Wastewater Treatment Engineering

Lecture 6

Rotating biological contactors (RBC)

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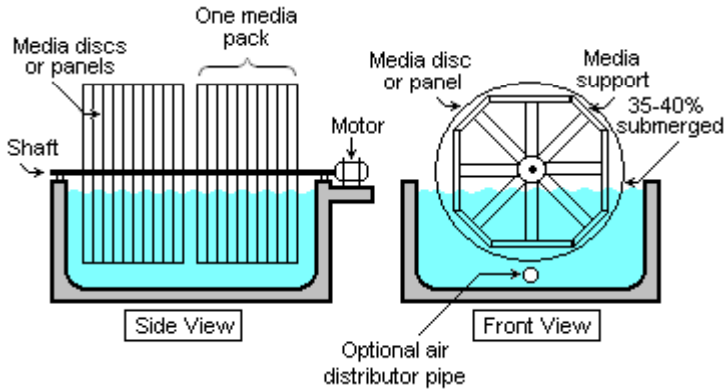
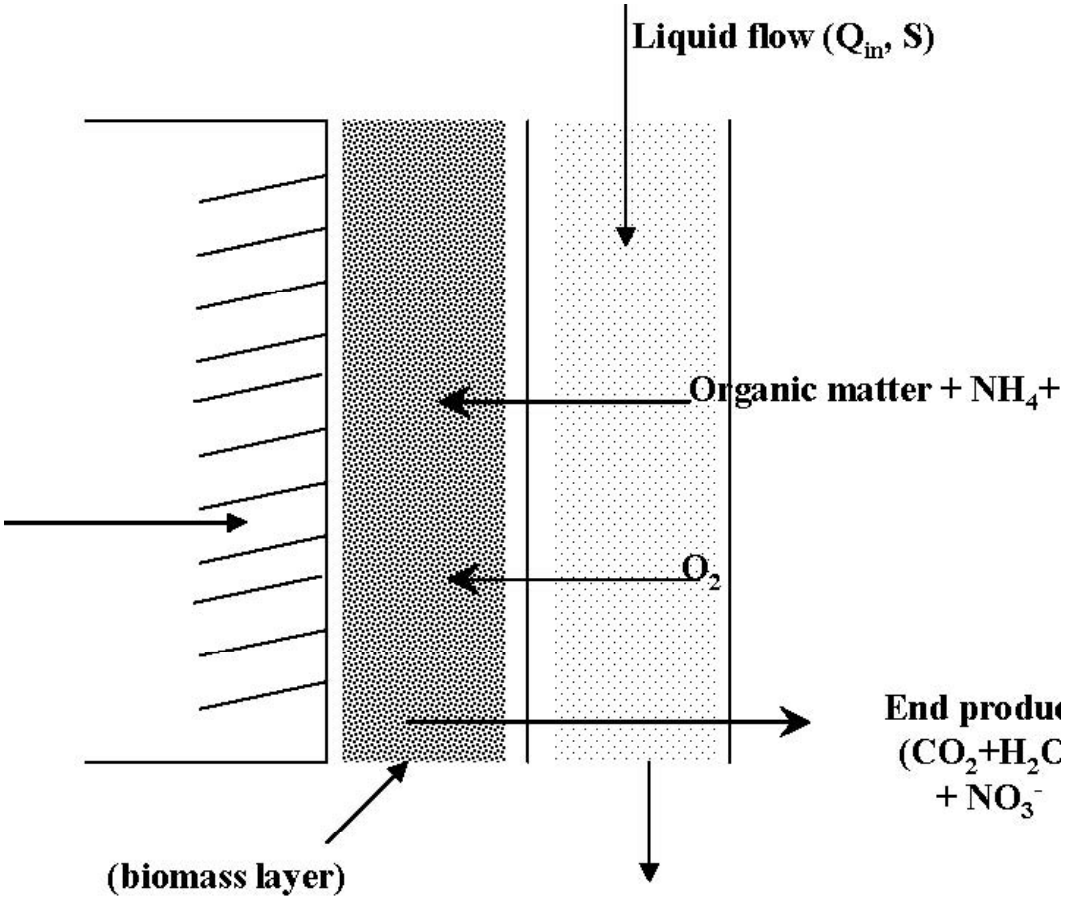
ROTATING BIOLOGICAL CONTACTORS

A rotating biological contactor (RBC) is an aeration device for reducing the BOD value of a liquid effluent. A fixed film of microorganisms is established on a contactor which is constructed from sets of discs made of corrugated GRP, high-density polyethylene or polypropylene fixed to a central horizontal shaft. The shaft may be 3-7 m long and is supported on bearings in a semicircular steel, glass reinforced plastic or concrete tank so that about 40 % of the contactor lies below the surface of the effluent to be treated. The shaft is turned slowly and the attached biomass is alternately submerged in the effluent where it absorbs BOD or raised out of the liquid so that the microorganisms absorb oxygen.



Rotating biological contactors (RBC)

- **Theory of attached growth treatment:**



Attached Growth Processes

- According to the figure shown, a biomass layer(bacteria) stick to the solid media and grow there. The liquid wastewater pass adjacent to the biomass layer forming a liquid layer. During the passage of the wastewater in the liquid layer and its contacts with the biofilm layer the organic matter, ammonia and dissolved oxygen in addition to other dissolved materials penetrate into the biomass layer by diffusion. The biochemical reactions such as organic matter oxidation, nitrification occur inside the biofilm layer. The end products such as CO_2, H_2O -,and NO_3 Leave the biofilm layer back to the Liquid Layer and move out with the liquid flow to the effluent stream.
- Denitrification can be achieved in attached growth system in the lower parts of these systems where anoxic conditions exist.
- The bacteria in the biomass layer grow and some of it die . The dead bacteria lose its sticky characteristics and its removed from the biomass layer by the action of the moving liquid.
- The removed bacteria is then removed by sedimentation in a final sedimentation tank.
- The biochemical reaction for BOD removed nitrification and denitrification are the same of those in the suspended growth system.

RBC process design considerations

- The following are the main design parameters needed to design the RBC System :-
  1. Staging of the RBC units
  2. Organic loading rate
  3. Hydraulic loading rate

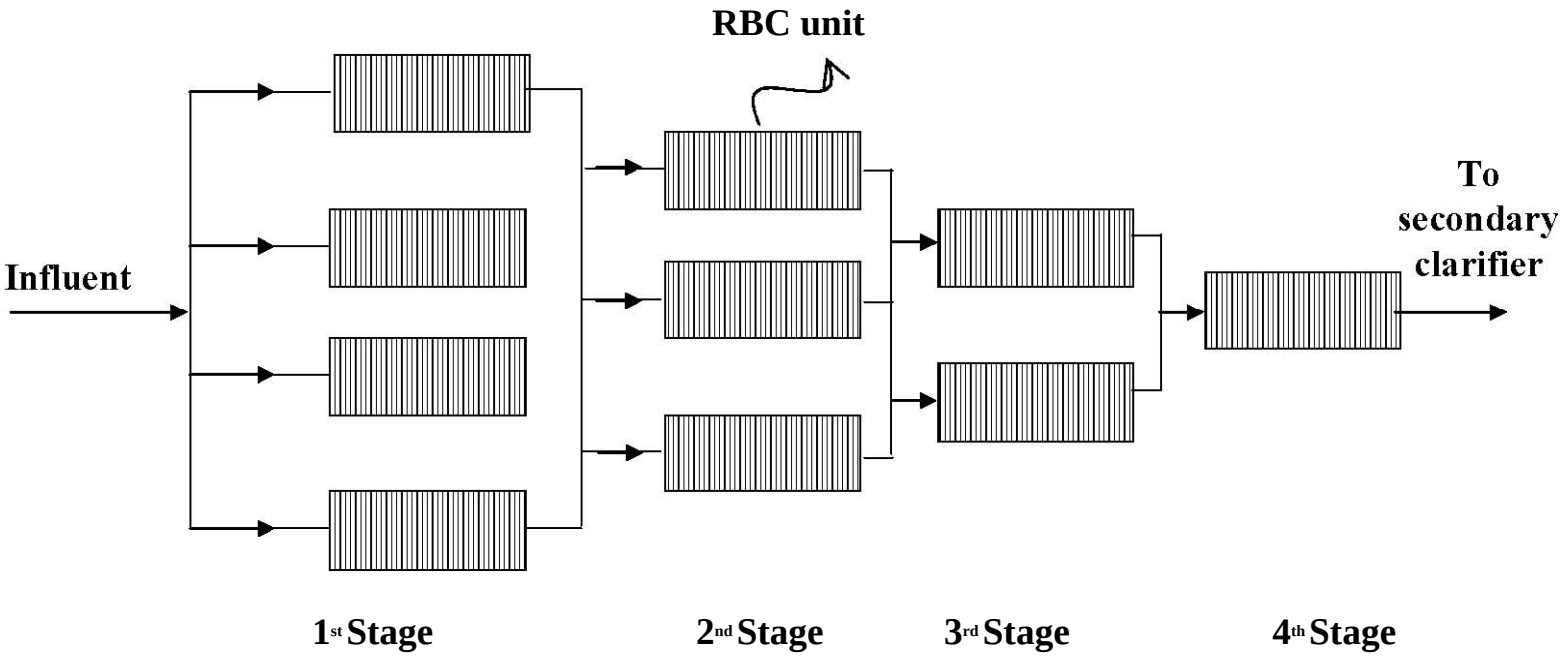
RBC process design considerations

Staging of the RBC units :-

- The RBC process application typically consists of a number of units operated in series.
- For this purpose , RPC is divided into stages . Number of stages depends on the treatment goals . For BOD removal " 2 " to " 4" stages are needed ,and " 6" or more stages for nitrification .
- NOTE : the number of shafts in each stage depends on the treatment
  - efficiency required .
  - · The separation between stages is accomplished by using
  - baffles in a single tank or by a series of separate tanks .
  - · As the wastewater flow through the system , each
  - subsequent stage receives an influent with a lower
  - organic matter concentration than the previous stage.
  - · The RBC units may be arranged parallel or normal to the
  - direction of wastewater flow.

RBC process design considerations

Staging of the RBC units



RBC process design considerations

Organic loading rate:-

- The organic loading rate for BOD removal only in the range 4-10 g(BOD)/m2/day
- The organic loading rate for BOD removal and nitrification in the range 2.5-4g(BOD)/m2/day
- The maximum 1st stage organic loading is 12-15g(BOD)/m2/day
- Nitrifying bacteria can not develop in RBC until(BOD5) drops to <15mglL.
- The maximum nitrogen surface removal rate that has been observed to be about 1.5g(N)/m2/day

RBC process design considerations

Hydraulic loading rate:-

- The hydraulic loading rate for BOD removal only in the range 0.08-0.16 *m3/m2*
- The hydraulic loading rate for BOD removal and nitrification in the range 0.03-0.08 *m3/m2*
- The hydraulic retention time for BOD removal only in the range 0.7-1.5 *hour*
- The hydraulic retention time for BOD removal and nitrification only in the range 1.5-4 *hour*

Design equation of RBC:

The following empirical equation developed by Optaken(US EPA,1985):

$$S_n = \frac{-1 + \sqrt{1 + 0.039(\frac{A_s}{Q})S_{n-1}}}{0.0195(\frac{A_s}{Q})}$$

Where S_n = soluble BOD concentration in stage(n), (mg/L)

As = disk surface area on stage(n), m2

Q= flow rate, m3 / d

Typical treatment plan configuration: