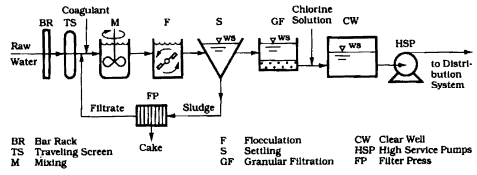
Treatment Processes



Screening → Aeration → Prechlorination → Coagulation → Flocculation → Sedimentation

1

Screening

- Coarse bar racks and fine traveling racks are employed at intake structure, on reservoirs and rivers.
- Coarse bar screen racks usually have clear spaces up to 3 inches (75mm) between the bars and are used to prevent the entry of large debris, such as logs, into the intake structure.

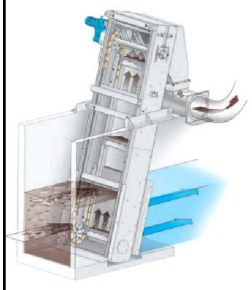
2

Screening

- Fine traveling screens located behind the bar racks usually have openings of about 3/8 to 1/2 inches (10 to 13 mm) and are used to prevent the entry of small debris, such as sticks, bark, leaves, and fish.
- Some river waters have high turbidities and coliform counts that may require presedimentation prior to other treatments.

3

Traveling Screens



4

Traveling Screens

5

Aeration

- Aeration may be used for gas stripping (degasification) to remove unwanted gases, such as carbon dioxide and hydrogen sulfide, and iron and manganese.
- Groundwaters, in particular, may require aeration to remove these contaminants.
- Usually, aeration is accomplished by cascades, multiple-tray aerators, spray nozzles, or diffused compressed air.

6

Aeration

- A **cascade** usually is a flight of three or four concrete or metal steps over which the water tumbles as a thin sheet.
- **Multiple-tray aerator** - Consists of a series of horizontal traps, each containing 8 to 12 inches of medium, the medium being ceramic balls 2 to 6 inches in diameter, slag, or stones.
- Some tray aerators have no medium and depend upon the perforated plates, slots, or screen trays.

7

Aeration

- **Spray nozzles** are sometimes used for aeration; however, they require considerable pressure head.

8

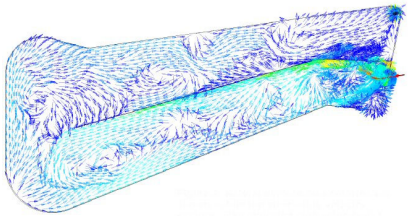
Aeration

Aerial view of a lagoon showing mixing taking place by aerators just below the surface

9

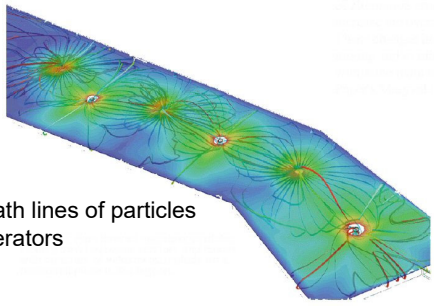
Aeration

Model of natural surface flow patterns using velocity vectors (blue represents low velocity)



10

Aeration



Model of path lines of particles between aerators

11

Aeration

Diffused compressed air tanks - The air is supplied by diffusers that are placed along the bottom of one wall to give a spiral roll to the water.

12

Aeration Model

The removal of carbon dioxide can be estimated as follows:

$$\frac{C}{C_0} = e^{-kn}$$

where: C is the effluent concentration, mg/l,
C_0 is the influent concentration, mg/l,
k is the rate constant, and
n is the number of trays

Typically, k is from 0.28 to 0.37 for carbon dioxide

13

Carbon Dioxide Removal Problem

- Groundwater containing 8 mg/l of carbon dioxide will be degasified using a multiple-tray aerator with five trays. The design population is 5,000, and the maximum demand is 150 gal/person-day. The k value is 0.33, and the hydraulic loading is 3 gpm/ft.^{2}.
- Determine:
  - The carbon dioxide content of the product water.
  - The size of the trays if the length-to-width ratio is 1.5 to 1 and the trays are made in 1 in. increments.

14

Carbon Dioxide Removal Problem

- The performance equation is: $\frac{C}{C_0} = e^{-kn}$
- Therefore:

$C = C_0 e^{-kn}$

Five aeration trays

$C = (8\ mg/l)e^{-5(0.33)}$

8 mg/l initial concentration

C = (8 mg/l)(0.1920) = **1.54 mg/l**

15

Carbon Dioxide Removal Problem

The flow to the aerator is:

$$Q = 5{,}000\ persons \left[\frac{150\ gal}{person - day}\right] = 750{,}000\ gal/day$$

$$Q = \left[750{,}000\ gal/day\right]\left[\frac{day}{1{,}440\ min}\right] = 520.8\ gal/min$$

Total flowrate

16

Carbon Dioxide Removal Problem

- The area is: $A = (520.8\ gpm)\left[\frac{ft.^2}{3\ gpm}\right] = 173.6\ ft.^2$

Flowrate

Loading rate

- Since L = 1.5W, therefore: A = LW = (1.5W)W

A = W(1.5W) = 173.6 ft.^{2}

W = 10.76 ft. or 10 ft. 9.1 in. or **10 ft. 10 in.**

L = 1.5(10.76 ft.) = 16.14 ft. or **16 ft. 2 in.**

17

Carbon Dioxide Removal Problem

- Groundwater containing 20 mg/l of carbon dioxide will be degasified using a series of ten multiple-tray aerators. Each aerator uses four trays. The aerators will be operated in parallel. For flexibility, any eight aerators will be operative at one time while two aerators are inoperative for cleaning and maintenance.
- The design population is 50,000, and the maximum demand is 150 gal/person-day. The k value is 0.31, and the hydraulic loading is 4 gpm/ft.^{2}.
- Determine:
  - The carbon dioxide content of the product water.
  - The size of the trays if the length-to-width ratio is 2:1 and the trays are made in 1 in. increments.

18

Carbon Dioxide Removal Problem

- The performance equation is: $\frac{C}{C_0} = e^{-kn}$
- Therefore:

$C = C_0 e^{-kn}$ (4 aeration trays)

$C = 20e^{-4(0.31)}$ (20 mg/l initial concentration)

C = 20(0.2894) = **5.79 mg/l**

19

Carbon Dioxide Removal Problem

The flow to each aerator is:

$$Q = 50{,}000\ persons \left[\frac{150\ gal}{person - day}\right] = 7.5\times10^6\ gal/day$$

$$Q = \left[7.5\times10^6\ gal/day\right]\left[\frac{day}{1{,}440\ min}\right] = 5{,}208.3\ gal/min$$

Total flowrate

$$Q = \left[5{,}208.3\ gal/min\right]\left(\frac{1}{8}\right) = 651\ gal/min$$

(# of aerators; Flowrate/aerator)

20

Carbon Dioxide Removal Problem

- The area is: $A = (651\ gpm)\left[\frac{ft.^2}{4\ gpm}\right] = 162.8\ ft.^2$

(Flowrate/aerator; Loading rate)

- Since L = 2W, therefore: A = WL = W(2W)

A = W(2W) = 162.8 ft.^{2}

W = 9.02 ft. or 9 ft. 0.25 in. or **9 ft. 1 in.**

L = 2(9 ft. 1 in.) or **18 ft. 2 in.**

21

Treatment Processes

Any Questions?

22