Stabilization Ponds

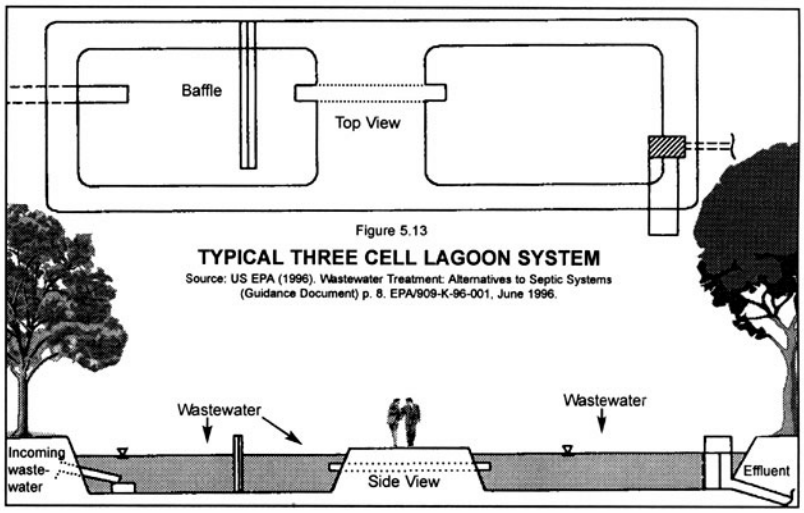
CE - 370

1

Introduction

- Stabilization ponds, also known as oxidation ponds or lagoons are one of the most ancient wastewater treatment methods known to humans.
- They're often found in small rural areas where land is available and cheap.
- Such ponds tend to be only a meter to a meter and a half deep, but vary in size and depth, and may be three or more meters deep.
- They utilize natural processes to "treat" waste materials, relying on algae, bacteria, and zooplankton to reduce the organic content of the wastewater.

2



3

Introduction

- A "healthy" lagoon will appear green in color because of the dense algae population. These lagoons require about one acre for every 200 people served.
- Mechanically aerated lagoons only need 1/3 to 1/10 the land that unaerated stabilization ponds require.
- It's a good idea to have several smaller lagoons in series rather than one big one; normally, a minimum of three "cells" are used. Sludge collects in the bottom of the lagoons, and may have to be removed every five or ten years and disposed of in an approved manner.

4

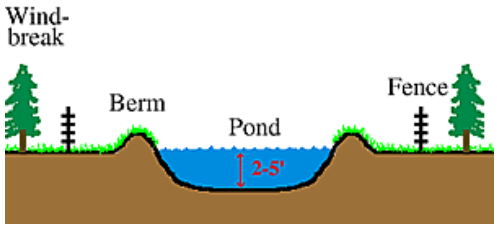
5

Requirements

- Stabilization ponds are very simple to construct. A bulldozer is used to remove soil from the ground and create a basin in which water can collect.
- The first requirement of a sewage pond is that it must be surrounded by a **berm** (a mound or wall of earth) or an **embankment** (a raised structure to hold back the water). The berm or embankment prevents storm water from running into the pond.
- The soil in which a pond is built must be impermeable. This will prevent the sewage from being absorbed into the ground and from leaking pollutants into the area.

6

Introduction



7

Requirements

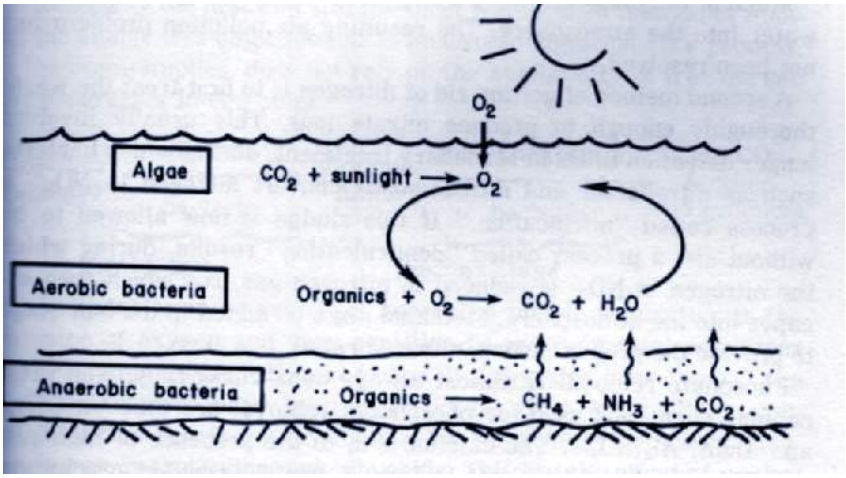
- A pond must be completely fenced to keep unwanted visitors out.
- Sewage ponds must be encircled by a windbreak, which usually consists of a row of pine trees. The windbreak will prevent the pond's odors from disturbing the nearby residents and will also make the area aesthetically pleasing.
- The depth of the pond is another important factor. The pond must be greater than two feet deep at all parts to exclude plant growth.

8

General Characteristics

- Wastewater enters the pond
- Organic matter is bio-oxidized
- End products of microbial activities include:
  - CO_2
  - NH_3
  - SO_4^{-2}
  - PO_4^{-3}
  - New microbial cells
- Algal population uses CO_2, SO_4^{-2} and PO_4^{-3} and sunlight to produce O_2, new algal cells and end products
- To further improve the quality of the pond effluent, algal growth must be removed

9



10

Classifications of Ponds

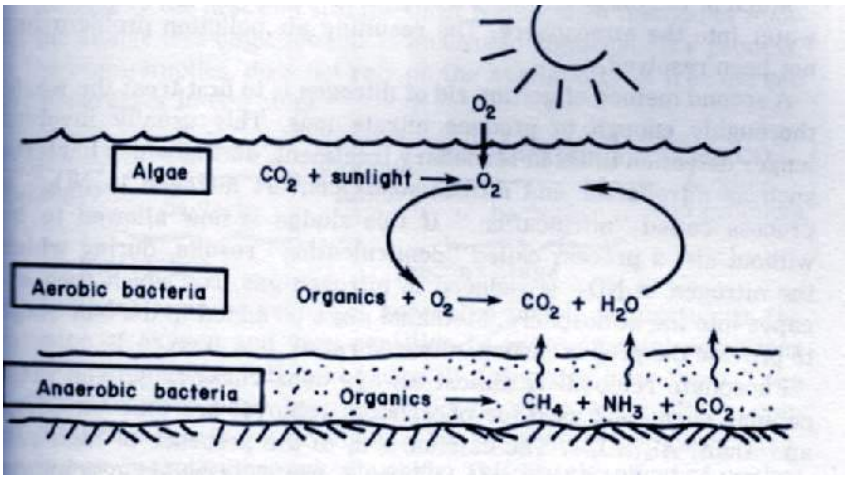
- According to O_2 profile, ponds are classified into:
  - Aerobic (O_2 throughout its depth)
  - Anaerobic (no O_2 throughout its depth)
  - Facultative (O_2 in upper depth and no O_2 in lower depth)
- Most of ponds are facultative
  - Loaded higher than aerobic ponds
- Amount of O_2 in facultative ponds depends on:
  - Organic loading
  - Sunlight intensity

11

Mechanism

- During night
  - Photosynthesis ceases after sunset
  - Production of O_2 stops
  - Dissolved O_2 deceases due to microbial and some of algal populations that use O_2
- During day
  - Sun rises and photosynthesis starts
  - Dissolved O_2 increase
  - Maximum O_2 occurs during middle of the day
- During summer
  - O_2 is between 2 and 3 mg/l during night
  - O_2 is between 14 to 16 mg/l during the day

12

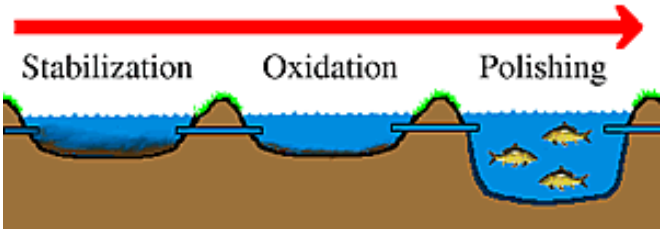


13

Mechanism

- During cloudy days, anaerobic condition may occur throughout the depth of the facultative pond
- As algal and microbial cells die, they settle to the bottom of the pond and undergo anaerobic decomposition
- Sludge accumulates very slow (only several millimeters per year)
- One third to one half of influent organic carbon is synthesized into microbial and algal cells that leave with the pond effluent
- Polishing treatment might be necessary to improve the quality of the effluent

14



15

Characteristics of Facultative Ponds

- Depth is 0.91 to 2.44 m
  - If pond is to be converted to aerobic (in future), then it should be deeper to accommodate aerators
- Shape is usually
  - Circular
  - Rectangular
- For single pond or ponds in parallel
  - Organic loading = 28 to 39.2 kg BOD_5/ha-day
- For ponds in series
  - Organic loading of first pond = 84.1 to 89.7 kg BOD_5/ha-day
  - Organic loading of downstream pond = 28 to 39.2 kg BOD_5/ha-day

16

Design of Facultative Pond

- The volume a facultative pond treating municipal wastewater can be determined by:

$$V = CQS_i \left[\theta^{(35-T)}\right] ff'$$

- V = pond volume, ft^2 (m^2)
- C = 4.7×10^{-3} for USCS units and 3.5×10^{-5} for SI units
- Q = flow, gal/day (liter/day)
- S_i = ultimate influent BOD or COD, mg/l
- *f* = algal toxicity factor, f = 1 for municipal and many industrial wastewaters
- *f'* = sulfide or other immediate chemical oxygen demand; *f'* = 1 for SO_4^{-2} equivalent ion concentration of less than 500 mg/l
- θ = temperature coefficient
- T = average water temperature for the pond during winter months, °C

17

Design of Facultative Pond

- The value of θ ranges between 1.036 to 1.085
- Recommended value of θ is 1.085
- For θ of 1.085 and depth of 5 ft (1.52 m), the area of pond can be calculated from:

$$A = CQS_i \left[1.085^{(35-T)}\right] ff'$$

  - A = area o pond, acres (ha), for a depth of 5 ft + 1 ft of sludge storage (1.5 m + 0.3 m)
  - C = 2.148×10^{-2} for USCS units and 2.299×10^{-3} for SI units
  - Q = flow, MGD (MLD)

18

Example 18.1

19

20