Water and Wastewater Treatment

CE421/521
Environmental Biotechnology
Tim Ellis
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Wastewater Treatment

- Three objectives of wastewater treatment:
  - reduce o_____ matter (includes xenobiotic & recalcitrant organics, e.g. pharmaceuticals, hormones, etc.)
  - remove n_____ (N&P)
  - reduce p_____

Categories of pollutants in wastewater

- S_____ and insoluble
- O_____ and inorganic
- N_____ and synthetic
- T_____ and non-toxic
- Volatile and non-volatile
- Xenobiotic and b_____
- Anthropogenic and n_____ occurring

Dilute nature of pollutants

- Large v_____
- C_____ & remove
- S_____ and liquid streams
- Use b_____ operations to treat both




Classification of biochemical operations

- Biochemical transformation
  - removal of s_____ o_____m_____
    - a_____ treatment for soluble chemical oxygen demand (COD) in 50 - 40,000 mg/L range
    - a_____ treatment for high CODs (4000 - 50,000 traditionally)
    - a_____ processes for CODs < 50 mg/L (e.g., carbon adsorption, ion exchange) and >50,000 mg/L (e.g., evaporation and incineration)
  - stabilization of i_____ organic matter
    - b_____ (sludge) removed by sedimentation
    - c_____ matter not removed by sedimentation (entrapment in biomass)
  - conversion of soluble i_____ matter
    - enhanced b_____ p_____ removal (EBPR)
    - n_____
    - d_____

Biochemical Environment

- t_____
  e_____
  a_____ (TEA)
  - a_____ - oxygen
  - a_____ - CO_2 or organics
  - a_____ - nitrate or sulfate
- e_____ of microorganisms

Bioreactor Configuration

- s_____ growth
  - c_____ s_____ tank reactors (CSTR)
  - CSTRs in s_____
  - p_____ f_____
- a_____ growth
  - p_____ tower - trickling filter
  - rotating d_____ - e.g., rotating biological contactor (RBC)
  - f_____ bed - e.g., anaerobic fluidized bed reactor

Suspended Growth Bioreactors

- Activated Sludge
  - Completely m_____
  - C_____
  - High p_____ o_____
  - Contact s_____
  - Sequencing b_____ reactor (SBR)
  - S_____ feed
  - Extended a_____
- Biological N_____ Removal
  - Biological phosphorus removal
  - S_____ batch reactors
  - Separate s_____ denitrification
  - S_____ sludge systems
  - Separate stage n_____

Suspended Growth Systems

- Aerated L_____
- Aerobic D_____
- Anaerobic C_____
- U_____ Anaerobic Sludge Blanket (UASB) Reactor
- Static Granular Bed Reactor
- A_____ Digestion
- Temperature Phased Anaerobic Digester

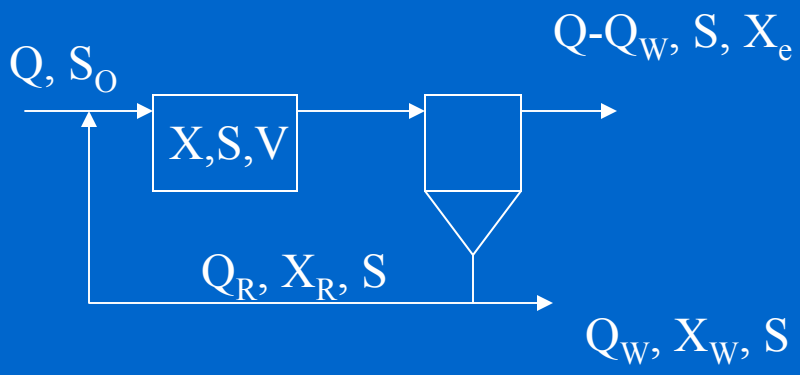
Attached Growth Bioreactors

- Fluidized B_____ Reactors
  - A_____
  - A_____
  - A_____
- 2. Rotating Biological C_____
- 3. T_____ Filter
- 4. A_____ Filter

Hybrid Systems

- Trickling Filter/S_____ Contact Process
- Activated Sludge/R_____ Biological Contactor
- Integrated Fixed Film Activated Sludge
- Membrane Bioreactors

Completely Mixed A.S. Design



Nitrification

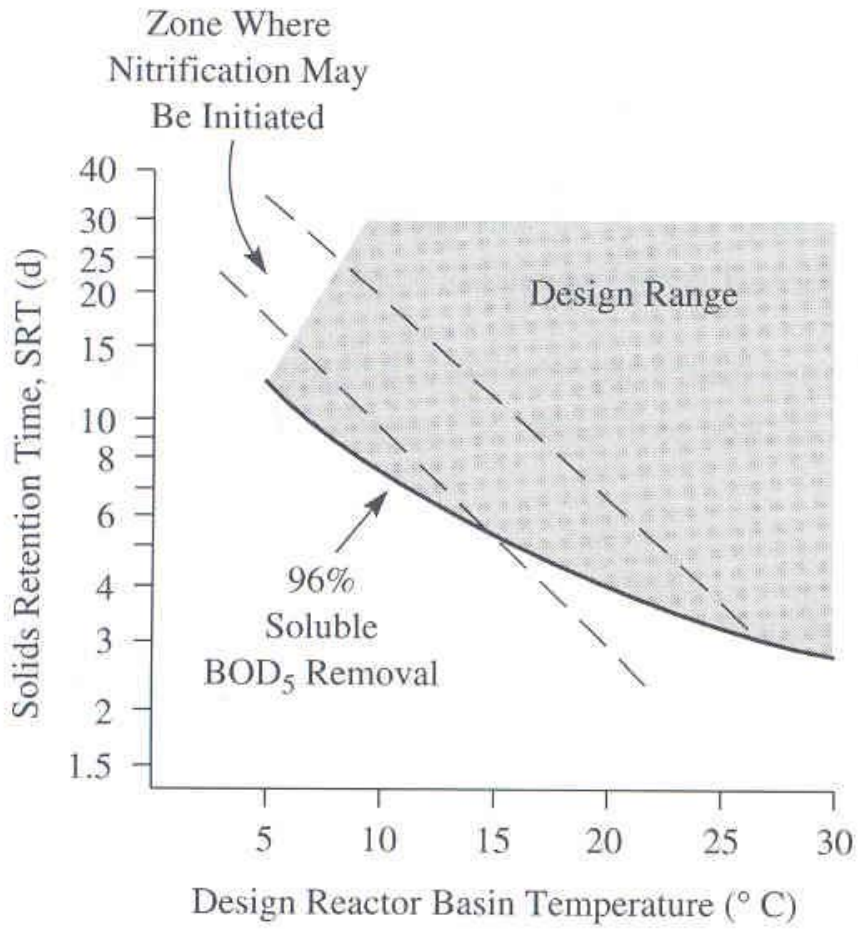
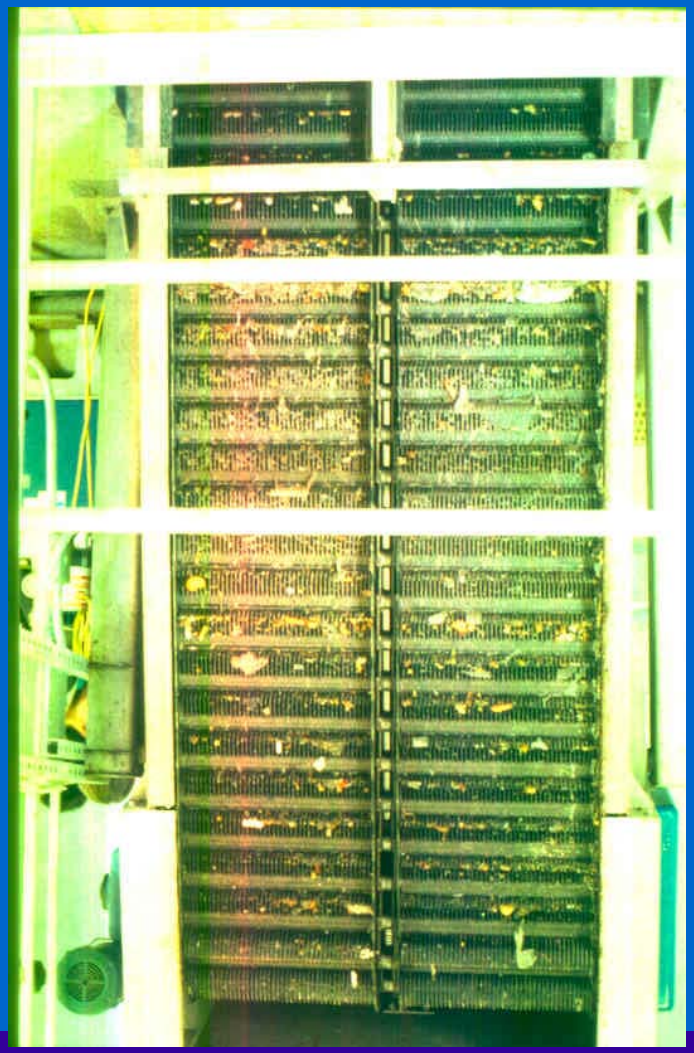


FIGURE 5-25
Design SRT for carbonaceous BOD_5 removal. (*Source:* Joint Task Force of the Water Environment Federation and the American Society of Civil Engineers, *Design of Municipal Wastewater Treatment Plants Vol. I,* Manual of Practice No. 8, Chapters 1–12, Alexandria, VA, 1992. Reprinted by permission.)

Boone wastewater treatment plant



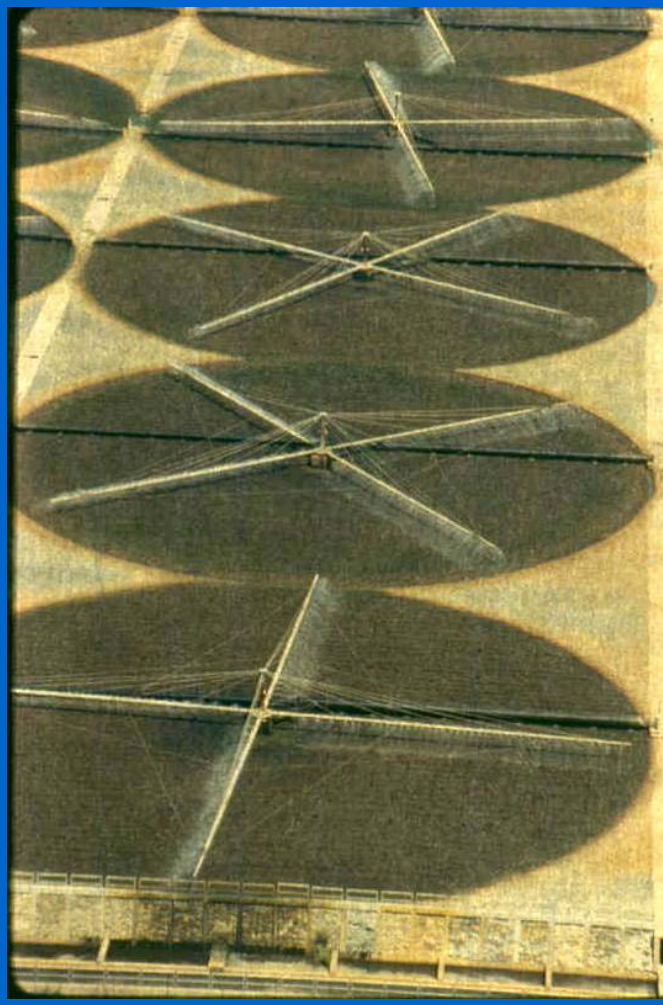
Boone wastewater treatment plant

Wastewater treatment plants

Wastewater treatment plants

Back River WWTP

Back River WWTP



Back River WWTP

Back River WWTP

Abu Dhabi WWTP

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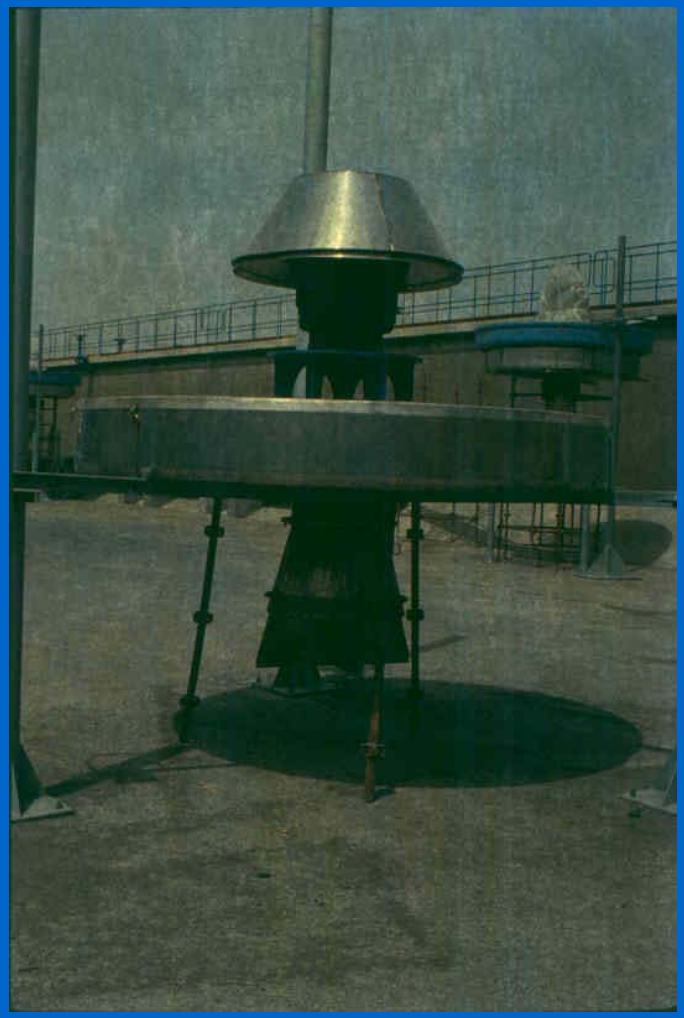
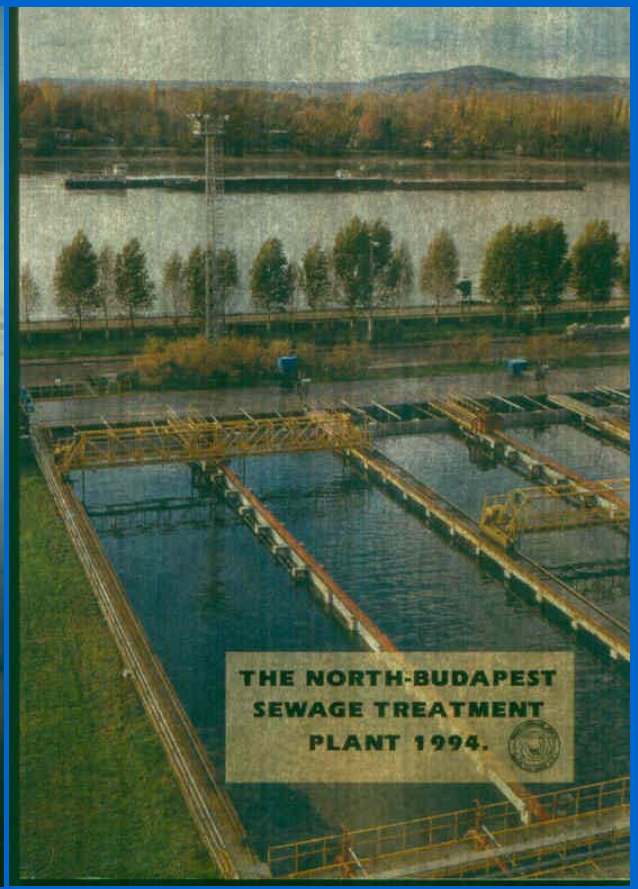
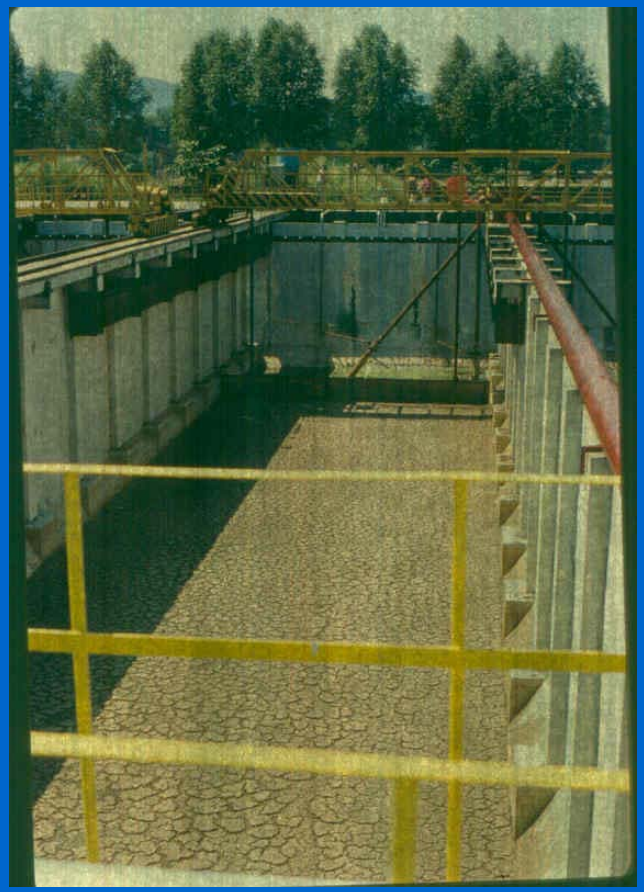


Abu Dhabi WWTP

Budapest WWTP





Lake Balaton WWTP

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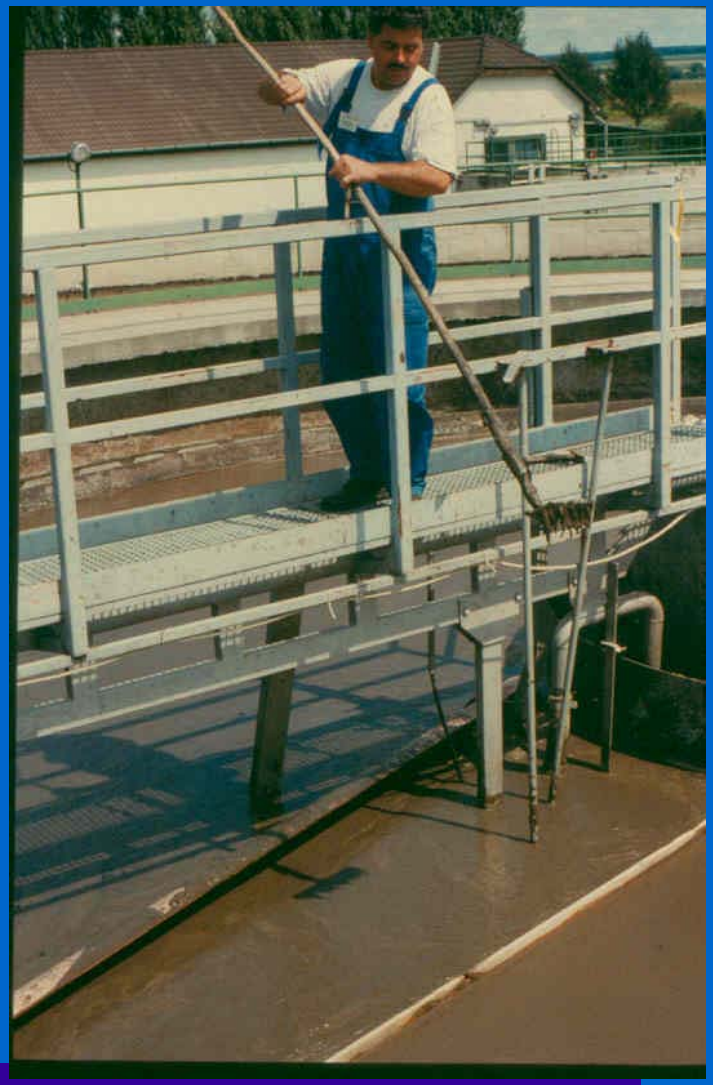
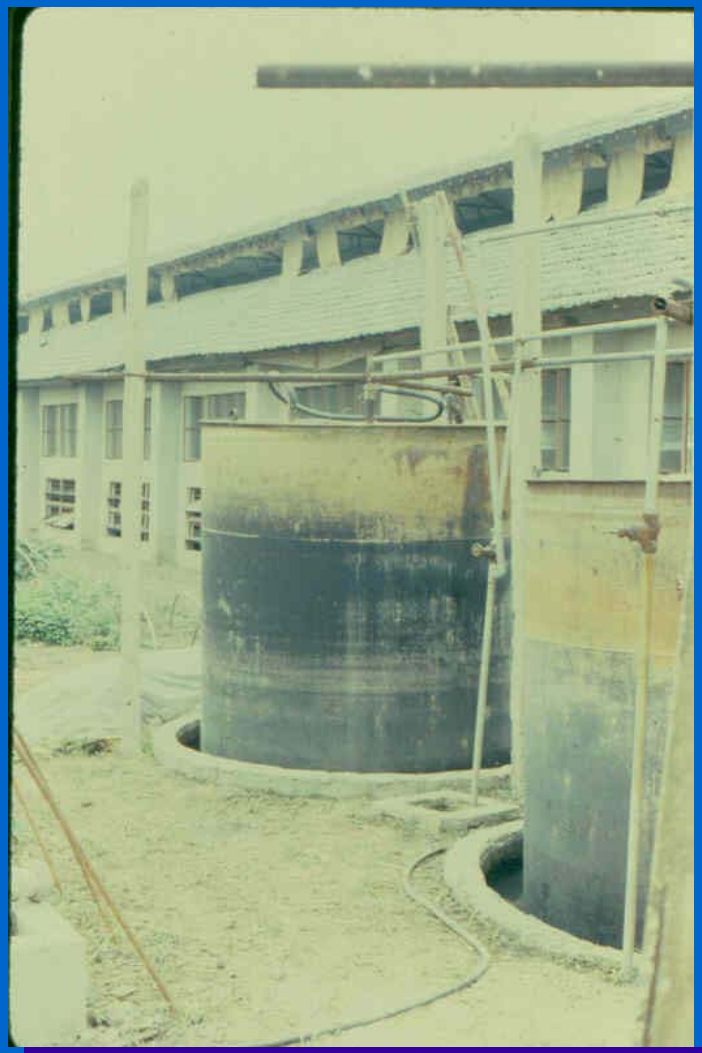


Lake Balaton WWTP

Wastewater Treatment in Developing Countries



Community Biogas Plant in China