WASTE STABILIZATION POND

300 years experience

Shallow man-made basins

Round, **square, rectangular** or irregular shape

Advantages

Simplicity

Simple to construct

Simple to operate and maintain

Only unskilled labor is needed

Low Cost

Capital and operational

Advantages

High Efficiency

BOD removal **> 90%**

Total N removal **70-90%**

Total P removal **30-45%**

Effective in removing **pathogens**

Principal Requirements

Sufficient land is available

Soil should preferably have a **coefficient of permeability** < 10^{-7} m/s
(to avoid the need for pond lining)

Types of WSP

Facultative pond

Maturation pond

Flow Diagram

influent

↓

screen

↓

facultative pond

↓

maturation pond

(can be more than 1 in series)

↓

effluent


①
Facultative pond
②
Maturation pond

Facultative Pond

1-2 m deep

Primary function is BOD removal

- Sedimentation of settleable solids
- Oxidation of non-settleable solids by heterotrophic bacteria

Zones in Facultative Pond

Aerobic zone (surface)

Facultative zone (middle)

Anaerobic zone (bottom)

Aerobic zone

Also known as **surface zone**

Aerobic **bacteria** and **algae** exist in **symbiosis**

Algae provide bacteria with **oxygen**

Bacteria provide algae with **carbon dioxide**

Facultative zone

Also known as **intermediate** zone

Partly **aerobic** and **anaerobic**

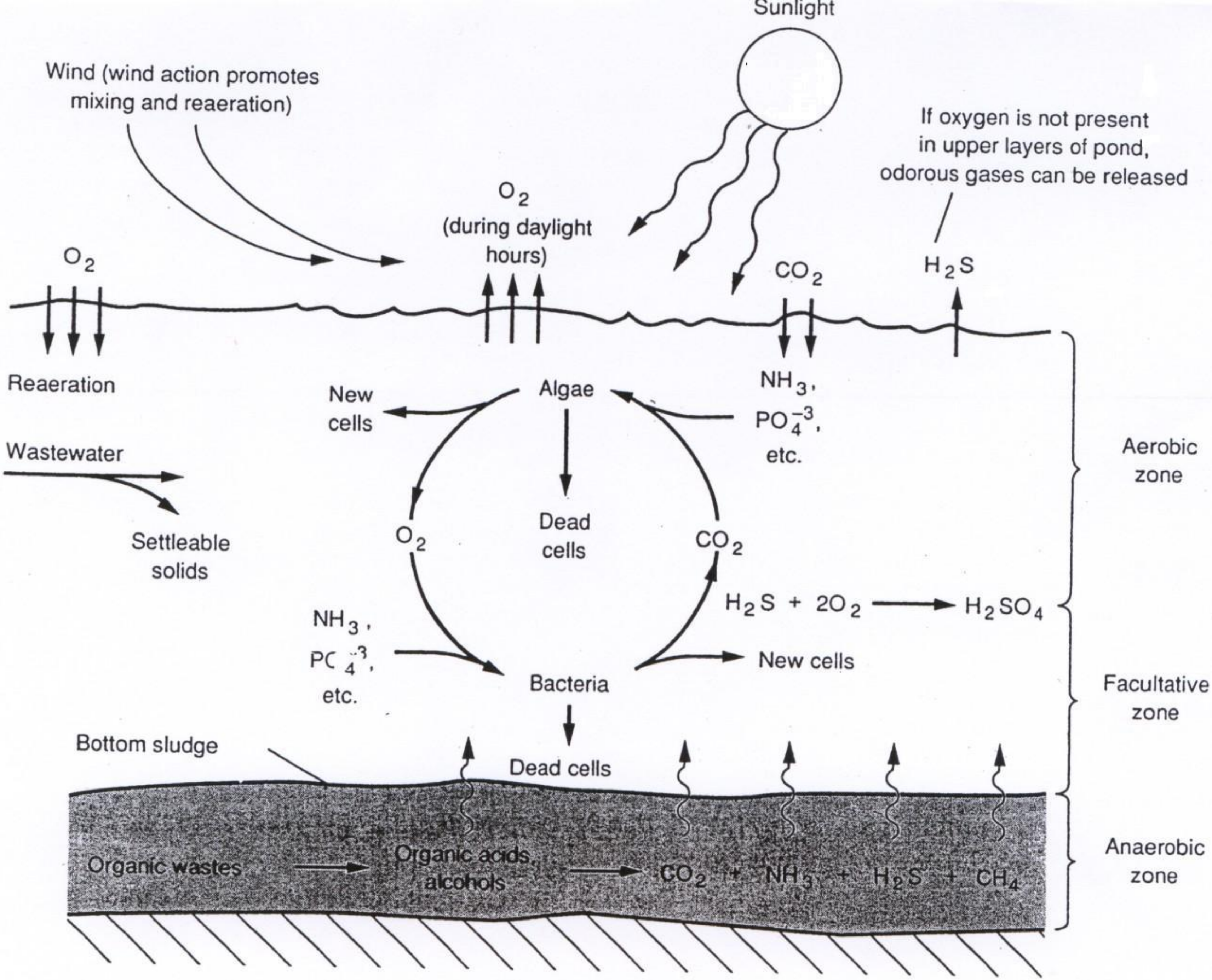
Decomposition of organic by **facultative** bacteria

Anaerobic zone

Also known as **bottom** zone

Anaerobic condition

Accumulated solids decomposed by anaerobic bacteria



Sunlight
Wind (wind action promotes mixing and reaeration)
If oxygen is not present in upper layers of pond, odorous gases can be released
O_2 (during daylight hours)
O_2
CO_2
H_2S
Reaeration
Algae
New cells
NH_3, PO_4^{-3}, etc.
Wastewater
Settleable solids
Dead cells
O_2
CO_2
$H_2S + 2O_2 \rightarrow H_2SO_4$
Aerobic zone
NH_3, PO_4^{-3}, etc.
Bacteria
New cells
Facultative zone
Bottom sludge
Dead cells
Organic wastes → Organic acids, alcohols → $CO_2 + NH_3 + H_2S + CH_4$
Anaerobic zone

Maturation Pond

1-1.5 m deep

Receive effluent from facultative pond

Primary function is **removal of pathogens**

Small amount of BOD removal occurs

Pathogen Removal

Faecal bacteria are removed in facultative and especially maturation ponds

The principal mechanism removal are:

Time and temperature

Light of wavelength **425 – 700 nm** can damage faecal bacteria

Sedimentation (especially protozoan cyst and helminth eggs)

Design

Facultative Pond

Permissible BOD loading $\lambda_{s,max}$

$$\lambda_{s,max} = 350\ (1.107 - 0.002T)^{T-25}$$

where T = temperature

Surface BOD loading (λ_s, kg/ha .d)

$$\lambda_s = 10L_iQ/A_f$$

where A_f = facultative pond area, m^2
Li = BOD influent, mg/L
Q = flow rate, m^3/d

Area of facultative pond

$$A_f = 10L_iQ/\lambda_s$$

Hydraulic retention time

$$t_f = A_f D/Q$$

where D = pond depth, m

Q = wastewater flow, m^3/day

Design

Maturation Pond

Based on **faecal coliform removal.** The equation for a **single** pond:

$$N_e = N_i/(1 + k_T t) \quad \text{(Eqn. 9.4)}$$

N_e = number of FC per 100 mL of effluent

N_i = number of FC per 100 mL of influent

k_T = first order rate constant for FC removal, 1/day

t = hydraulic retention time, day

For a series of facultative and maturation ponds

$$N_e = \frac{N_i}{\left(1 + K_T t_f\right)\left(1 + K_T t_m\right)^n}$$

N_e = number of FC/100 mL of the final effluent

N_i = number of FC per 100 mL of influent

n = number of maturation

The value of k_T is temperature dependent

$$k_T = 2.6\,(1.19)^{T-20}$$

Effluent for a single tank

$$l_e = \frac{l_i}{K_1 t + 1}$$

l_e = BOD effluent concentration, mg/L

l_i = influent concentration, mg/L

K_1 = first order rate constant for BOD removal, per day

t = retention time, day

For n ponds in series

$$I_e = \frac{I_i}{(1 + K_1 t_f)(1 + K_1 t_m)^n}$$

Effect of temperature

$$K_{1(T)} = K_{1(20)} \theta^{T-20}$$

K_1@ 20^{o}C = 0.3 per day and θ = 1.05