

Aerobic Treatment Unit Overview



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Definitions

- Methods of wastewater treatment
 1. Anaerobically
 - No oxygen
 - Septic tank pretreatment
 2. Aerobically
 - With oxygen
 - Aerobic treatment units, media filters, soil treatment systems



The Aerobic Process

- Presence of molecular oxygen
- Organic matter + $O_2 = CO_2 + H_2O + \text{new cells}$

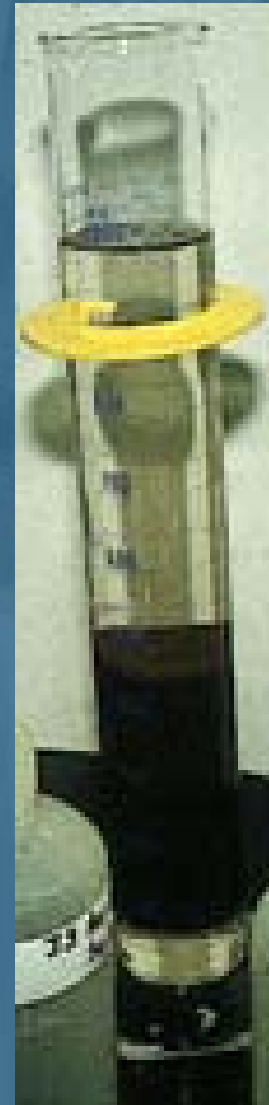


Biochemical Oxygen Demand (BOD)

- Measure of organic matter
- Measures amount of oxygen used by microbial population to biodegrade organics in the wastewater and converting ammonium to nitrate
- Units = mg/L or ppm
- 5 day, 20° C test
- CBOD is Carbon demand portion
- NBOD is Nitrogen demand portion
- A high BOD waste stream will cause the consumption of dissolved oxygen at a greater rate

Measurement of Organic Matter Solids

- Total suspended solids (TSS)
 - Filter sample through 0.45 micron filter
 - Solids remaining on filter are SS
 - Solids passing through are dissolved
- Settleable solids
 - Used to determine when to remove solids from the suspended-growth ATU



Aerobic Treatment Unit (ATU)

- **What is it and why is it used?**
 - A tank used in lieu of a septic tank or following one
 - Provides aerobic treatment in saturated conditions
 - Provides better quality effluent – organics & solids, especially
 - In some locations, reductions in soil depth and sizing permitted

How ATUs Work



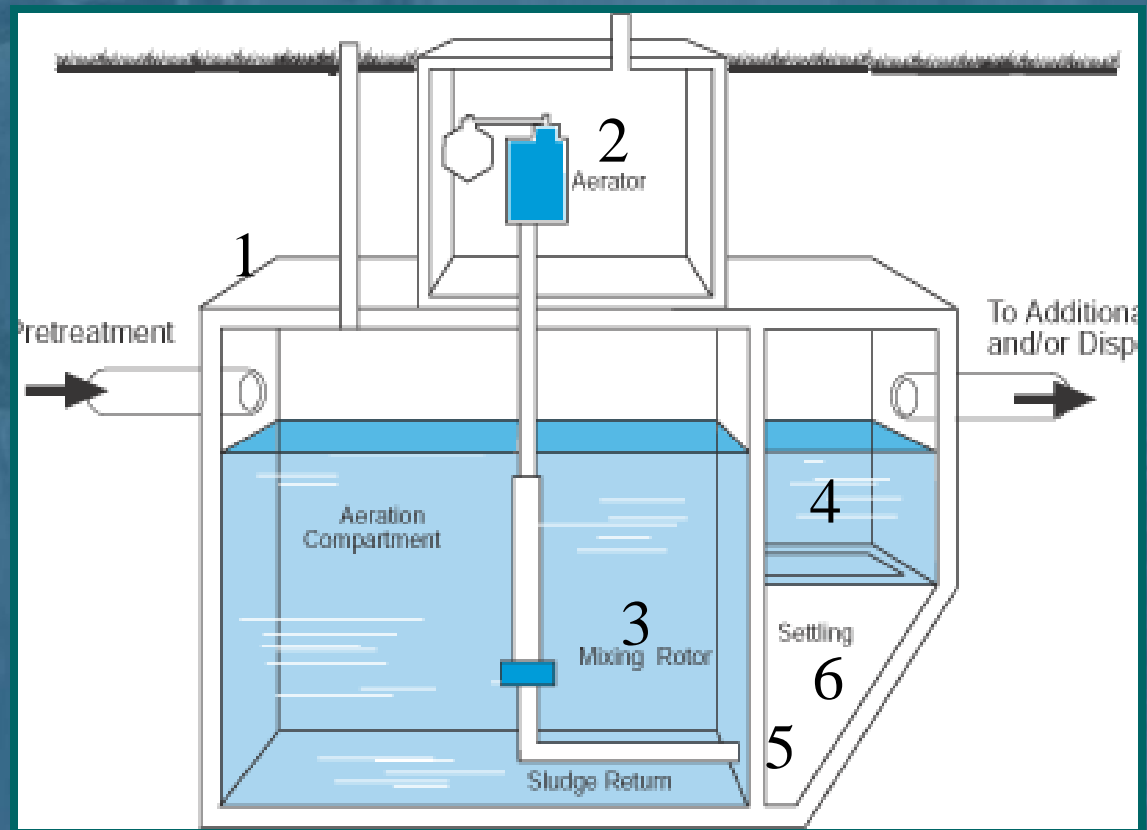
- The effluent is aerated via one of several means providing dissolved oxygen (DO)
- DO, microorganisms and food mixed together
 - Aerobic organisms digest food (BOD) & settle out
 - 10 - 20 times faster than anaerobic process (more efficient)
 - After organisms settle out they can be:
 - Returned to be reused
 - Pumped out when dead
- Generates high quality effluents with variety of oxidized end products - little odor, stable effluent not requiring further breakdown

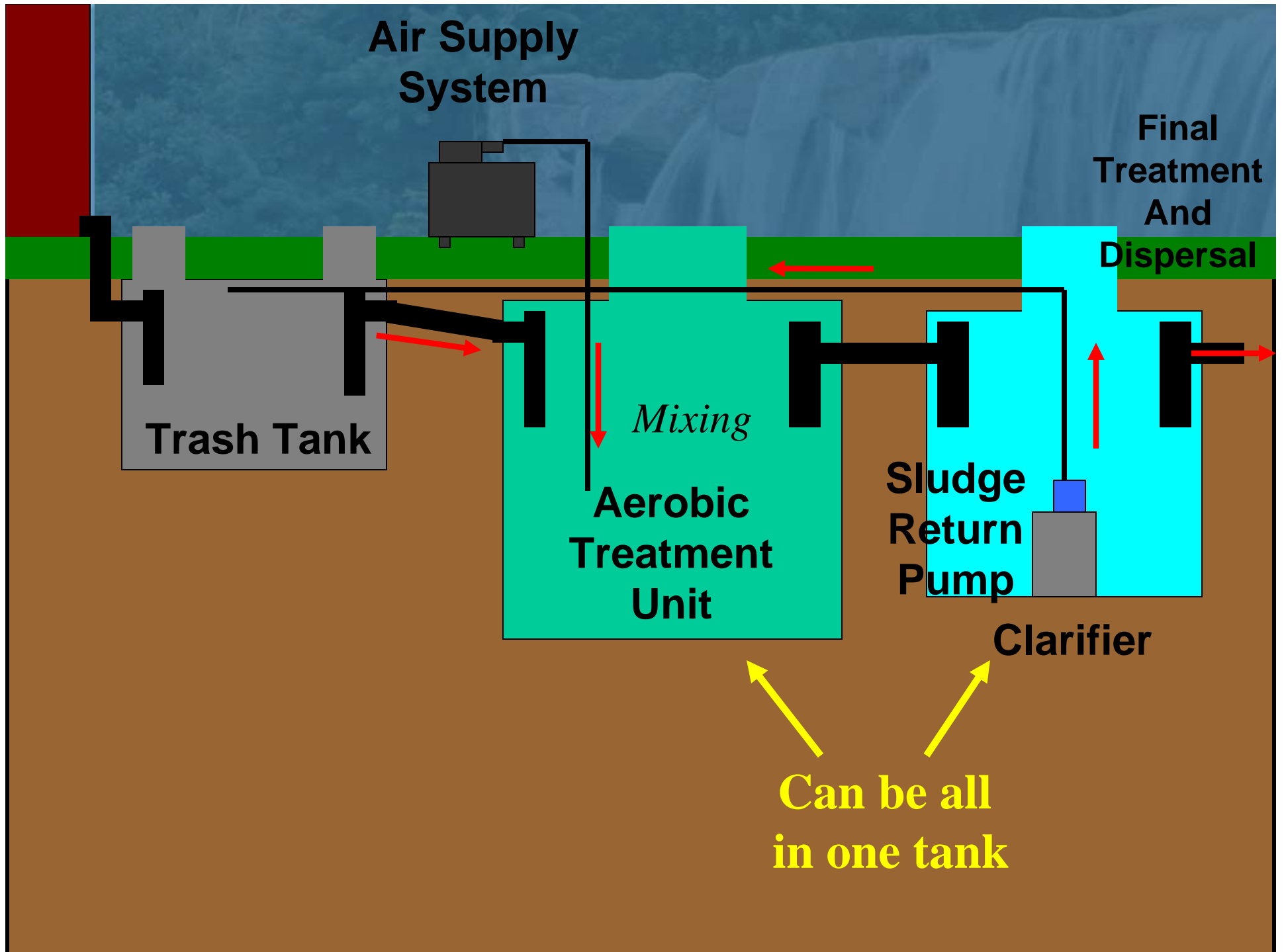
Other Important Parameters

- Microbes need **more than** food (organic carbon), dissolved oxygen and water
 - Temperature must be life-sustaining
 - Need steady supply of food to maintain stable microbial population
 - pH needs to be controlled
 - Biocides can kill
 - Acid drain cleaner
 - Antibiotics

Six Parts of an ATU

1. Tank
2. Air
3. Mixing
4. Settling
5. Return
6. Waste







Three Tank System

Pump Tank

Aeration Chamber
and Clarifier

Trash Tank

FLOW

Trash Removal and Anaerobic Treatment

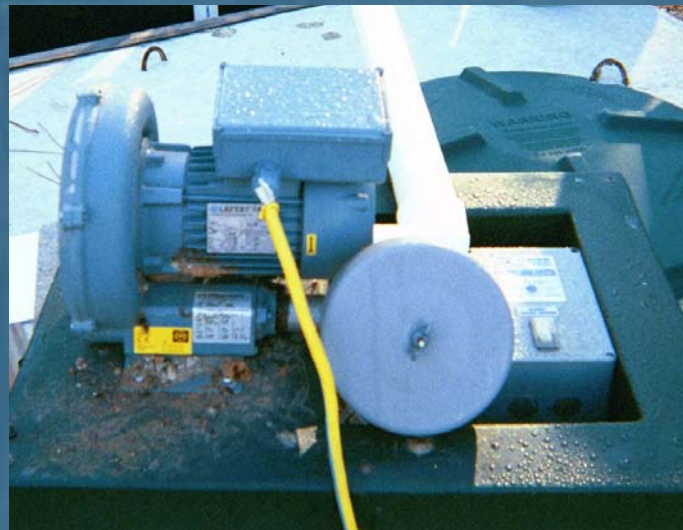
- Generally referred to as the “trash tank” or septic tank
 - Removes non degradable materials from the waste stream
 - Provides anaerobic treatment
 - Can be used as a component of a denitrification process

Flow Equalization

- Variations in flow seriously complicate treatment process
 - need stable flow and stable substrate supply to maintain stable microbial population
 - single family home can have extreme variations from vacations (no flow) to laundry (high flow)
 - Equalization tanks (before ATU) can buffer flow
 - dose the ATU during low flows
 - store excess wastewater during high flows

Venting/Air Supply

- Air supply methods:
 - Aspirator/aerator
 - Compressor
 - Blower
 - Free Air



Aspirator/Aerator

- Vacuum pulls air into the water
- Spinning shaft or impeller causes the vacuum
- Check air flow
- Remove aerator
- Clean shaft



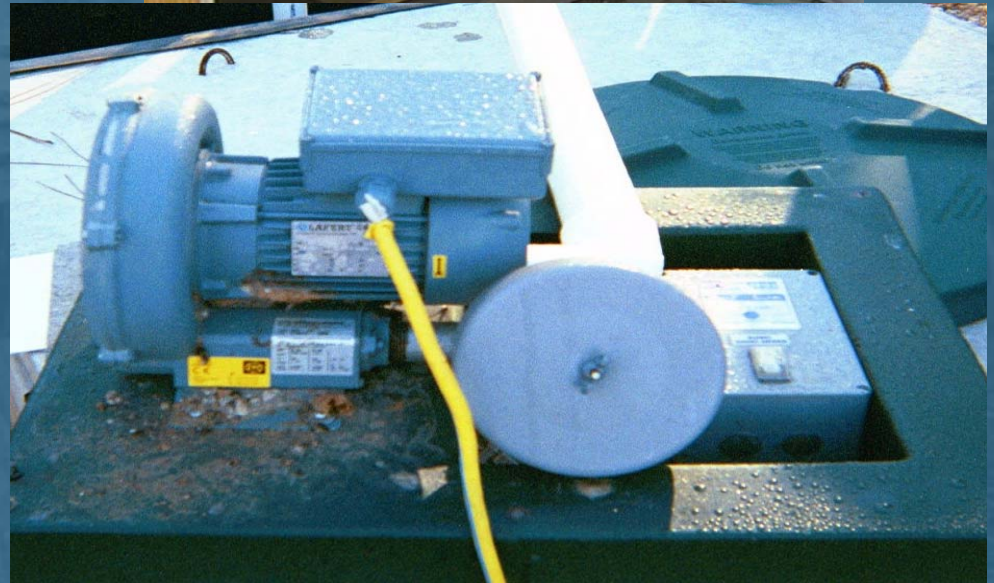
Compressors

- Greater pressure
- Lower air flow
- Two distinct types of compressors
 - Rotary
 - Linear
- Listen for operation
- Check operating pressure
- Clean filters
- Rebuild as necessary



Blowers

- Greater air flow
- Lower pressure
- Check inlet screens/filters
- Air flow discharge from unit



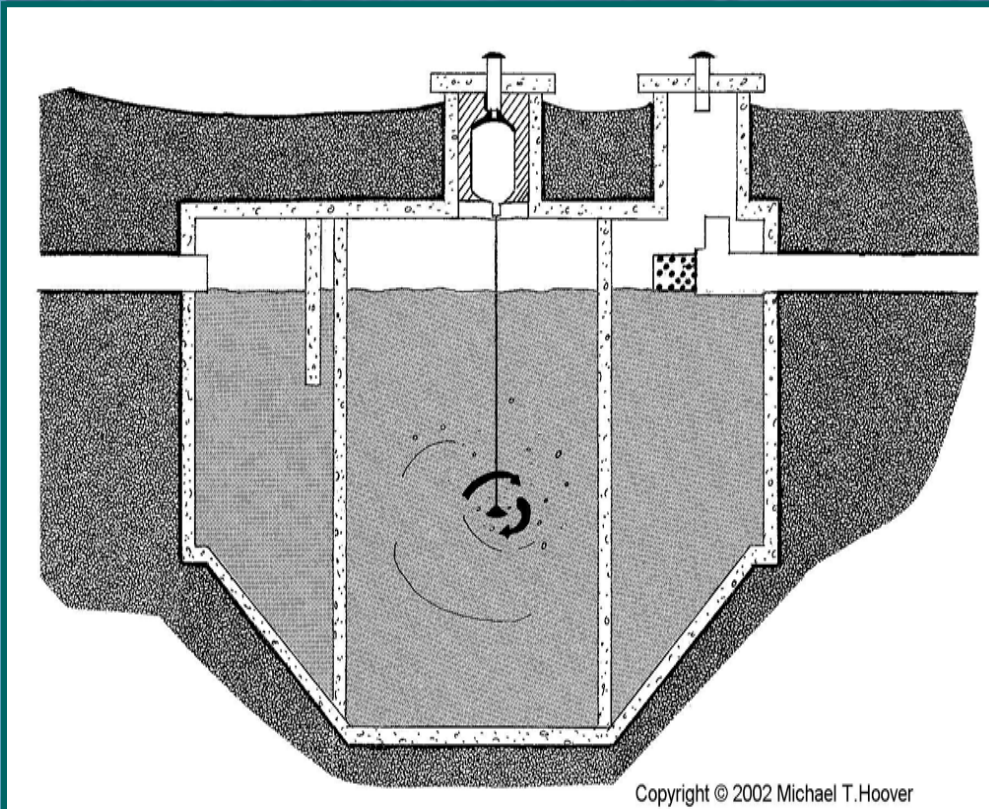
Free Air

- Rotating media through air space in top of unit
- Water accepts oxygen from air
- Check air vent
 - Need air exchange



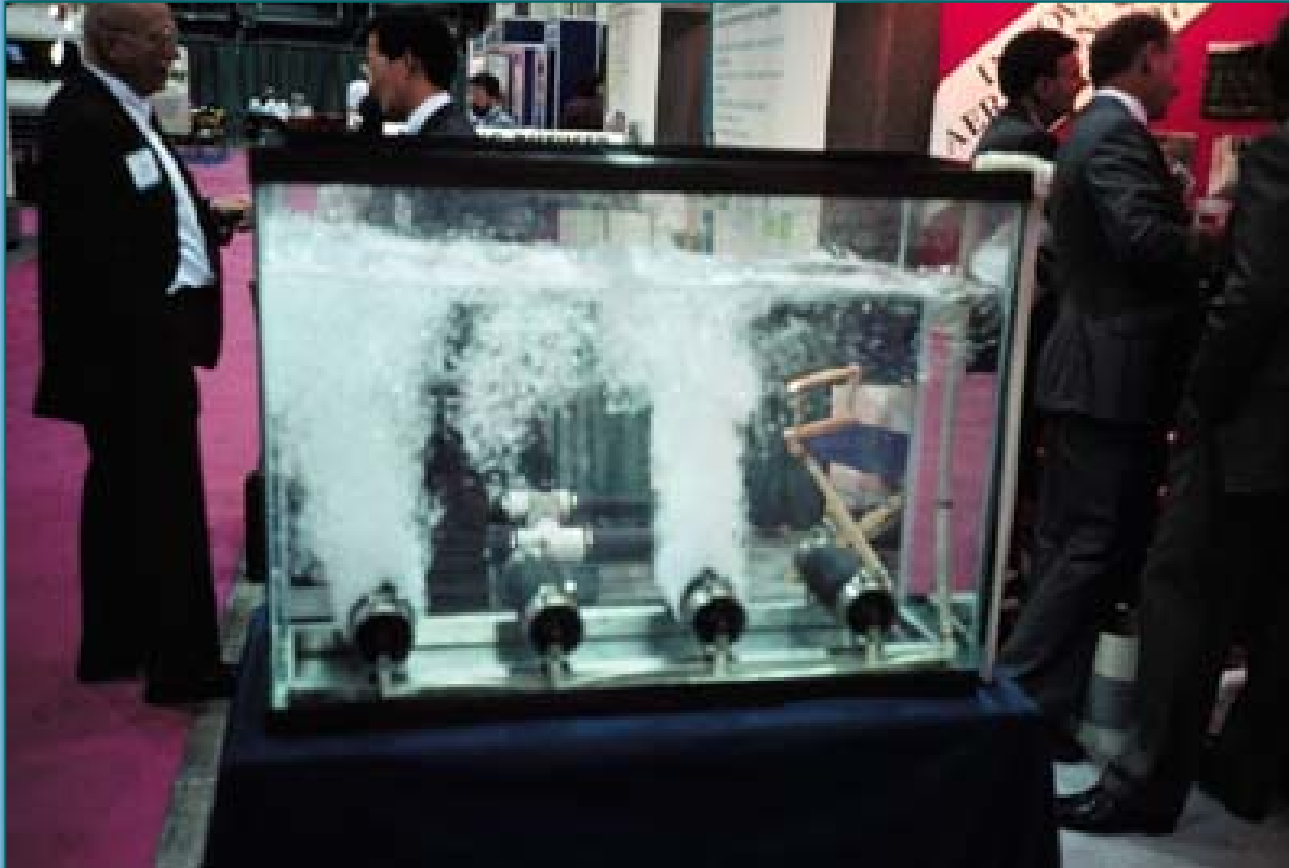
ATU Aeration

- Mechanical



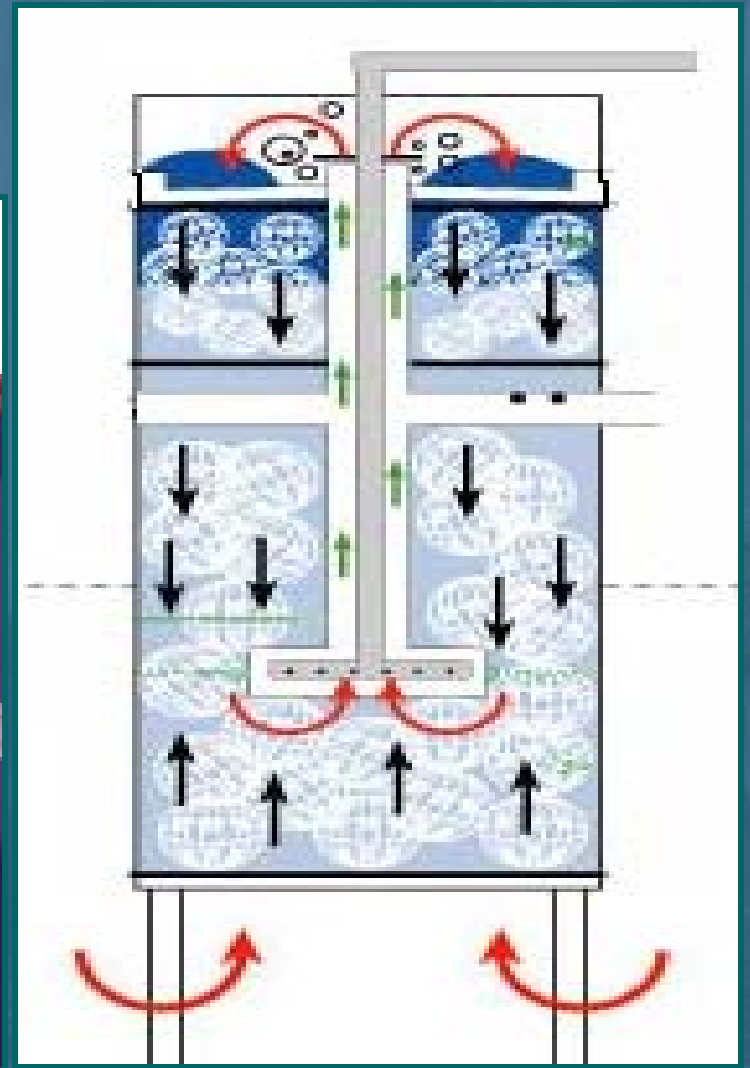
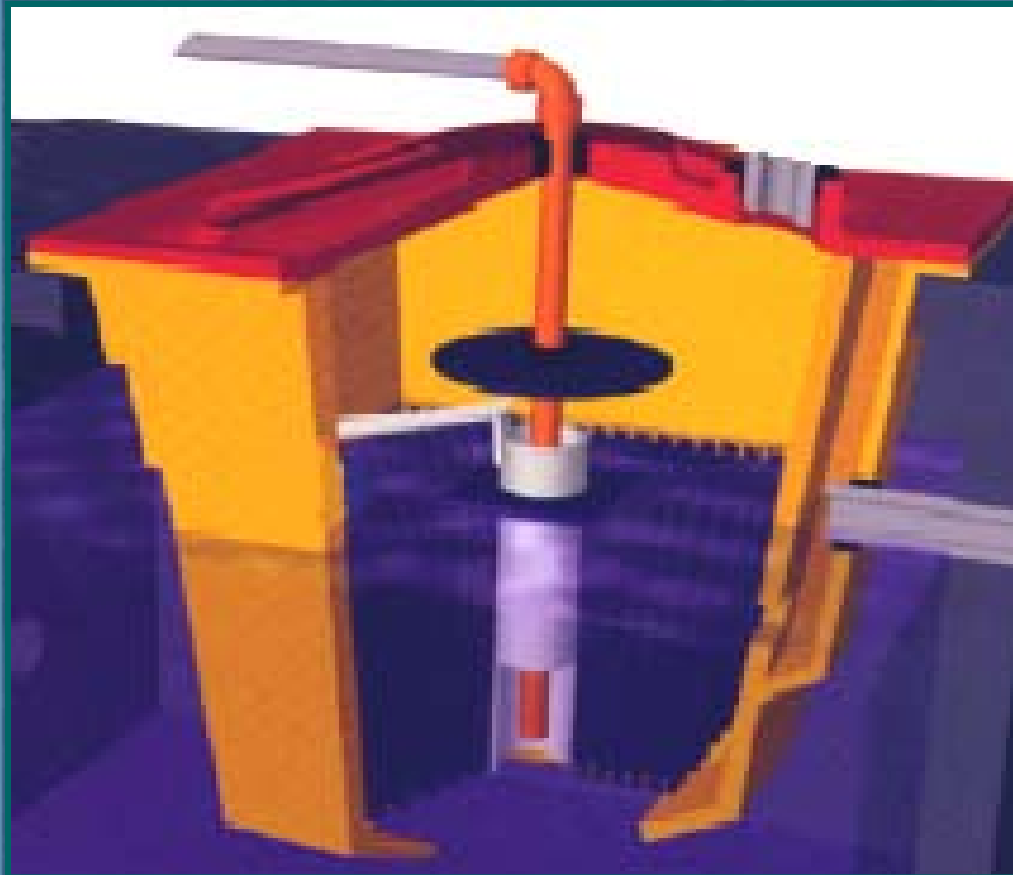
ATU Aeration

- Diffused



ATU Aeration

- Air-lift pump



Oxygen Transfer

- Air is approximately 19% oxygen
- Oxygen in the air bubbles must transfer to water
- Oxygen molecules diffuse through the air in the bubble and then across the bubble surface and into the water
- Balance efficiency of oxygen transfer and volume of air moved through the unit

Air Dispersion



Perforated Pipe

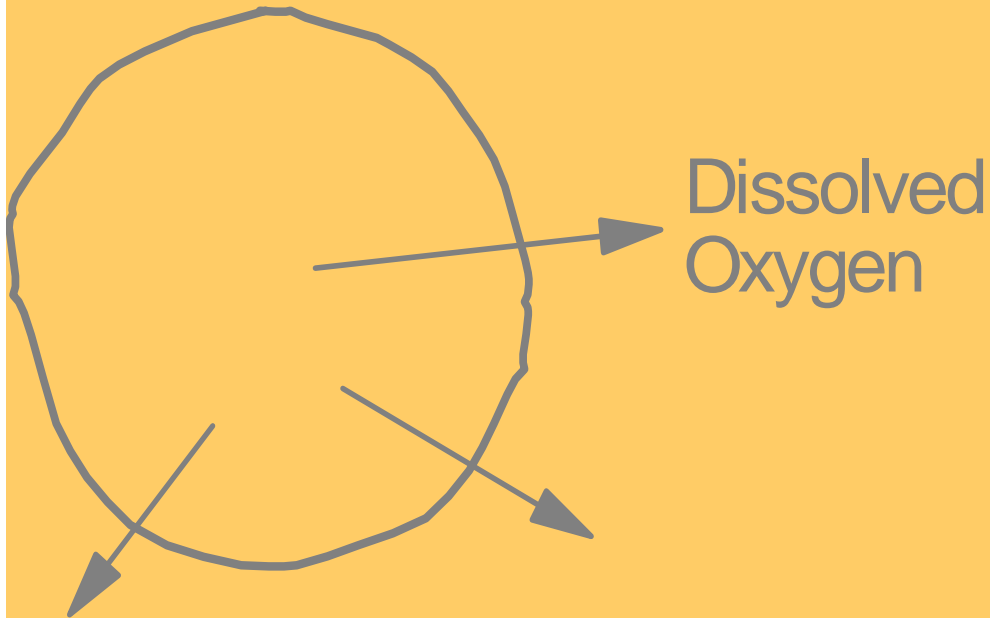


Porous Stone Diffuser

- Introduces air into the water
- Supply lines
- Dispersion methods
 - Holes
 - Slots
 - Porous material
- Potential for plugging in the orifices that could reduce air flow

Type of Oxygen Transfer in ATUs

Liquid system - Saturated



O_2

Less Transfer



O_2

More Transfer

Oxygen Transfer

ATU Configurations

- Generally speaking, ATUs are:
 - Intermittent flow
 - not a constant flow from wastewater source
 - Complete mix
 - aeration provides complete mix of D.O., microbes and food
 - Constant volume
 - flow in is approximately equal to flow out
 - flow equalization is usually provided in the primary tank

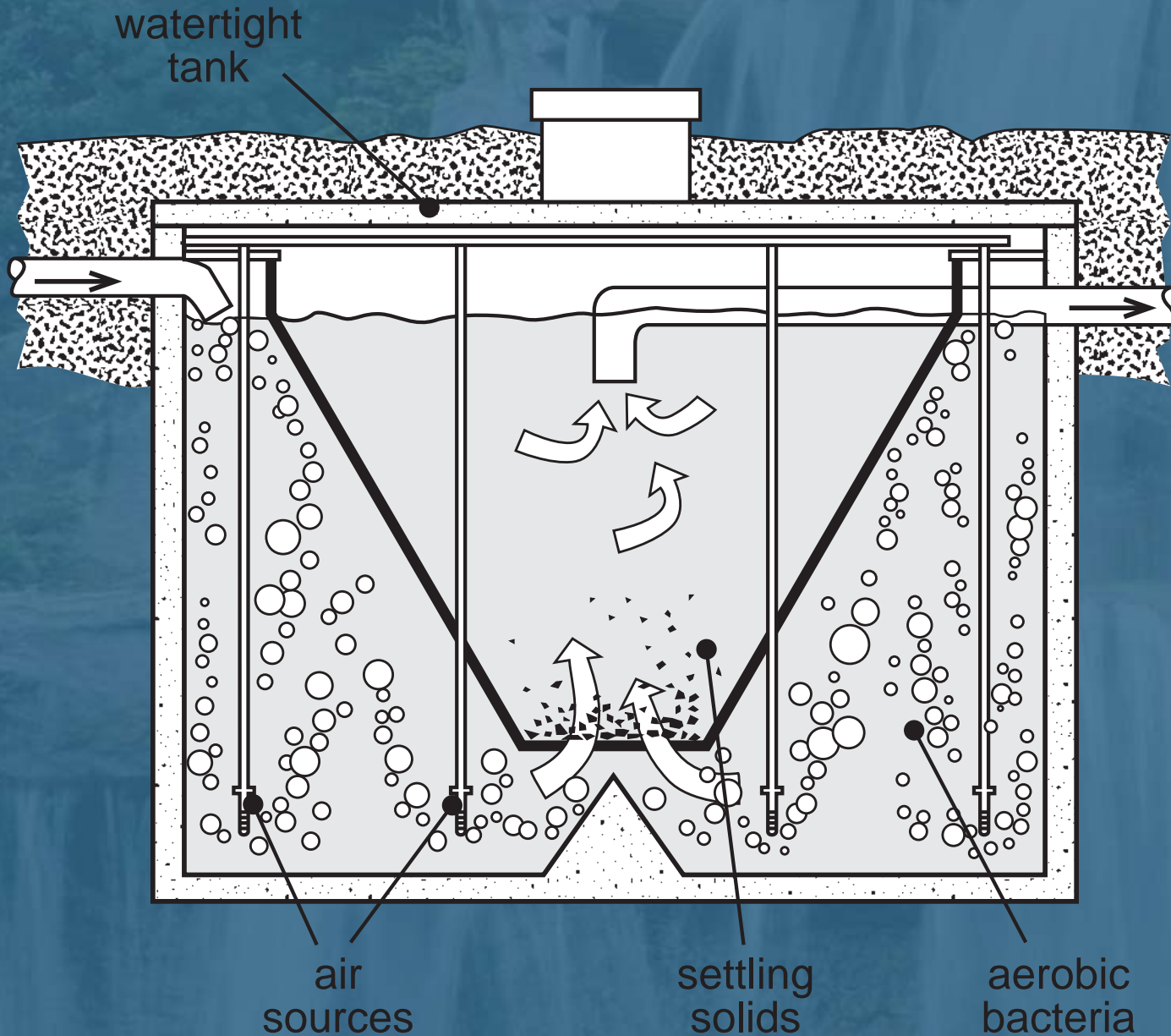
Types of ATUs

- Suspended growth
- Submerged attached growth/fixed film media
- Combination suspended growth/attached
- Sequencing batch reactor
- Rotating biological contactor

Suspended Growth Reactors

- Suspended Growth
 - activated sludge process
 - biomass is thoroughly mixed with nutrients and biodegradable compounds
 - organisms flocculate and form active mass of microbes - biological floc
 - food mixed with bugs

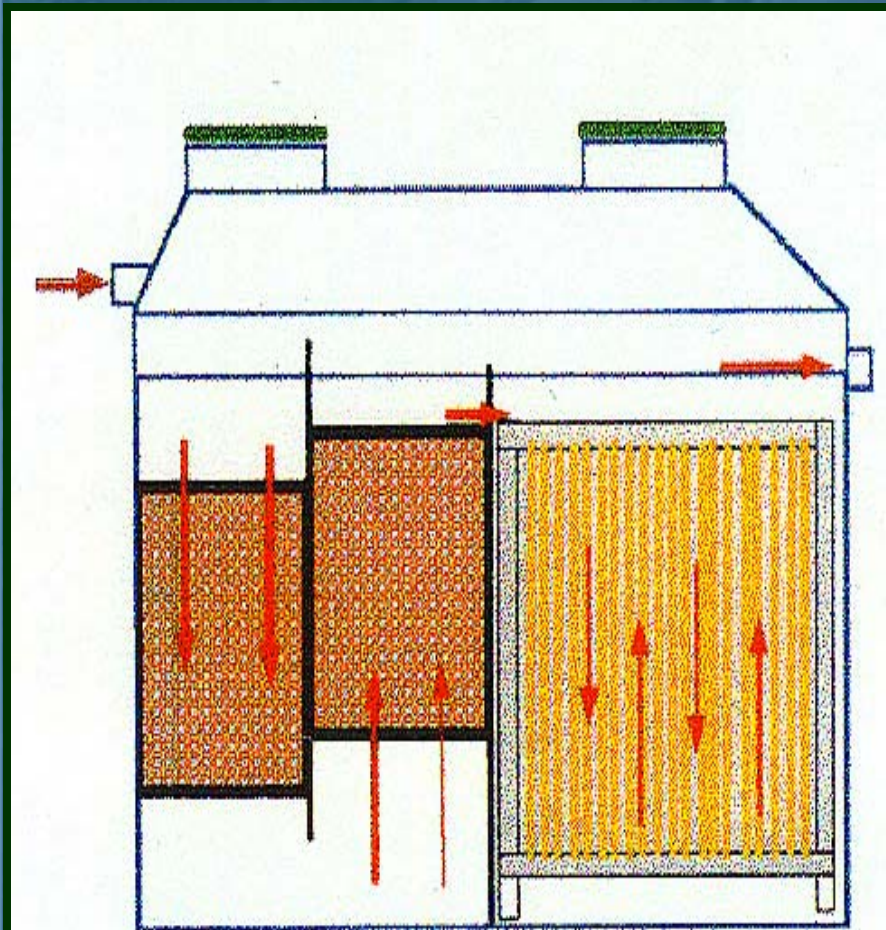
Typical Suspended Growth Reactor



Attached Growth Reactors

- Attached Growth
 - Fixed-film process (like media filters)
 - Inert medium provided for microbial attachment
 - Effluent flows through media
 - Colloidal and dissolved organics compounds absorbed by biological film
 - Food brought to bugs

Attached Growth Reactors

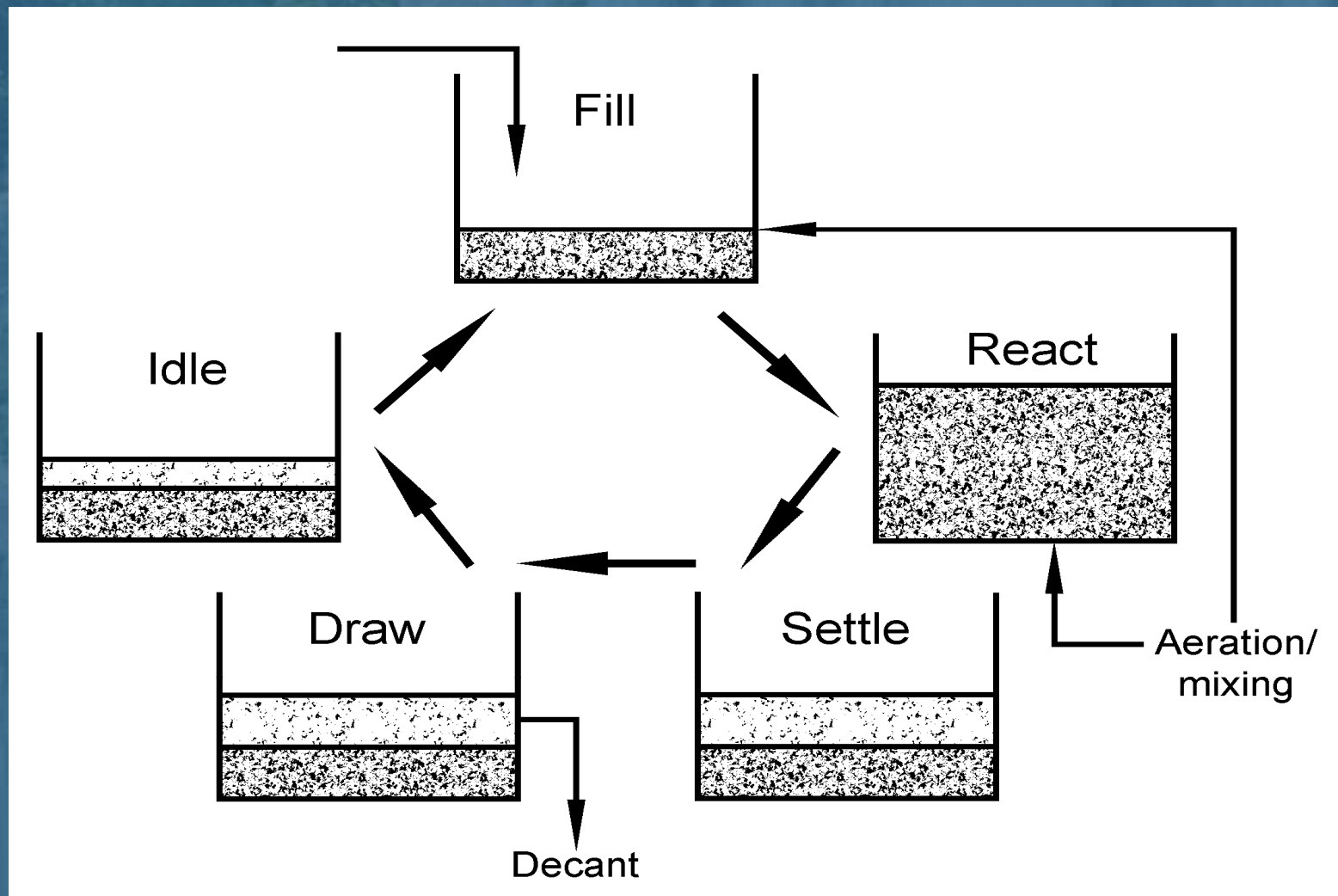


Attached growth media

Sequencing Batch Reactor

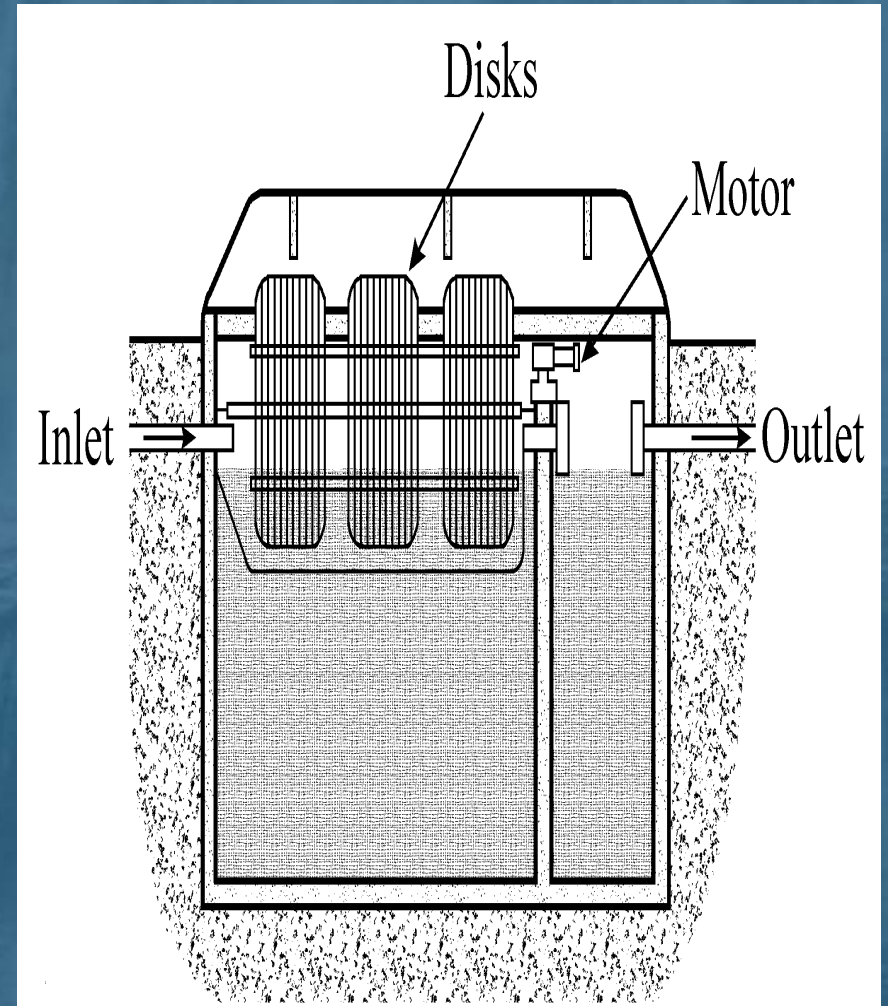
- Flow equalization chamber for dosing effluent into the treatment chamber
- Typically suspended growth treatment process
- Periodic process
 - flow equalization, aeration, clarification, and biomass wasting
 - sequential processes in same or multiple tanks

Sequencing Batch Reactor



Rotating Biological Contactor

- Fixed film media
- Media is a disk
- Motor slowly rotates disks through the effluent
- Aeration is achieved by passing the media through the air space in the chamber



ATU Considerations

- Tank made of concrete, fiberglass or polyethylene
- Downsized from municipal systems
- Tend to be more sensitive to upset than septic tanks
- Most are for residential wastes, some models have been developed for higher organic wastes

ATU Considerations Cont'd

- All proprietary systems
- Cost is \$2,500 - \$7,000+ for unit
- NSF has a standard (#40) for testing
- Treatment efficiencies – some variability

BOD₅ - 5-60 mg/l

TSS - 5-60 mg/l

Fecal coliform - <100,000/100 ml

- On-going proper operation, monitoring & maintenance are critical

NSF Standard 40

Class I Effluent Standard

- CBOD₅
 - 30-day average not to exceed 25 mg/L
 - 7-day average not to exceed 40 mg/L
- TSS
 - 30-day average not to exceed 30 mg/L
 - 7-day average not to exceed 45 mg/L
- pH between 6.0 and 9.0
- Others
 - Color – 15 units
 - Odor – non-offensive
 - Oily film – non-visible evidence other than air bubbles
 - Foam - none

NSF Standard 40

Mechanical Evaluation

- Controls and Sensors
 - ATUs must have sensors and controls that can detect failure
 - Must be able to deliver visible and audible signal to homeowner
- Must have ground-level access
 - for maintenance
 - covers must be secured for safety

ATU Applications

- At part of full size soil based system
 - New
 - Repair
- At part of downsized soil based system
 - Vertical separation
 - Horizontal separation
- As part of a reuse system
- As part of a surface discharging system

Surfacing System Rejuvenated with an ATU



N & P Removal in ATUs

- Not typically designed for nitrogen removal
 - ATUs convert ammonium to nitrate
 - Minimal nitrogen is removed in biomass
 - Can be part of a denitrification process
- Not typically used for phosphorus removal
 - Phosphate will be released from organic form
 - Minimal phosphorus is removed in biomass
- Additional unit processes must be added onto ATUs for effective N & P removal

ATUs Can Help Solve Problems

- Reduced separation
 - Pathogen reduction
- Reduced square footage
 - Reduced BOD/TSS
- High strength waste
 - Reduced BOD/TSS/FOG
- System recovery
 - Reduced BOD/TSS
 - Dissolved oxygen
- Nitrogen removal
 - Recycling





Shallow, Narrow
Drainfield Lines

PL

Septic Tank
with Fast Unit

Pump Basin with
UV Disinfection Unit

ATU Mngt: Aeration Chamber

- Mixing in aeration chamber
 - Rolling motion
- DO in aeration chamber
 - 2 mg/L
- pH in aeration chamber
 - 7.0
- Temperature in aeration chamber
 - Room temperature
- Odor – musty
- Color – brown in mixing zone
- Collect sample from aeration chamber



ATU Mngt: Aeration Chamber

- 30 minute settleability test
 - Beaker with 10 even gradations
 - Fill beaker with sample from aeration chamber.
 - Let stand for 30 minutes and read level of clear zone
- 20% to 60% is ok



20-60%



% of Settling



ATU Mngt: Excess Sludge

- Accumulated sludge must be removed
- ATU owners must have a service contract with a Service Provider and/or Pumper
- NSF requires visit every 6 months



ATU Mngt: Venting/Air supply

- Air filter/screen:
 - Cleaned
 - Washed/Dried
 - Replaced
 - Every Time
 - Yearly
- Filter Locations
 - Internal
 - External



DO Testing

- Meter
- Kit



ATU Start Up

- Establishment of microbial population
 - Recommended method is add a few gallons of mixed liquor from operational ATU or activated sludge plant
 - Could add a few shovels-full of an organic soil
- Poor treatment of water
 - More food than bugs
 - Biomass will be poorly flocculated

Troubleshooting ATUs

- Sludge bulking
 - Extreme growth of filamentous bacteria
 - Attach to floc particles and impede settling
- Foaming on water surface
 - Growth of hydrophobic bacterium
 - Causes foaming and frothing on surface
 - Froth spray available to reduce surface tension
- Burping
 - Biogas release from sludge that disperses solids

Troubleshooting ATUs: Loading

- Water – hydraulic
 - Flow volume
 - Flow rate
- Food – organic
 - BOD
 - Concentration, mg/l
 - Mass, pounds per day
- Food to microorganism ratio



Troubleshooting ATUs: Foaming

- Issue sometimes at start up
- Too much soap
- Unbalance of microbes
 - Hydraulic overload
 - Organic overload
 - Toxics



Troubleshooting ATUs: Odors

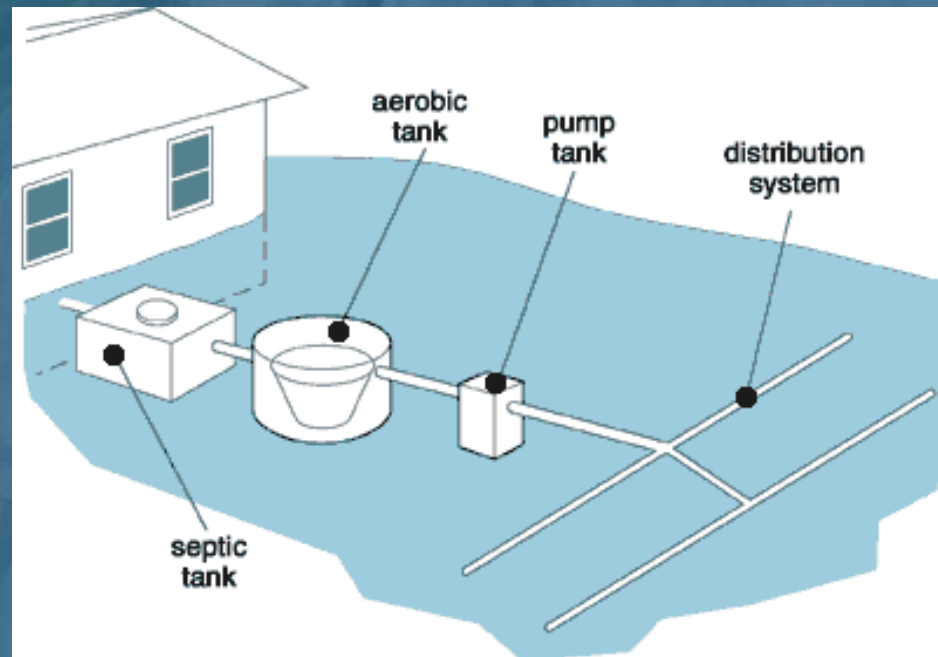
- Odors
- If smells like sewage (musty is normal)
 - Food/air ratio if off
 - Toxics entering the system
- Reduce loading and take toxics out



Pros and Cons of ATUs

- Pros
 - Small land use requirement
 - Have success dealing with high strength waste
 - Lots of research data on performance, NSF etc
- Cons
 - Odors are noticeable if system is not being used or maintained properly
 - Less passive then some other systems

Questions



<http://septic.umn.edu>