Two Cell Lagoon Operation and Maintenance

Drinking Water Quality Section

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EPB 310

General

The intent of this document is to provide guidance to follow for the operation, maintenance and sampling procedures during treatment of wastewater in a two-cell lagoon. *Wastewater*, also known as *sewage*, is essentially the water supply of a community after it has been fouled by various uses. It may be composed of a combination of domestic wastewater (human and animal wastes), industrial wastewater (wastewater in which industrial wastes predominate) and stormwater (runoff resulting from precipitation).

If untreated wastewater is allowed to accumulate, the decomposition of organic materials it contains can lead to the production of large quantities of unpleasant gases. In addition, untreated wastewater contains numerous pathogenic (disease-causing) microorganisms that dwell in the intestinal tract or that may be present in certain industrial waste. For these reasons, good wastewater treatment is necessary to prevent disease and nuisance conditions and to protect the environment.

1. Physical Description of a Typical Wastewater Treatment Lagoon

For the purpose of this document, a two-cell lagoon will only be considered. The two cells used for wastewater treatment are not simply two holes in the ground into which wastewater is discharged. Wastewater treatment lagoons are designed and constructed for the purpose of providing the right environmental conditions for bacteriological processes to proceed. They should be easily and safely operated without causing any adverse effects to the environment.

The requirements of good wastewater treatment can be met if lagoon cells are constructed in such a way as to:

i. Control seepage to groundwater. This can be accomplished by constructing the lagoon in an area which contains good clay material or covering the interior surfaces of each cell with a layer of well compacted clay.
ii. Have sloped and grassed dykes. This makes it easier to maintain the dyke, cut the grass and helps reduce erosion. The slope of the inner face of the dyke is usually 1 metre vertical to 4 metres horizontal. The slope of the outer face of the dyke should be no steeper than 1 metre vertical to 3 metres horizontal.
iii. Have dykes of at least 3 metres top width to provide a good access road around the cells for inspection purposes.
iv. Have a fence that encloses the entire cell area to prevent trespassing by man or animal.
v. Have the inlet piping in the primary cell located so as to prevent short circuiting.
vi. Have transfer pipe(s) and control valve(s) between the two cells.
vii. Have an overflow at the designed operating level installed between the primary and secondary cells. This may consist of a half culvert, open channel or other device.
viii. Have an outlet pipe from the secondary cell located as near as possible to the receiving area for treated wastewater.

The first cell is the treatment cell (primary cell). The size of the cell depends upon the sewage strength and flow rate of the wastewater discharged by the community. Primary cells should not be designed to operate at depths (liquid level) greater than 1.5 metres. Greater depths reduce treatment efficiency and odour problems could result.

The second cell is the holding cell. The capacity is based on a minimum 180 day retention period (longer period may be required where effluent irrigation is used).

2. Wastewater Treatment Steps

This process is carried out by breaking down of organic matter by the bacteria present in the wastewater. There are three types of bacteria that work in this process: aerobic, anaerobic and facultative bacteria

Aerobic bacteria need dissolved oxygen to live and grow and live in the upper part of the lagoon. Anaerobic bacteria that live in the lower part of the lagoon can live and grow only when there is no dissolved oxygen. Facultative bacteria live in the mid-depth region of the lagoon. They live and grow with or without dissolved oxygen. Since all three types of bacteria are present in the lagoon and active in breaking down the organic matter, the lagoon is called *facultative waste stabilization lagoon*. Oxygen must be provided for the aerobic bacteria. Nature does this in two ways:.

i. by wind action on the water surface mixing air into the wastewater; and
ii. by photosynthesis – a process by which sunlight is utilized as an energy source by small green plants called algae to convert carbon dioxide and nutrients into new cell growth and produce oxygen.

3. Operation and Maintenance

Proper operation and maintenance of a lagoon is essential for efficient wastewater treatment. If a lagoon is well operated and maintained, the stored wastewater in the cells should have a green colour and no unpleasant odour.

(a) Operation: To properly operate a lagoon, the lagoon operator is mainly concerned with the following:

i. When to discharge: Under normal operating conditions, a two-cell lagoon is discharged twice a year. Discharge times are:
   - During spring runoff – the quality of effluent at this time of year is such that dilution with spring runoff is preferable.
   - During fall, no later than November 1 – the effluent at this time has received a high degree of treatment. Discharge after November 1 requires special permission from the Water Security Agency - contact the Environmental Project Officers for further information.

ii. **Discharge Procedures:** For good public relations, the lagoon operator should inform downstream landowners about the start time, date and estimated duration of the discharge before discharge is started.

   Spring discharge: Spring discharge is done in the following sequence:
   - close the transfer valve between the two cells and discharge the second cell only, by opening the discharge valve. When discharge is completed, close the discharge valve;
   - open the transfer valve between the cells and equalize liquid depths in each cell; and
   - when the liquid levels in both cells are equal, close the transfer valve and keep it closed during summer operation. Now the lagoon will operate in series with liquid being transferred by the overflow structure.

   Fall Discharge: Fall discharge is done in the following sequence:
   - keep the transfer valve closed;
   - open the discharge valve and release liquid from the second cell. When this is drained, close the discharge valve; and
   - open the transfer valve and leave this valve open during winter operation.

iii. **Odour Control:** Odour problems created by anaerobic conditions may be controlled by either of the following methods:
   - adding oxygen to the cells by mechanical methods using a surface aerator or subsurface tubing; or
   - adding sodium nitrate as a source of oxygen. The amount of this chemical to be added on the first day is 112 kg/ha (100lb/acre), then 56 kg/ha (50 lb/acre) per day thereafter if odour persists.

This addition can be applied at a lift station or a manhole prior to the lagoon. It can also be added by broadcasting from a boat. This method should only be used in the case of extreme emergency.

iv. **Removal of Floating Debris:** Plants with floating leaves and scum formation on the water surface reduce the amount of sunlight available, and therefore reduce the amount of oxygen produced by the algae. Floating debris can be removed with a rake from a boat.

v. **Operational Records:** The lagoon operator should keep the following records:
- dates of discharge;
- amount of time that was required to discharge;
- colour of wastewater in each cell prior to discharging;
- odour;
- dates of collecting and submitting samples to an analytical laboratory;
- specific locations of the collected samples; and
- cell levels before and after discharge.

(b) Maintenance: Once the cells are constructed, periodic maintenance must be followed to ensure that the cells will function properly.

(i) **Dyke Maintenance:** Dyke maintenance includes:
- (a) **Rodent control** – periodic checks should be made to see that burrowing animals such as muskrats, have not damaged the dyke. Rodent control may be achieved by trapping or shooting. After the rodents have been eliminated, the operator should repair any dyke damage.
- (b) **Seepage control** – the ground around the toe of the dyke should be checked frequently to determine if seepage is occurring. Seepage through the dyke can weaken it leading to structural failure. When seepage is suspected, the lagoon operator should advise the Water Security Agency and contact an engineering firm for advice.
- (c) **Erosion control** – erosion can take place on either the inner sloped side due to wave action, or the outer sloped side due to surface runoff. Wave action erosion is controlled by the use of rip-rap material. Rip rap should be placed above and below the waterline around the affected area. Surface runoff around the perimeter of the lagoon should be controlled to prevent exterior dyke erosion. This can be done by proper grading.

(ii) **Removal of Sludge Mounts:** During winter operation, solids may build up in a mound around the inlet. This can cause objectionable odours. Solids accumulation could also lead to a blockage in the inlet pipe. A sludge mound can be dispersed manually from a boat, by high pressure hosing or by dragging in a crisscross fashion with a car frame. During cleaning operations the inlet pipe must be flagged to prevent damage.

(iii) **Maintenance of Overflow:** The overflow between the primary and secondary cells should be kept open and well maintained. Overtopping the dyke due to a blocked overflow can result in breaching of the dyke and eventually complete dyke failure.

(iv) **Fence and Gate Repairs:** The fence and gate must be kept in good condition to help prevent trespassing by unauthorized personnel and to keep out livestock.

(v) **Vegetation Control:** A well-kept lagoon is not a good breeding place for mosquitoes. This means keeping the grass cut on the dyke and eliminating any vegetation growing at the waters edge. Growth can be cut or burned, but it should be done regularly. Weeds and bullrushes in the cells must also be kept cut. This can be done with a hand scythe

from a boat. Trees should also be cut in proximity around the cells, particularly for larger lagoon systems. Trees limit wind action. Wind assists in introducing dissolved oxygen into the cells. Certain tree species may be beneficial in limiting or remediating seepage from lagoons, however location is also important so as not to limit proper wind action. In situations where lagoon usage is significantly below capacity, tree removal may be less critical, however growth in immediate proximity to the wastewater should be properly managed.

(vi) **Liquid Waste Haulers:** A properly designed receiving area, pad or chutes or should be employed and maintained. Please see section 4.4.3 of EPB 503 - Guidelines for Sewage Works Design for more information.

4. Sampling and Laboratory Control

Several laboratory tests are normally required to gauge lagoon performance. These tests include: pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), suspended solids (SS), and total and fecal coliform tests. Other parameters are normally analyzed as well, to determine the effluents impact on the receiving environment.

The pH test is to measure the intensity of acidity or alkalinity of the wastewater. Its value ranges between 0 and 14. If the pH is less than 7, we say that the wastewater is acidic. If the pH is greater than 7, we say that the wastewater is alkaline.

The DO test is to measure the amount of dissolved oxygen in the wastewater. Remember that DO in wastewater is essential for aerobic bacteria to live and treat the wastewater. Normal lagoon DO ranges are 5 to 20 milligrams per litre (mg/L). If the DO drops below 5 mg/L, then corrective action can be taken by installing supplementary aeration equipment.

Samples for pH and DO tests should be taken during late afternoon (pH and DO are maximum in late afternoon and minimum at sunrise). The BOD test is to measure the organic strength of the wastewater. Normal raw sewage varies between 150 and 250 mg/L.

The SS test is to measure the amount of solid particles which are in suspension in the wastewater. Suspended solids are normally removed by the process of sedimentation or settling. In normal domestic sewage the values of SS and BOD are very similar.

The coliform test is an indicator of the amount of disease causing (pathogenic) bacteria in the wastewater. The total coliforms in the lagoon should not exceed the value stipulated in Table 4.1 of Guidelines for Sewage Works Design EPB 503.

Samples for wastewater analysis should be collected in each spring and fall. To obtain a representative sample, collect it about half-way through the discharge period. Use a clean, well-rinsed 2.5 litre plastic container for pollution control parameters and a 250 millilitre sterile container for bacteriological analysis. Further information on sampling of effluents and receiving waters is available in a specific document: EPB 281 – Sampling Guidelines for Effluents and Receiving Waters.

5. Lagoon Observations

By observing the colour changes within the lagoon, the operator can interpret actual liquid conditions.

Listed below are cell wastewater colours, and the conditions that each colour indicates:

- **Dark Sparkling Green:** good; high pH and DO.
- **Dull Green to Yellow:** not so good; pH and DO are dropping; blue-green algae are becoming established.
- **Gray to Black:** very bad, pond is anaerobic.
- **Purple:** not so good; presence of purple sulphur bacteria (anaerobic conditions).
- **Pink colour throughout the cell:** not so good. An overabundance of Daphnia can also cause problems since they use algae for food and hence lower the oxygen content of the cell.
- **Tan to Brown:** okay, if caused by type of algae bloom. Not good if due to bank erosion or silt.

6. Safety Considerations

Stabilization lagoons, like other wastewater treatment facilities, must be treated with care from a safety and public health point of view by operators and the general public alike.

Listed below are factors that a safety conscious lagoon operator must keep in mind:

(a) Personal Hygiene:

(i) discuss possible immunizations with your family doctor;
(ii) do not smoke while working around sewage lagoons;
(iii) after working around a sewage facility do not wear dirty coveralls to your home;
(iv) always clean any equipment such as safety belts, face masks, gloves, etc., after using. You or someone else may want to use it again;
(v) always wear rubber or plastic coated gloves when cleaning out pumps, handling hoses or working anywhere around the lagoon; and
(vi) see your doctor for all injuries. When working with wastewater the smallest cut or scratch is potentially dangerous.

(b) Public Health

Lagoon cells are facilities for treating human and industrial wastes, and as such people should be advised to keep away from them. Be especially careful with vehicles and lawn mowers on lagoon dykes.