated sludge system you need to ensure the following:

- The activated sludge should contain adequate numbers of purifying organisms.
- Dissolved oxygen should be present in sufficient concentration in all portions of the aeration tanks.
- The activated sludge should be separate readily from the treated sewage in the final settling tanks.

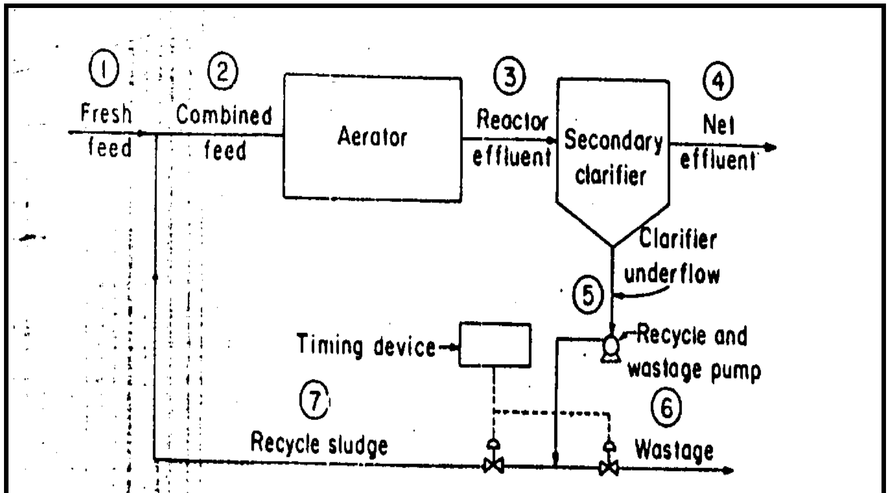


Fig. 5.21. Arrangement for sludge wastage.

3.6 CHECKLIST AERATION SYSTEM

Equipment	Suggested Step Procedures	Details	Frequency
A. Aeration tank	1. Inspect for proper operation	1a. Mechanical equipment 1b. Presence of foaming on surface 1c. Boiling or uneven surface aeration pattern	Twice/shift
	2. Check Dissolved Oxygen level	2a. Dissolved Oxygen in range of 1.0 to 3.0 mg/l Check and calibrate meters and gauges as recommended by manufacturer.	Every 2 hours Daily to weekly
	3. Perform routine wash down	3a. Hose down inlet channels, tank walls - especially at the water line, effluent baffles, weirs and channels, and other appurtenant equipment at water line	Twice/month to monthly
	4. Check control gates and gate operators for proper operation	4a. Operate gates and operators to full open and close position. Adjust gates to proper position to equalize flow distribution 4b. Lubricate as recommended by manufacturer	Twice/shift Monthly
	5. Check froth spray system, if provided	5a. Unplug spray nozzle as necessary and check for proper spray angle	
	6. Inspect baffles and effluent weirs	6a. Maintain baffles in good condition. Maintain effluent weirs at equal evaluation	

Equipment	Suggested Steps	Details	Frequency
B. Aeration Piping	1. Inspect piping for leaks	1a. Visually observe and listen for leaks at pipe and joint connections	Daily
	2. Inspect diffuser header assemblies	2a. Remove header assemblies from tank. Check diffusers and connections for damage and plugging	Twice/year
	3. Check aeration pipe valves and diffuser header assembly control valves for proper operation	3a. Operate valves to full open and close position. Adjust valves to proper positions.	Monthly Daily
	4. Check air flow meters, gauges and condensate traps	4a. Check and calibrate meters and gauges as recommended by manufacturer. 4b. Drain condensate traps.	
C. Air Compressors (Centrifugal and positive placement)	1. Check air filters	1a. Clean or replace filters as recommended by manufacturer.	Twice/shift
	2. Check operation of compressors and motors	2a. Check for excessive vibrations, unusual noises, lubricant leakage, bearing overheating. 2b. Check oil levels, if so equipped, maintain proper levels 2c. Check packing, mechanical seals - adjust and maintain as recommended by manufacturer 2d. Check compressor intake and discharge valves for proper position	

Equipment	Suggested Steps	Details	Frequency
	3. Check compressor air discharge back pressure	3a. Record back pressure. Increasing pressure is indicative of diffuser plugging	Daily
	4. Perform regular maintenance as recommended by manufacturer		Daily to weekly
	5. Alternate compressors in service		
D. Mechanical aerators	1. Check units for proper operation	1a. Check for excessive vibration, unusual noises, motor and gear box overheating	
		1b. Check for proper oil level in gear box and proper motor lubrication	
		1c. Check condition of baffles - if so equipped, and repair or replace as required	
	2. Maintain units properly	2a. Follow manufacturer's instructions	Twice/shift

TYPICAL AIR REQUIREMENT PARAMETERS

Diffused Aeration System			Mechanical Aeration System	
CF Air/lb Removed		CF Air/Gal	lbs O_2 lbs Removed	
COD	BOD		COD	BOD
1000 - 2000	800 - 1500	0.5 - 3.0	1.5 - 1.8	1.0 - 1.2

STANDARD OPERATING PROCEDURES AERATION AND D.O. CONTROL

PROCEDURE	FREQUENCY	METHOD	RANGE	CONDITION	PROBABLE CAUSE	RESPONSE
Check D.O. Level	Every 2 hours	D.O. Meter Iodometric method*	Normally 1 to 3 mg/l	High Satisfactory Low	Too much aeration -- Too little aeration	Decrease aeration Continue monitoring Increase aeration
Check uniformity of aeration pattern in aeration tank	Daily	Visual observation	Uniform mixing & roll pattern, & air bubble disbursement	Dead spots Uneven roll pattern Localized boiling	Improper distribution of air Improper distribution of air Diffuser malfunction	Perform D. O. profiles and balance air Distribution with header valves Pull and check for plugged diffusers
Check air requirement (diffused aeration)	Daily	Calculation SCF/LB COD or LB BOD removed	see previous table	High Satisfactory Low	Poor 0_2 Transfer or nitrificaiton -- Inaccurate D.O., COD, or BOD measurement	Check uniformity of aeration Check for nitrificaiton Continue monitoring Recalibrate D.O. meter Check lab analysis
Check air requirement (mechanical aeration	Monthly	Calculation LBS 0_2/lb COD or LB BOD removed	see previous table	High Satisfactory Low	Low loading ---- High loading, insufficient aeration capacity	Reduce numbser of units in operation-- check for adequate mixing. Improve primary treatment increase number of units in operation

Equipment	Suggested Step Procedures	Details	Frequency
A. Clarifier	1. Inspect for proper operation	1a. Mechanical equipment 1b. Presence of suspended sludge	Twice/shift
	2. Perform daily wash down	2a. Hose down the influent channels, tank walls - especially at the water line, effluent weir and launders, effluent channel and center feed baffles	Daily to weekly
	3. Maintain sludge collection equipment and drive units	3a. Follow manufacturer's instructions.	Monthly
	4. Inspect baffles and effluent weirs	4a. Maintain baffles in sound condition 4b. Maintain effluent weirs at an equal elevation.	Twice/shift or more frequently Twice/shift
	5. Check sludge blanket depth	5a. Measure sludge blanket depth 5b. Sludge should be removed to maintain a blanket depth of 1 to 3 feet. Adjust RAS rates as necessary	Daily Twice/month to monthly
	6. Check D.O. level in clarifier before discharging over effluent weirs	6a. D.O. level should be maintained at minimum of 0.5 mg/l. Adjust aeration air as necessary.	
	7. Check gates and operators for proper operation	7a. Operate gates and operators to full open and close position. Adjust gates	Twice/month to monthly

		to proper position to equalize flow distribution	

Suggested Steps

Equipment	Suggested Step Procedures	Details	Frequency
A. Pumps	1. Check operation of the pumps and motors	1a. Check for excessive vibration, unusual noises, lubricant leakage, and overheating	Twice/shift
	2. Alternate pumps in service	1b. Check oil reservoir level - if so equipped	
	3. Maintain pumping units	1c. Check oil feed rate -- if so equipped	
	4. Fully open and close all valves	1d. Check packing or mechanical seals - make adjustment per manufacturer's instructions	
	5. Check operation of air vacuum and air relief valves	1e. Check position of suction and discharge valves	
		1f. Check pump suction and discharge pressure - if so equipped	Daily to weekly
	6. Check operation of any pump controls and instrumentation, such as flow meters, density meters, control signal loop.		
		3a. Follow manufacturer's instructions	
		4a. Make necessary adjustments or repairs	
		4b. Maintain valves and operators according to manufacturer's instructions	Monthly
		5a. Maintain according to manufacturer's instructions	Weekly
		6a. Maintain according to manufacturer's instructions	Weekly
			Daily

3.7 TROUBLE SHOOTING

Aeration System Problems

Observation	Probable Cause	Necessary Check	Solutions
1. Boiling action, violent turbulence throughout aeration tank surface. Large air bubbles, 1/2" or greater, apparent	A. Overreaction resulting in high DO and/or floc shearing	1. Generally, D.O. should be in range of 1.0 to 3.0 mg/l throughout tanks	1) Reduce air SCFM rate to maintain D.O in proper range.
2. Uneven surface aeration pattern. Dead spots or inadequate mixing in some areas of tank	A. Plugged diffuses B. Under aeration resulting in low D.O. and/or septic odors	1. Check maintenance records for last cleaning of diffuses 2. Spot check diffuses in tank for plugging 1. Check D.O should be in range of 1.0 to 3.0 mg/l throughout tank. 2. Check for adequate mixing in aeration tank 3. Check RAS rates and	1) If diffuses have not been cleaned in the last 12 months, do so 2) If several are plugged, clean all diffuses in tank 1) Increase air SCFM rate to maintain D.O. in proper range 2) Calculate SCFM of air per linear foot of diffuser

		sludge blanket depth in clarifier	header pipe. Minimum requirement is 3 SCFM/linear ft. Adjust air SCFM rate as necessary to maintain adequate D.O. and mixing. 3) Adjust RAS rate to maintain sludge blanket depth of 1 to 3 feet in clarifier.

Aeration System Problems (continued)

Observation	Probable Cause	Necessary Check	Solutions
3. Excessive air rates being used with no apparent change in organic or hydraulic loading. Difficult to maintain adequate D.O. level	A. Leaks in aeration system piping B. Plugged diffuses. Air discharging from diffuser header blow-off pipes causing local boiling to occur on surface near diffuser header pipe.	1. Check air pipe and joint connection; listen for air leakage or soap test flanges and watch for bubbling caused by air leaking. 1. Check maintenance record for last cleaning of diffuses	1) Tighten flange bolts and/or replace flange gaskets. 1) If diffuses have not been cleaned in the last 12 months, do so

	C. Insufficient or inadequate oxygen transfer. D. High organic loadings (BOD, COD, Suspended matter) from in-plant side stream flows	2. Spot check diffuses in tank for plugging 1. Check aeration system performance. a. Diffused aeration system should provide between 800 to 1500 cu. ft. air per pound BOD removed. b. Mechanical aeration system should provide between 1 to 1.2 pounds oxygen per pound BOD removed. 1. Check to see if organic loading from side stream flows contributes significantly to overall process loading	2) If several are plugged, clean all diffuses in tank 1) Replace with more effective diffuses or mechanical aerators. 2) Add more diffuses or mechanical aerators. 1) If loadings are greater than 25%, optimize operational performance or upgrading of other implant processes will be required.

Foaming Problems

Observation	Probable Cause	Necessary Check	Remedies
1. White, thick, billowing or sudsy foam on aeration tank surface.	A. Overloaded aeration tank (low MLSS) due to process start up. Do not be alarmed, this problem usually occurs during process start up.	1. Check aeration tank BOD loading (lbs/day) and lbs MLVSS in aeration tank. Calculate F/M ration to determine lbs/day MLVSS inventory for current BOD loading. 2. Check secondary clarifier effluent for solids carryover. Effluent will look cloudy. 3. Check D.O. levels in aeration tank.	1) After calculating the F/M and lbs MLVSS needed, you will find that the F/M ratio is high and the lbs MLVSS inventory is low. Therefore, do not waste sludge from the process or maintain the minimum WAS rate possible if wasting has already started. 2) Maintain sufficient RAS rates to minimize solids carry over especially during peak flow periods. 3) Try to maintain D.O. levels between 1.o to 3.0 mg/l. Also be sure that adequate mixing is being provided in the aeration tank while attempting to maintain D.O. levels 1) Reduce WAS rate by not more than 10% per day until process approaches normal control parameters 2) Increase RAS rate to minimize effluent solids carryover from secondary clarifier. Maintain sludge blanket depth of 1 to 3 feet from clarifier floor.
	B. Excessive sludge wasting from process causing overloaded aeration tank (Low MLSS).	1. Check and monitor for trend changes which occur in the following: a. Decrease in MLVSS mg/l b. Decrease in MCRT, Gould Sludge Age c. Increase in F/M ration d. D.O. levels maintained with less air rates e. Increase in WAS rates	

Foaming Problems (continued)

Observation	Probable Cause	Necessary Check	Solutions
	C. Highly toxic waste, such as metals or bactericide, or colder wastewater temperatures, or severe temperature variations resulting in reduction of MLSS.	1. Take MLSS sample and test for metals and bactericide, and temperature. 2. Monitor plant influent for significant variations in temperature.	1) Reestablish new culture of activated sludge. If possible, waste sludge from process without returning to other in-plant systems. Obtain seed sludge from other plant, if possible. 2) Actively enforce industrial Waste Ordinances.
	D. Hydraulic washout of solids from secondary clarifier.	1. Check hydraulic detention time in aeration tank and surface overflow rate in secondary clarifier.	1) Refer to Troubleshooting Guide No. 3, Observation 1.
	E. Improper influent wastewater and/or RAS flow distribution causing foaming in one or more aeration tanks.	1. Check and monitor for significant differences in MLSS concentrations between	1) MLSS and RAS concentrations, and D.O.'s between multiple tanks should be reasonably consistent 2) Modify distribution facilities as necessary to maintain equal influent wastewater and/or RAS flow rates to aeration basins.

		multiple aeration tanks. 2. Check and monitor primary effluent and/or RAS flow rates to each aeration basin.	

Foaming Problems (continued)

Observation	Probable Cause	Necessary Check	Solutions
2. Shiny, dark tan foam on aeration tank surface.	A. Aeration tank approaching under-loaded (high MLSS) condition due to insufficient sludge wasting from the process.	1. Check and monitor for trend changes which occur in the following: a. Increase in MLVSS mg/l b. Increase in MCRT, Gould Sludge Age c. Decrease in F/M ratio d. D.O levels maintained with increasing air rates e. Decrease in WAS rates	1) Increase WAS rate by not more than 10% per day until process approaches normal control parameters and a modest amount of light tan foam is observed on aeration tank surface. 2) For additional checks and remedies refer to Troubleshooting Guide No. 5 and 6. 3) For multiple tank operation refer to Observation No. 1, Probable Cause "E".
3. Thick, scummy dark tan	A. Aeration tank is	1. Check and monitor for	1) Increase WAS rate by not more than

foam on aeration tank surface.	critically under loaded (MLSS too high) due to improper WAS control program.	trend changes which occur in the following: a. Increase in MLVSS mg/l b. Increase in MCRT, Gould Sludge Age c. Decrease in F/M ratio	10% per day until process approaches normal control parameters and a modest amount of light tan foam is observed on aeration surface.

Foaming Problems (continued)

Observation	Probable Cause	Necessary Check	Solutions
		d. D.O levels maintained with increasing air rates e. Decrease in WAS rates f. Secondary effluent nitrate level above 1.0 mg/l g. Increase in secondary effluent chlorine demand h. Decrease in aeration tank effluent pH.	2) For additional checks and remedies refer to Troubleshooting Guide No. 5 and 7. 3) For multiple tank operation refer to Observation No. 1, Probable Cause "E" of this guide.
Dark brown, almost blackish sudsy foam on aeration tank surface. Mixed liquor color is very dark brown to almost black. Detection of septic or sour odor from aeration tank.	A. Anaerobic conditions occurring in aeration tank	1. Refer to Troubleshooting Guide No. 1, Observation No. 1 and 3	

Secondary Clarifier

Guide # 3 **-Solids Washout/Billowing Solids**

Observation	Probable Cause	Necessary Check	Solutions
1. Localized clouds of homogenous sludge solids rising in certain areas of the clarifier. Mixed liquor in settle ability test settles fairly well with a clear supernatant	A. Equipment malfu nction .	1. Refer to Troubleshooting Guide No. 1, Observations 1A, 2A and 2B. 2. Check the following equipment for abnormal operation. a. Calibration of flow meters b. Plugged or partially plugged RAS or WAS pumps and transfer lines c. Sludge collection mechanisms, such as broken or worn out lights, chains, sprockets, squeegees, plugged sludge withdrawal tubes. 3. Check sludge removal rate and sludge blanket depth in clarifier	2) Repair or replace abnormal operating equipment 3) Adjust RAS rates and sludge collector mechanism speed to maintain sludge blanket depth at 1 to 3 feet from clarifier floor.

- Solids Washout/Billowing Solids (continued)

Observation	Probable Cause	Necessary Check	Solutions
	B. Air or gas entrapment in sludge floc or denitrification occurring	1. Perform sludge settle ability test and gently stir sludge when settling to see if bubbles are released. 2. If bubbles are released, check nitrate mg/l in secondary effluent to see if the process is nitrifying.	1) If the process is not nitrifying, refer to Probable Cause A above, and Troubleshooting Guide No. 7, Observation 2. 2) If the process is nitrifying, refer to Troubleshooting Guide No. 5, Probable Cause A
	C. Temperature currents	1. Perform temperature and D.O profiles in clarifier 2. Check inlet and outlet baffling for proper solids distribution in clarifier.	1) If temperatures exceed 1 to 2 degrees between top and bottom of clarifier, use an additional aeration tank and clarifier if possible 2) Modify or install additional baffling in clarifier 3) Refer to Probable Cause A-1, and A-2 above.
	D. Solids washout due to hydraulic overloading	1) Check hydraulic detention time in aeration tank and clarifier, and surface over flow rate in clarifier.	1) If hydraulic loadings exceed design capability, use additional aeration tanks and clarifier if possible 2) Reduce RAS rate to maintain high sludge blanket depth in clarifier 3) If possible, change process operation to sludge reaeration or contact stabilization mode 4) Refer to Probable Causes B1, B2 and C2 above

- Solids Washout/Billowing Solids (continued)

Observation	Probable Cause	Necessary Check	Solutions
2. Localized clouds of fluffy homogenous sludge rising in certain areas of the clarifier. Mixed liquor in settle ability test settles slowly, leaving stragglers in supernatant.	A. Overloaded aeration tank (low MLSS) resulting in a young, low density sludge.	1. Check and monitor trend changes which occur in the following: a. Decrease in MLVSS, mg/l b. Decrease in MCRT, Gould Sludge Age c. Increase in F/M ration d. Lower air SCFM rate to maintain D.O. level	1) Decrease WAS rates by not more than 10% per day to bring process back to optimum parameters.

Secondary Clarifier

- Bulk Sludge

Observation	Probable Cause	Necessary Check	Remedies
1. Clouds of billowing homogenous sludge rising and extending throughout the clarifier tank. Mixed liquor settles slowly and compacts poorly in settle-ability test, but supernatant is fairly clear.	A. Improper organic loading or D.O. level	1. Check and monitor trend changes which occur in the following: a. Decrease n MLVSS mg/l. b. Decrease in MCRT, Gould Sludge Age. c. Increase in F/M ratio. d. Change in D.O. levels. e. Sudden SVI increase from normal, or decrease in SDI.	1) Decrease WAS rates by not more than 10% per day until process approaches normal operating parameters. 2) Temporarily increase RAS rates to minimize solids carry over from clarifier tank. Continue until normal control parameters are approached. 3) D. O. level throughout aeration tank greater than 0.5 mg/l, preferably to 3 mg/l.
	B. Filamentous organisms	1. Perform microscopic examination of mixed liquor and return sludge. If possible, try to identify type of filamentous organisms, either fungal or bacterial. 2. If fungal is identified, check industries for waste which may cause problems.	1) In no filamentous organisms are observed, refer to Probable Cause "A" above. 2) Enforce Industrial Waste Ordinance to eliminate wastes. Also see Remedy 4 below.

Bulk Sludge (continued)

Observation	Probable Cause	Necessary Check	Remedies
	3. If bacterial are identified, check influent wastewater and in-plant side stream flows returning to process for massive filamentous organisms.	3) Chlorinate influent waste-water at 5 to 10 mg/l dosages. If higher dosages are required, use extreme caution. Increase dosage at 1 to 2 mg/l increments. 4) Chlorinate RAS at 2 to 3 lbs/day/1000 lbs MLVSS. 5) Optimized operational performance or upgrading of other in-plant unit process will be required if filamentous organisms are found in side stream flows.	
	1. Check nutrient levels in fluent wastewater. The BOD to nutrient ratios should able 100 parts BOD to 5 parts total nitrogen to 1 part phosphorus to 0.5 iron.	1) If nutrient levels are less than average ratio, field tests should be performed on the influent wastewater for addition of nitrogen in the form a anhydrous ammonia, phosphorus in the form of trisodium phosphate and/or iron in the form of ferric chloride.	
	2. Perform hourly ML Settle-ability tests.	2) Observe tests for improvement in sludge setting characteristics with the addition of nutrients.	

- Bulk Sludge (continued)

Observation	Probable Cause	Necessary Check	Remedies
	D. Low D. O. in aeration tank.	1. Check D.O. at various locations throughout the tank.	1) If average D.O. is less than 0.5 mg/l, increase air SCFM rate until the D.O. level increases to between 1 and 3 mg/l throughout the tank. 2) If D.O. levels are nearly zero in some parts of the tank, but 1 mg/l or more in other locations, balance the air distribution system or clean diffusers. Refer to Troubleshooting Guide No. 1, Observation 2.
	E. pH in aeration tank is less than 6.5	1. Monitor plant influent pH.	1) If pH is less than 6.5, conduct industrial survey to identify source. If possible, stop or neutralize discharge at source. 2) If the above is not possible, raise pH by adding an alkaline agent such as causticsoda or lime to the aeration influent.
		2. Check if process is nitrifying due to warm wastewater temperature or low F/M loading.	1) If nitrification is not required, increase WAS rate by not more than 10% per day to stop nitrification. 2) If nitrification is required, raise pH by adding an alkaline agent such as caustic soda or lime to the aeration influent.

Sludge Clumping

Observation	Probable Cause	Necessary Check	Remedies
1. Sludge clumps (from size of a golf ball to as large as a basket ball) rising to and dispersing on clarifier surface. Bubbles noticed on clarifier surface. Mixed liquor in settle ability test settles fairly well, however, a portion of and /or all of the settled sludge rises to the surface within four hours after test is started.	A. Denitrification in clarifier.	1. Check for increase in secondary effluent nitrate level. 2. Check loading parameters. 3. Check D.O. and temperature levels in the aeration tank. 4. Check RAS rates and sludge blanket depth in clarifier	1) Increase WAS rate by not more than 10% per day to reduce or eliminate level of nitrification. If nitrification is required, reduce to allowable minimum. 2) Maintain WAS rates to keep process within proper MCRT, Gould Sludge Age, and F/M ratio. 3) Maintain D.O. at minimum level (1.0 mg/l). Be sure adequate mixing is provided in the aeration tank. 4) Adjust RAS rate to maintain sludge blanket depth of 1 to 3 feet in clarifier.
	B. Sectility occurring in clarifier.	1. Refer to Troubleshooting Guide No. 1, Observation No. 2. 2. See 3 and 4 above.	

Cloudy Secondary Effluent

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES
1. Secondary effluent from clarifier is cloudy and contains suspended matter. Mixed liquor in settle ability test settles poorly, leaving a cloudy supernatant.	A. MLSS in aeration tank low due to process start-up.	1. Refer to Troubleshooting Guide No. 2, Observation No. 1.	
	B. Increase in organic loading.	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of protozoa. 2. Check organic loading on process. 3. Check D.O. level in aeration tank.	1) If no protozoa are present, possible shock organic loading has occurred. 2) Reduce WAS rate by not more than 10% per day to bring process back to proper loading parameters and increase RAS rates to maintain 1 to 3 foot sludge blanket in clarifier. 3) Adjust air SCFM rate to maintain D.O. level within 1.0 to 3.0 mg/l.
	C. Toxic shock loading	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of inactive protozoa.	1) If protozoa are inactive, possibility of recent toxic load on process. 2) Refer; to Troubleshooting Guide No. 2, Observation No. 1.C.

- Cloudy Secondary Effluent (Continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES
	D. Over aeration causing mixed liquor floc to shear.	1. Perform microscopic examination on mixed liquor. Check for dispersed or fragmented floc and presence of active protozoa.	1) Refer to Troubleshooting Guide No. 1, Observation No. 1.A.
	E. Improper D.O. levels maintained in aeration tank.	1. Refer to Troubleshooting Guide No. 1, Observation No. 1.A.	

Ashing And Pinpoint/straggler Floc

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES
1. Fine dispersed floc(about the size of a pinhead) extending throughout the clarifier with little islands of sludge accumulated on the surface and discharging over the weirs. Mixed liquor in settle ability test, settles fairly well. sludge is dense at bottom with fine particles of floc suspended in fairly clear supernatant.	A. Aeration tank approaching under loaded conditions (High MLSS) because of old sludge in system.	1. Check and monitor trend changes which occur in the following: a. Increase in MLVSS mg/l. b. Increase in MCRT, Gould Sludge Age. c. Decrease in F/M ratio. d. D.O. levels maintained with increasing aeration rates. e. Decrease in organic loading f. Decrease in organic loading (BOD/COD in primary effluent). 2. Check for foaming aeration tank.	1) Increase WAS rates by not more than 10% per day to bring process back to optimum control parameters for average organic loading. 2) Refer to Troubleshooting Guide No. 2 for any foaming which may be occurring in aeration tank. 3) Adjust RAS rates to maintain sludge blanket depth of 1 to 3 feet in clarifier. 4) Refer to Troubleshooting Guide No. 1 for additional observations.

Ashing And Pinpoint/straggler Floc (Continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES
2. Small particles of ash-like material floating on clarifier surface.	A. Beginning of denitrification.	1. Stir floating floc on surface of 30 minutes settling test.	1) If floating floc releases bubbles and settles, see Troubleshooting Guide No. 5, Probable Cause A. 2) It if does not settle, refer to Probable Cause B, below.
	B. Excessive amounts of grease in mixed liquor.		1) If the grease content exceeds 15 percent by weight/ of the MLSS, repair or replace scum baffles as needed. 2) If grease content is excessive, implement an industrial waste monitoring and enforcement program.

		1. Perform a grease analysis on MLSS, and check scum baffles in primary tank. 2. Check grease content in raw wastewater.	

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES
3. Particles of straggler floc about 1/4" or larger, extending throughout the clarifier and discharging over the weirs. Mixed liquor in settle ability test, settles fairly well. Sludge does not compact well at the bottom with chunks of floc suspended in fairly clear supernatant.	A. Aeration tank slightly under loaded (Low MLSS) due to organic load change.	1. Check and monitor trend changes which occur in the following: a. Decrease in MLVSS mg/l. b. Decrease in MCRT, Gould Sludge Age. c. Increase in F/M ratio. d. Less aeration rate used to maintain D.O. e. Increase in WAS rates. f. Increase or decrease in organic loading (BOD/COD in primary effluent). 2. Check for foaming in aeration tanks.	1) Decrease WAS rates by not more than 10% per day to bring process back to optimum control parameters for average organic loading. 2) Refer to Trouble shooting Guide No. 2 for any foaming which may be occurring in aeration tank. 3) Adjust RAS rates to maintain sludge blanket depth of 1 to 3 feet in clarifier. 4) Decrease aeration SCFM rates to maintain minimum D.O. of only 1.0mg/l in aeration tank. Refer to Troubleshooting Guide No 1 for additional observations.

The Rotating Biological Contact consists of a large number of plastic media discs mounted on a main shaft. These media discs are carefully spaced and are also designed to provide turbulence as they move through the waste water.

How does it work? Usually about 40% of the media area is submerged in the wastewater tank; as the unit turns the media is alternatively exposed to the air and wastewater and water drains back to the tank.

The draining action from the disco process leaves a thin film of liquid, and allows a high rate of exchange of oxygen from the atmosphere to the wastewater. Biological growth is facilitates and the biological mass continues to grow using up organics in the water.

During the period of contact with the wastewater, the biological film absorbs organic matter and then during contact with the atmosphere it absorbs oxygen, so enabling aerobic oxidation to proceed. When the mass gets heavy it is sheared off into the wastewater.

The wastewater containing the solids flows a secondary clarifier where sludge is settled out. Primary treatment is also required for wastewater before it enters the RBC.

4.2 OPERATIONAL REQUIREMENTS

The only moving part in the plant is slowly rotating discs which are usually driven by an electric motor. Some inspection would therefore be carried out to ensure that:

- No harmful foreign materials are in the plant.
- The motor is not overheating
- The liquid is flowing.

The concentration of dissolved oxygen in the liquor is related to the speed of the disc rotation. Increasing the speed of the disc rotation will increase the contact between microorganisms and the wastewater and will improve oxygen transfer. However, this improvement is offset by higher operating costs which are not usually practical.

The time required to build up a viable microbial mass on the support medium of an RBC is likely to be measured in days or weeks.

Parameter	Frequency of Observations and Measurement
Flow - Plant influent - Plant effluent	 1 per day 1 per week
Water Temperature (Each unit)	1 per week
Oxygen demand (Each unit)	1 per week
BOD - Plant influent - Plant effluent	1 per week
Solid suspended (Influent/Effluent)	1 per day
Dissolved solid (Influent/Effluent)	Optional

4.4 TROUBLE SHOOTING GUIDE FOR ROTATING BIOLOGICAL CONTACT

The plants usually produce good reduction of carbonaceous BOD and suspended solids. However the degree the of nitrification depends upon the loading and operating factors for the individual plants.

The plants have a degree of self regulation in that an increase in the BOD_5 of the wastewater will cause greater microbiological activity over a longer length of the discs.

5.0 WASTE STABILIZATION PONDS

Waste stabilisation ponds or lagoon systems are large, shallow and usually rectangular basins in which there is a continuous inflow and outflow of wastewater. The biological treatment that occurs in ponds is an entirely natural process achieved principally by bacteria and micro algae, and one that is unaided by man action
The types and modification of lagoon system are many. Lagoons may be classified as anaerobic, facultative or aerated aerobic or aerated facultative
Aerobic lagoons are frequently called oxidation ponds.

As a unit process for treating organic waste material, waste stabilisation pond may be used in series or in parallel; they can be followed by settling tanks with sludge recirculating to the influent system and operated as one of many variants of the activated sludge process. They can be used as polishing ponds for tertiary treatment.

- The waste stabilisation ponds may be designed for
- complete evaporation of inflow

crops through irrigation.

The waste water matter applied in the pond influent is thus partly stored on the floor of the pond, partly lost as biodegradation products and partly discharge as biomass, notably algae, in the effluent. Hence in the degree of effluent quality control they can achieve they are probably somewhat inferior to other more complex systems because of the variable concentration of algae escaping in the effluent.

5.2 FACTORS AFFECTING PERFORMANCE AND DESIGN

- Oxygen supply
- Mixing
- Organic loading
- Retention time
- Temperature
- Physical configuration

TABLE 5.1 OPERATIONAL PARAMETERS TO EVALUATE THE WASTE STABILISATION PONDS

Parameter	**Frequency**	
	Lower	**Ideal**
Flow -Plant influent - Plant effluent	 1 per day 1 per week	 continuously
Operational depth (Each unit)	1 per week	1 per day
Water Temperature(Each unit)	1 per week	1 per day
Color(Each unit)	1 per day	
Oxygen demand (Each unit	1 per week	1 per week
BOD - Plant influent - Plant effluent	2 per month 1 per month	1 per week 1 per week
Solid suspended (Influent/Effluent)	2 per month	1 per week
Dissolved solid (Influent/Effluent)	Optional	
Metereologic Air Temperature, Precipitation, Evaporation, Clouding, Wind velocity and Direction	Daily	

5.3 TROUBLE SHOOTING GUIDE FOR WASTE STABLISATION POND

I - Activated Sludge
II - Waste Stabulisation

The Operator needs to know:

- What each part of the system is supposed to do?
- How each process or piece of equipment operates normally?
- How to recognize abnormal conditions?
- What alternative are available when trouble exists?

The purpose of this section is to present a ready and quick operators reference to process problems and their solutions.

The operator need to be familiar with the process therefore should know:

- Classify the process
- Identify equipment
- Compares equipment performance.

This information will help to determine adequacy of equipment.

(1) Is the equipment being used properly as designed?

(1) Is the equipment adequately controlled?

(1) Is there too much time down resulting in the excessive cost or loss of working hours?

- Control of floating macrophytes or vegetation

Observation	Probable cause	Necessary check	Solutions
The vegetation supplied food to some animals. stop the wave movement. Generate unpleasant odours.	Not good maintenance or circulation		a) Cutting the grass on the embankments and removing it so that it does not fall into the pond. (b) Raise the water level to cover the vegetation. c) Reduce the water level and burn the vegetation.
Growing of trees, bush, etc. Reduction of wind velocity	Bad maintenance		a) Periodically cutting bushes b) Plant grass on the lagoon bank to avoid growing of tallest plants. c) Spray chemicals to destroy the bushes (the authorities should approve it)

- Wastewater control level

Observation	Course	Necessary check	Solutions
The lagoon is easily dried. Produces unpleasant odours and proliferation of insects	Leaking through the bottom or through the berm.		a) Place a layout of clay or use others means to seal the bottom. b) At the berm use a good quality clay to patch it. c) In some case the water lost could be replaced with good quality water or wastewater if the system has more that one pond.

- Thin film

(1)	(2)	(3)	(4)
Avoid the film formation to prevent unpleasant odours and insect reproduction	The settling material is being raised. Not good circulation and wind action. The highest level of oil and grease in the influent could produce the thin film.	Suspended Solves	a) Use rake, portable pump or outboard to break the film. b) Remove and dispose in the sanitary landfill.

- Unpleasant odours

(1)	(2)	(3)	(4)
General public problem e.g.	Long term clogging Not good water circulation Industrial wastewater. Low growth of algae due to the nature of water too acid too alkaline, or not enough nutrients.	Nitrate, Phosphates	a) Use parallel inflow to reduce the charge. b) Install supplementary aeration, outboard, etc.). c) Nutrients (add nitrate and phosphate). d)The acidity can be resolve adding lime (pH= 7.5-9.0).

- Eutrophication

(1)	(2)	(3)	(4)
Low pH (<6.5) and OD less than 1 mg/l, unpleasant odours as a result of dead algae	The blue-green algae shows an incomplete treatment , and inefficient nutrients balance.	Alkalinity, OD, pH	a) Apply thrice a copper sulphate solution. - If the total alkalinity is over 50 mg/l applied 1.25 kg of copper sulphate per 1000 m in the pond.

- Insects

(1)	(2)	(3)	(4)
Insects and larvae in the pond	Inefficient circulation and maintenance		a) Keep the lagoon free of vegetation. b) Surface without film. c)Plant fish fly d) Control of operational level. c) Periodically increase and decrease water level.

-Improve removal of algae in the effluent

(1)	(2)	(3)	(4)
The majority of Suspended solids in the lagoon effluent is due to algae	Climatic conditions assisting a particular algae population	Suspended Solids	a) Remove the effluent below the surface through a good tidy up of divisions b) Use multiplex pond in series. c) Use sandy media filter (need engineering approach). d) Use aluminum sulphate in the effluent.

- Load low

(1)	(2)	(3)	(4)
This lagoon can produce filamentous algae and mold. Which Interfere, with sun light. Can clog the outlet	Excessive capacity		a) Increase load b) Use series operation

- DO low

(1)	(2)	(3)	(4)
D O low indicates future anaerobic conditions and unpleasant odours. Low treatment efficiency	Difficulties of sunlight penetration, retention time (low), BOD, load high or industrial hazardous waste. DO in the morning in hates months can not be lower than 3 mg/l.	DO	a) Remove bush (water lentil) if it covers more than 40% of the pond. b) Reduce organic load in the primary lagoon changing to a parallel operation. c) Supply supplementary aeration (surface aerators, diffusors or outboard periodically). d) Introduce circulation employing portable pump to return the effluent to influent. e) Supply Sodium nitrate f) Find out if over load if for an industrial sources and close down.

- Short cut

(1)	(2)	(3)	(4)
Odours problems, low OD in some part of the lagoon, anaerobic conditions pH low. Select some points in the lagoon and analysis OD and pH, if 100 to 200% indicate low OD and pH the lagoon is short cut.	Poor wind action due to trees, bush or other vegetation are not appropriated located. Construction problems	OD, pH	a) Cut trees and bush almost 150 m from the pond berm to the wind direction. b) Install more division at the inlet. c) Set recirculating improving mixed. d) Set various inlets and outlets. e) Eliminate bush. d) Levelly bottom.

-Over load

(1)	(2)	(3)	(4)
Could show incomplete treatment of the wastewater. Unpleasant odours and colour in the lagoon (Yellow and gray). OD, pH, BOD can show over load	Short cut, industrial waste, waste material. leaking, new construction, inadequate climatic conditions.	DO, BOD, pH	a) Disconnected the lagoon for some periods. b) Use pond in parallel. c) Apply recirculating. d) Research short cut possibility. e) Install aerators
Death algae	High BOD in the effluent. Low retention time. Inlet and outlet not good located. High organic loading and possibility of toxic compounds.	BOD, SS	a) Check sewer system. b) Use portable pump to recirculate. c) Set new outlet and inlet. d) Reduce loading from industrial zone. e) Avoid toxic influent.

APPENDIX I

GENERAL ABOUT SAMPLING IN TREATMENT PLANT OPERATIONS

The treatment operations requires sampling and analysis for two primarily objectives:

(a) Record results are essential to show what entered the plant and what left the plant in terms of concentration, condition and character.

(b) Control of operations involves optimization of conditions favoring better rations of benefit per unit of time, space, cost or effort.

The sampling program should be a cooperative effort among supervision, operators, samplers, analyst and other interested parties. It should be checked for validity and applicability of information obtained and reviewed periodically or whenever conditions may have changed.

(a) Each installation is limited in man power skills and equipment, some more than others. A compromise must be reached that will provide essential information for that particular situation

(b) Each part of the team should be clearly aware of what samples to obtain, why, where, when and how, they are to be used. The operations must be scheduled for smooth working arrangements.

- The sampler must be aware that he is responsible for the starting point in a series consisting of sampling determination, reporting and use of the derived information.
- Sampling must follow prescribed location, time and technique schedules agreed upon beforehand and tested for validity in line with operation objectives.
- Each sample must be clearly identify according to the designated system in terms of location, time, type, etc. Unusual conditions that may be affect results should be noted on the identification tag. Marked changes in sample characteristics should be reported promptly to proper authority for possible corrective action.
- Samples should be stored under conditions minimizing changes before analysis

♦ Treatment plant samples involve a high degree of variability and changes in characteristics within the plant.

(a) The influent samples are subject to greater variability than samples from any other part of the plant or the receiving water.

- The influent flow contains a variety of materials under unstable conditions.

- Certain components are readily separated from the flow because of size, density, volatility or other characteristics.

- Highly putrescible material may be stabilized rapidly in process.

- Geographic factors control rate of flow to the plant and mixing or stabilization en route. A given slug discharge may not be detectable if it enters the collection system at a point where it can be dispersed among other contributions.

- Smaller collection system emphasize both variability and effects of single contributors.

- A given channel flow may include solids movement along the bottom and float able materials at the surface. A sample of this flow contains variable proportions of both depending upon turbulence at the sampling site.

- Contributing population activities are scheduled by working, eating, sleeping weather, TV, and other influences. Wastewater load varies according with the time of the day, week or month.

(b) The plant functions as an equalization basin as well as a processing facility.

- A given slug discharge is dispersed among liquids already in process.
- It may require several hours to traverse various process units. Plant performance sampling at the inlet and outlet at given time is likely to represent different process loads or conditions.
- Changing conditions within the plant affect determination of certain analytical criteria in process.
- An influent and effluent BOD involve different progressions.

♦ Treatment plant sampling program preferably should be designed to show what has been done during the operation and what has been done during the operation and what remains to be done.

(a) Integrity of the sampling is determinated by the comparisons between actual performance and reported performance.

- Treatment plant loading includes that into process.
- The discharged flow includes treated, by passed, or process return flows.
- Plant achievement reflects the difference in material balance among incoming and outgoing process water contributions of nutrients, oxygen demand, solids or other criteria.

MONITORING AND COLLECTING SAMPLES HELP TREATMENT PLANTS

SAMPLING

Treatment operations require sampling and analysis for two main reasons:

(1) To record what entered the plant and what left the plant in terms of concentration, condition and character.

(2) To monitor operations so as to be able to make adjustments for best results.

The sampling program should be a cooperative effort among supervisors, operators, samplers, analysts and other interested parties. Each member of the team should be clearly aware of what samples to obtain, why, where , and when they are being collected, and how they are to be used.

The taking of wastewater and sludge samples are to be made at the same location, the same depth and the same manner.

Sampling equipment and containers should be washed out with the water or sludge to be investigated

Samples for laboratory examinations are to receive special treatment. The laboratory management will provide details of sampling requirements - quantities, times, sampling points, and type of handling.

MONITORING NEEDS

Primary Treatment

Inlet, Outlet and Overflow structures - Check regularly to keep free of clogging

Stornwater Tanks - Check drainage mechanisms and keep functional. Clean tanks as required

Screening System - Check for proper functioning at start and end of work.Clean regularly. Keep dirty screens in closed containers to avoid flies and smells. Clean as quickly as possible.

Grit Chamber - Keep clean to ensure adequate space to collect material.

Measurement facilities - flow metres, pH and Oxygen meters should be serviced regularly and cartefully. Remove deposits. Calibrate according to manufacturers instructions.

Primary Clarifier - Keep sloping walls free of sludge deposits. Keep inlet and outlet valve clean. Determine sludge level in clarifier at least once per week. Draw off only well-digested sludge - black and without odour. Leave about third in the tank for seeding.

Sedimentation or Secondary Settling Tanks - Keep serviced as with primary clarifier. Remove sludge continuously as return sludge to the aeration tank or to waste system.

Aeration Tanks - Clean and Service carefully. Determine sludge volume once per day after 1/2 hour settling time. Measure oxygen concentration daily. Check pH value regularly. Report significant changes in sludge such as colour or structure to management Monitor circulation of air. Watch for pressure increases .

Sludge Basins/Sludge Lagoons - Fill to depth of 20 cm to 40 cm. Remove sludge as soon as it has dried out. Check half-yearly.

Lagoon Plants -Clean inlets and outlets daily if needed. Remove weed growth.Check lagoon bottom for sludge deposits half-yearly. Check sealing of lagoon at sides and bottom.

Pipelines and Fittings - Check for corrosion, encrustation and deposits once per year.

Sewage Treatment Plant Sites Check fencing, entrances, gates, lighting and warning signs on a regular basis. Keep entrances closed. Control pests and keep grounds aesthetically pleasing. Landscape if you can.

Buildings **-** Keep machinery room, and all operational rooms clean. Keep equipment and tools clean and readily accessible.

Activated Sludge Process: A process used for purification and Stabilization of wastewater by return of solids concentrate formed during prior contact. The organism rich concentrate speeds biochemical activity in the presence of excess oxygen.

Advanced waste treatment: A term including any treatment process applied for renovation of wastewater that goes beyond the usual 90-99% oxygen demand and organic solids removal of secondary treatment.

Aeration: The operation adding oxygen to, removing volatile constituents from, or mixing a liquid by intimate contact with air.

Aerobic bacteria: Organisms that require dissolved oxygen in the aquatic environment to enable them to metabolize or to grow.

Algae: Primitive plant, one or many celled, usually aquatic and capable of growth on mineral materials via energy from the sun and the green coloring material, chlorophyll. Generally considered as the source of food for other organisms.

Anaerobic: a condition in which dissolved oxygen is undetectable in the aquatic environment.

Anaerobic Bacteria: Organisms that can metabolize and grow in the absence of dissolve oxygen.

Bacteria: Primitive organisms having some of the features of plants and animals.

Biodegradation: The stabilization of wastewater contaminants by biological conversion of pollutants into separable materials at a higher oxidation state.

Biological Processes: Activities of living organisms to sustain life, growth and reproduction.

BOD: Biological oxygen demand. A test for estimation of wastewater polluting effects in terms of the oxygen requirements for bio-chemical stabilization under specified conditions and time.

CEHI: Caribbean Health Institute.

Chamber: A general term applied to a space enclosed by walls or to a compartment, often prefixed by descriptive word, such as “grit chamber”, screen Chamber”, discharge chamber”, etc.

Chlorine: A greenish yellow gaseous element having strong disinfecting and oxidizing properties in water solution.

Chlorination: The application of chlorine to water or wastewater for the purposes of disinfection, oxidation, odor control or others effects.

Clarifier: A basin or tank serving as an enlargement of a channel to permit separation of floating or settling materials from the clarified water (sedimentation basin).

COD: A test for the estimation of the polluting effects of a wastewater in terms of oxygen requirements from a strong chemical oxidant under specific conditions.

Comminutor: A device for cutting sewage solids until they pass an acceptable screen opening to improve pumping and wastewater processing.

Concentration: The act of increasing mass per unit volume or mass such as concentrating a sludge from 3 to 6 % solids, or a means of designating the amount of material per unit volume or mass. Commonly mg of substance per liter of volume or percentage in wastewater technology.

Contamination: A general term referring to the introduction of materials into water that makes the water less desirable for its intended use.

Detention time: The time required for a given unit of liquid to flow through the tank or process unit.

DO: Dissolved molecular oxygen usually expressed in mg DO /l or percent in true solution form.

Drying: The removal of water.

Efficiency: The ratio of materials out of a process to those into that process, usually expressed as a percentage.

Effluent: A liquid flowing out of a chamber, treatment operation, or basin. For wastewater treatment primary, secondary or finals effluents are commonly designated.

Filter: A porous media through which a liquid may be passed to effect removal of suspended materials.

Flotation: Raising suspended matter to the surface of the liquid in a tank as scum by aeration or other means.

Gravity: System flowing without pumping

Grit: The heavy material in water or sewage such as sand, gravel, etc.

Lagoon: A relatively shallow basin or natural depression used for storage and stabilization of water, wastewater or sludge.

Mixed liquor: A mixture of return sludge and wastewater in the aerator of an activated sludge plant.

PAHO: Pan- America Health Organization.

pH: The logarithm of the reciprocal of the hydrogen-ion concentration.

Recirculation: The return of effluent to the influent of a process unit to reduce influent concentration, stabilize the system maintain high hydraulic flow, to process or for other beneficial reasons.

Screening: Materials removed by screen.

Scum: A mass of sewage matter which floats on the surface of sewage.

Skimmer: A device for removing floating grease or scum from the surface of sewage in a tank.

Sludge: Accumulated or concentrated solids from sedimentation or clarification of wastewater.

REFERENCES

D.C. Health and Company (1978). Applied Foodservice Sanitation, Second Edition, National Institute for the Foodservice Industry and National Sanitation Foundation, USA, 1978.

EPA (1977). Process Control Manual for Aerobic Biological Wastewater Treatment Facilities, Environmental Protection Agency, Washington DC, 1977.

JCM (1977). Wastewater Treatment Plant Design, Joint Committee of the Water Pollution Control Federation and the American Society of Civil Engineers, 1977.

Nelson W.E. (1972). Using Treated Effluent for Irrigation: Soil, Plant and water Criteria, Virgin Islands, 1972.

SEDUE (1985). Programa de Capacitación para operadores de Plantas de Tratamiento, Operación y Mantenimiento de Instalaciones para el tratamiento primario y Lagunas de Estabilización, Secretaría de Desarrollo Urbano y ecología, Mexico.

Vlugman, A. A. (1992). CEHI/PAHO Assessment of Operational Status of wastewater Treatment Plants in the Caribbean, pp.57 and Annexes.

WHO (1987). Waste Stabilisation Ponds Design Manual for Mediterranean Europe, World Health Organisation Regional Office for Europe, 1987.

.