

TROUBLESHOOTING AN AEROBIC TREATMENT UNIT FOR EFFECTIVE OXYGEN DELIVERY

PRESENTED BY

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**THE MATERIALS PRESENTED ARE THE OPINIONS OF
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Overview

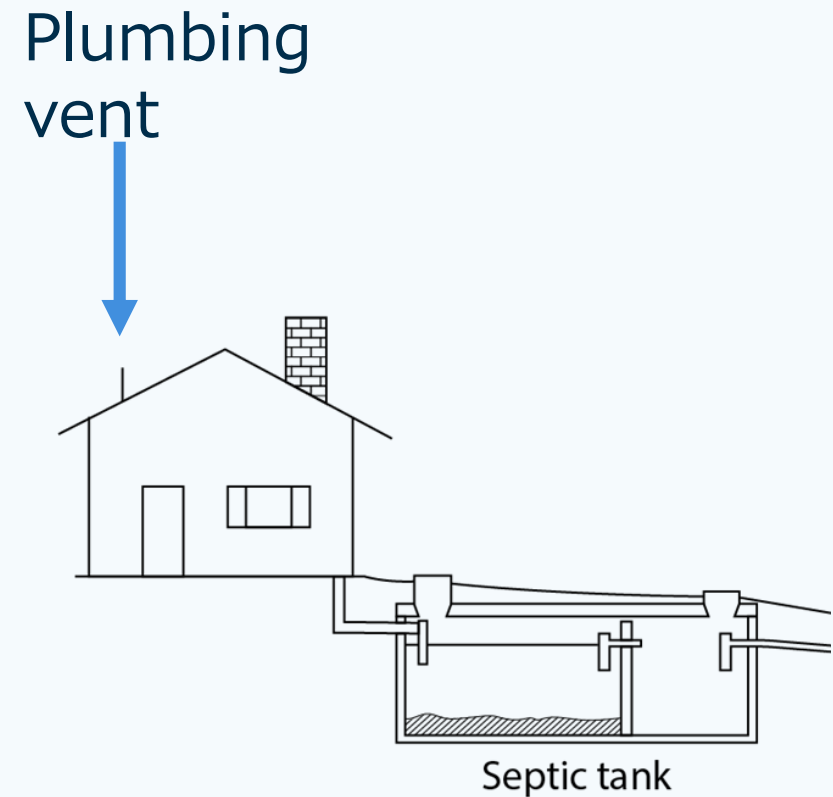
- Physical effect of air exchange on liquid movement through OWTS components
- Chemical effect of air exchange (DO availability)
- Oxygen state in treatment components

The basics...

- Liquid flow through the system is physically impossible without air exchange – IT MUST BREATHE.
- Air exchange provides dissolved oxygen necessary for
 - Treatment processes
- Our atmosphere is the source
 - 21% oxygen by volume
- Air entry and exit is critical for aeration

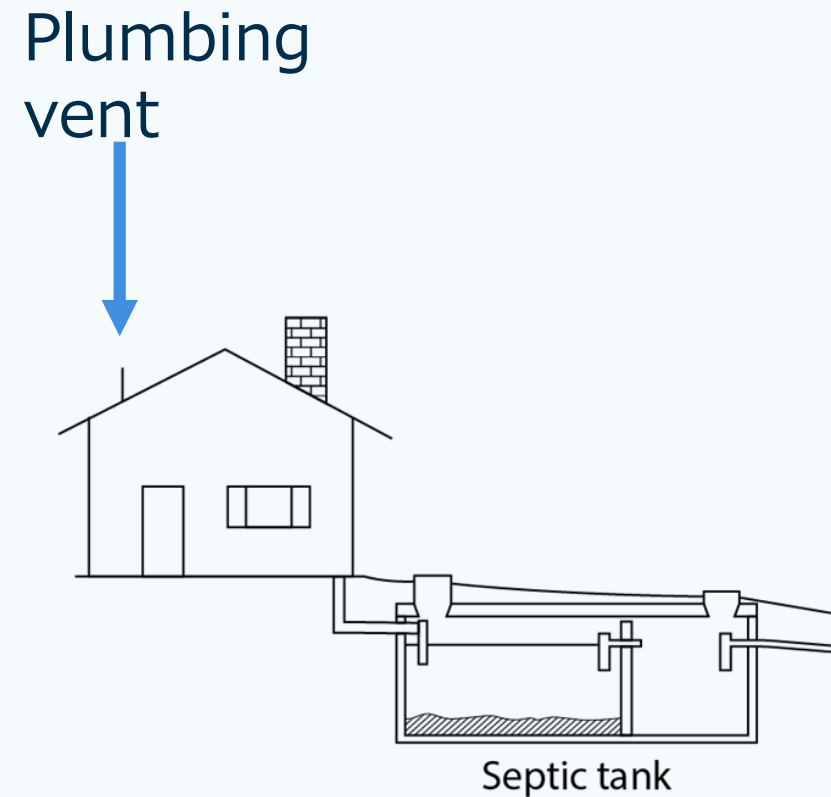
Air exchange in through an OWTS

- Air exchange results in a “chimney” effect
- Pulls air up from the OWTS through the plumbing vent
- From lower to higher elevation



Air exchange in an OWTS

- Head space air exchange
 - Water enters tank and displaces air which must vent
 - As liquid leaves the tank – air must enter head space or flow stops
- Air locked tanks
 - Restricted air movement results in restricted liquid entry/exit

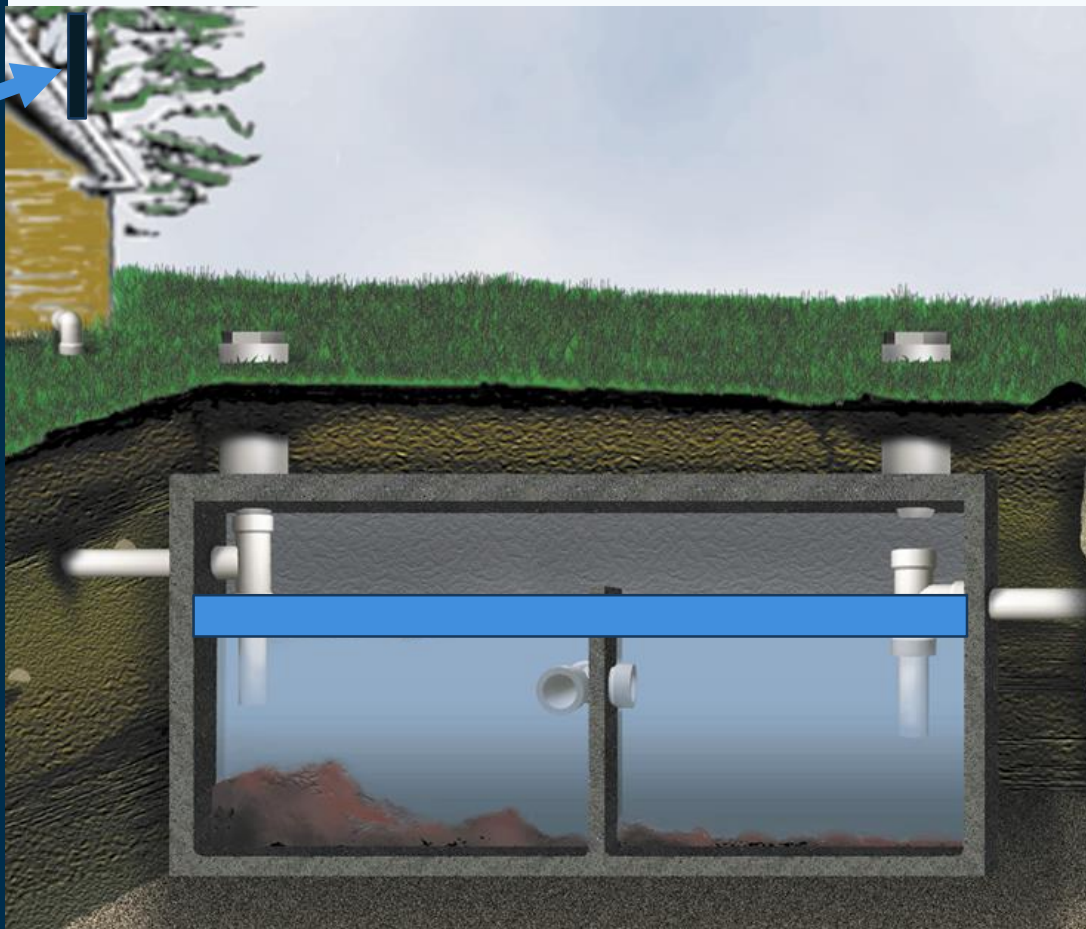


AIR



Liquid/air entry & exit - septic tank

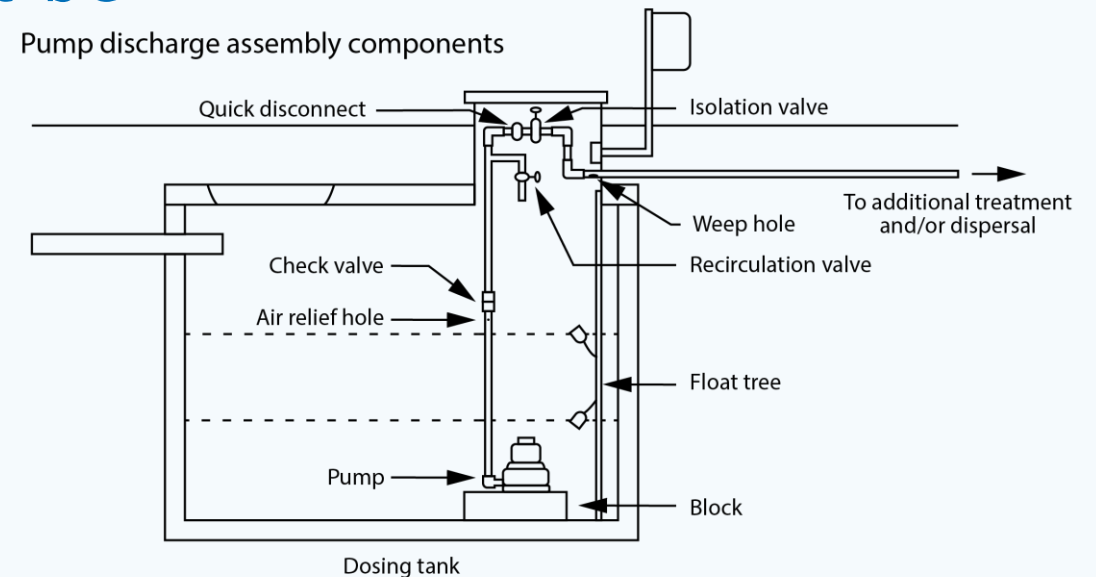
Roof vent



- Entry plumbing above exit
- Components “breathe” through building plumbing vent
- 35 gallons/17.5 gal/inch
- Two (2) inch increase in water surface

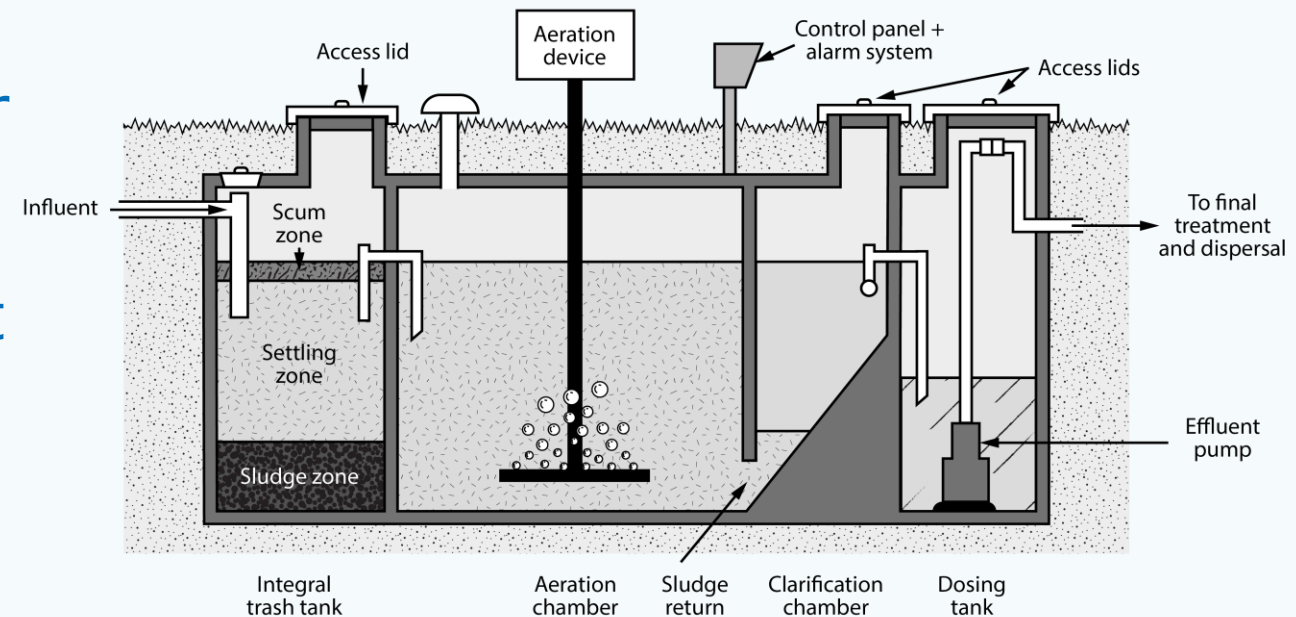
Air exchange through dosing systems

- Dosing tanks stop the chimney effect
 - Pumping system: one-way flow
 - Succeeding components must be vented to the atmosphere



Air exchange through treatment systems

- Identify air flow pathways in treatment systems
- Identify “blockages” to air exchange
- All components must vent
- Some require direct venting to atmosphere



Oxygen state in treatment components

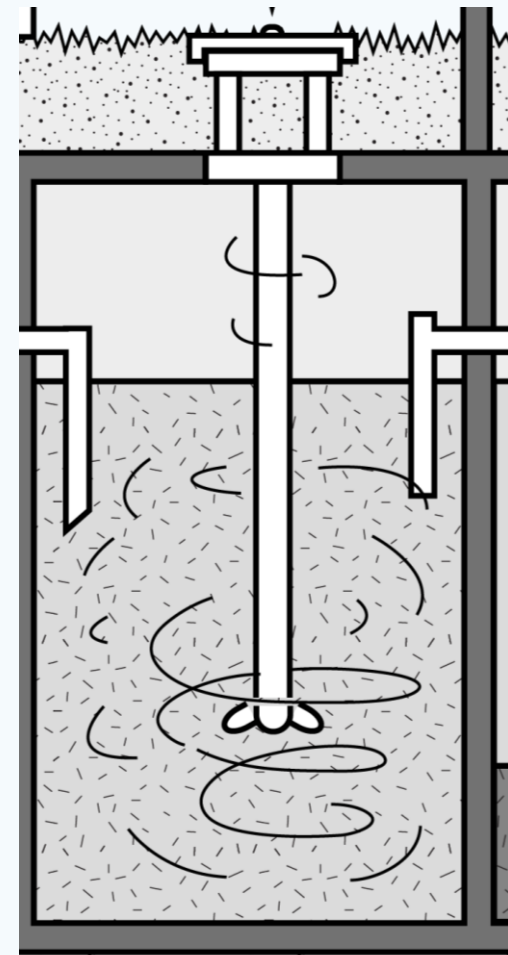
- Optimal growing conditions promote healthy microbial populations for specific processes
- Dissolved oxygen (DO) concentration defines oxygen state
 - Aerobic: equal to or greater than 1.0 mg/L, ideal >2.0 mg/L
 - Anaerobic: less than 1.0 mg/L, ideal <0.1 mg/L
- Anoxic condition is a subset of anaerobic
 - <0.5 mg/L with bound oxygen in the form of nitrate (NO_3^-)
 - Optimum range 0.1 -0.3 mg/L DO

Treatment configurations and aeration approach

- Aerobic treatment media configurations
 - Saturated medium
 - *Submerged media or*
 - *Suspended growth systems*
- Aeration approach
 - Passive air exchange
 - Mechanical mixing
 - Compressed aeration
 - Impeller venturi effect

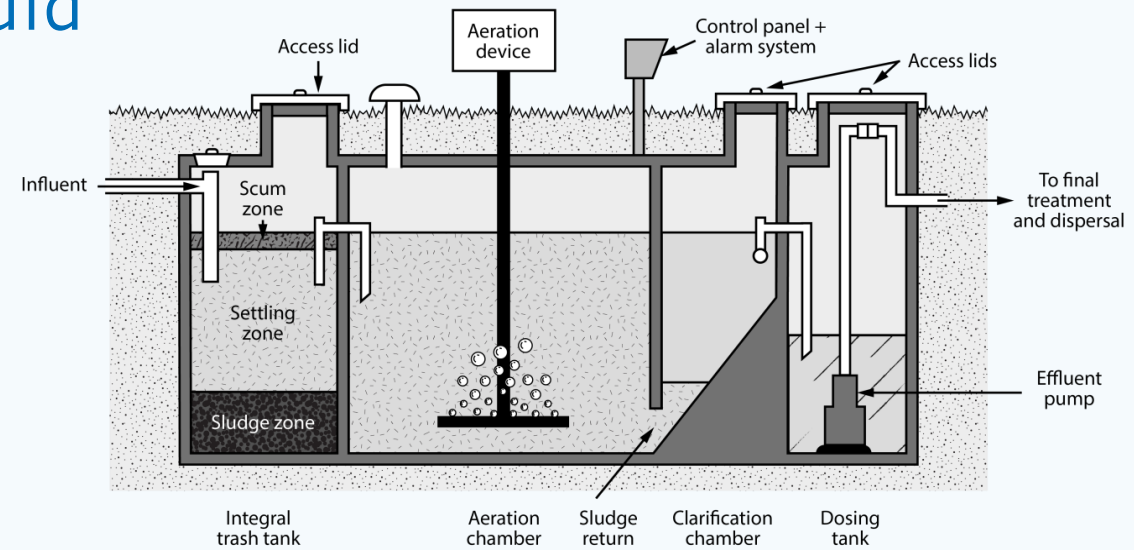
Passive aeration aerobic systems

- Mechanical mixing aeration
 - Circulates gases from headspace of treatment tank into liquid
 - Head space air exchange is critical
 - Chimney effect through house plumbing vent is critical for air exchange



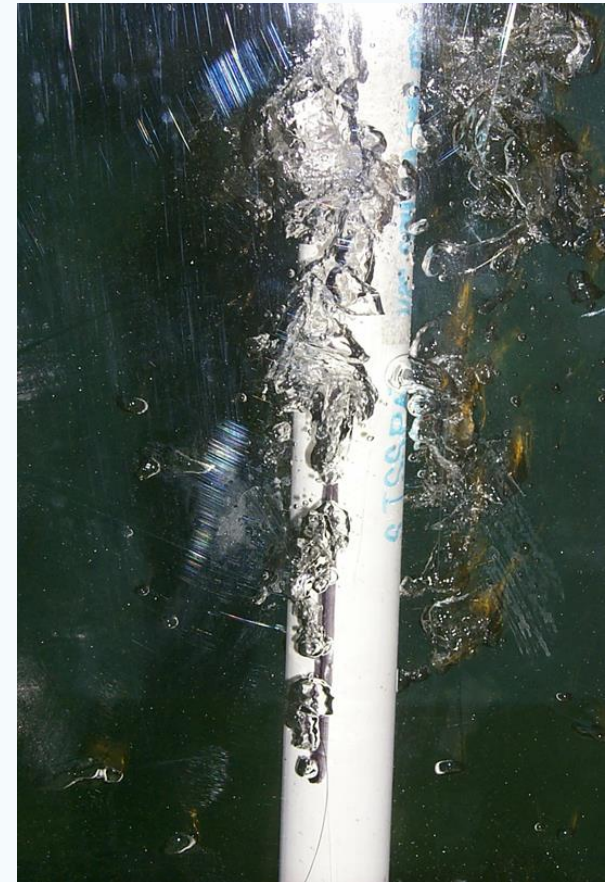
Compressed aeration aerobic systems

- Positive air movement into liquid
 - Compressor
 - Blower
- Diffusers generate air bubbles within liquid



Air bubbles: oxygen transfer and mixing

- Air is approximately 21% 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 (CFM) moved through the unit.



Air Dispersion using diffusers



Perforated Pipe

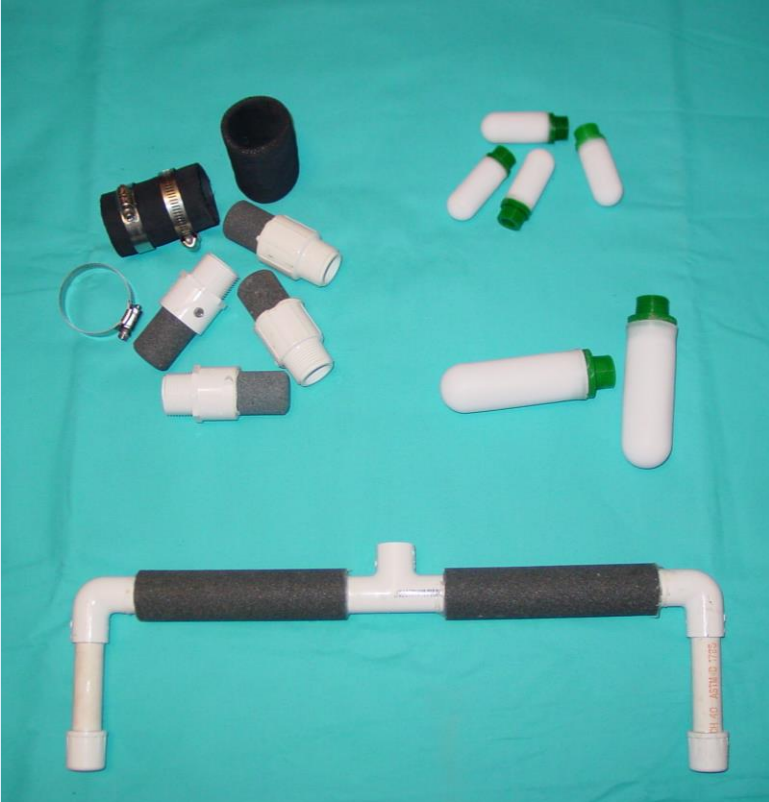


Porous Stone Diffuser

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

Diffuser Maintenance

- Residue accumulates on diffuser
- Residue decreases flow rate
- Restore air flow rate
 - Clean diffuser
 - Replace diffuser





Air supply pressure reading

Where do you measure?

- Measured at the unit
- Pressure gage
- Schrader valve

What should it be?

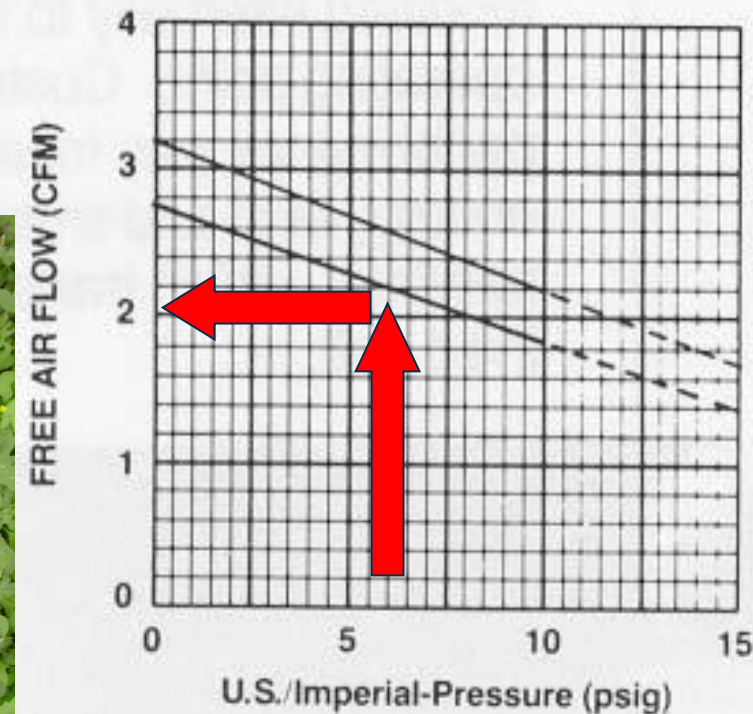
- Performance curve

How to read it

Schrader Valve

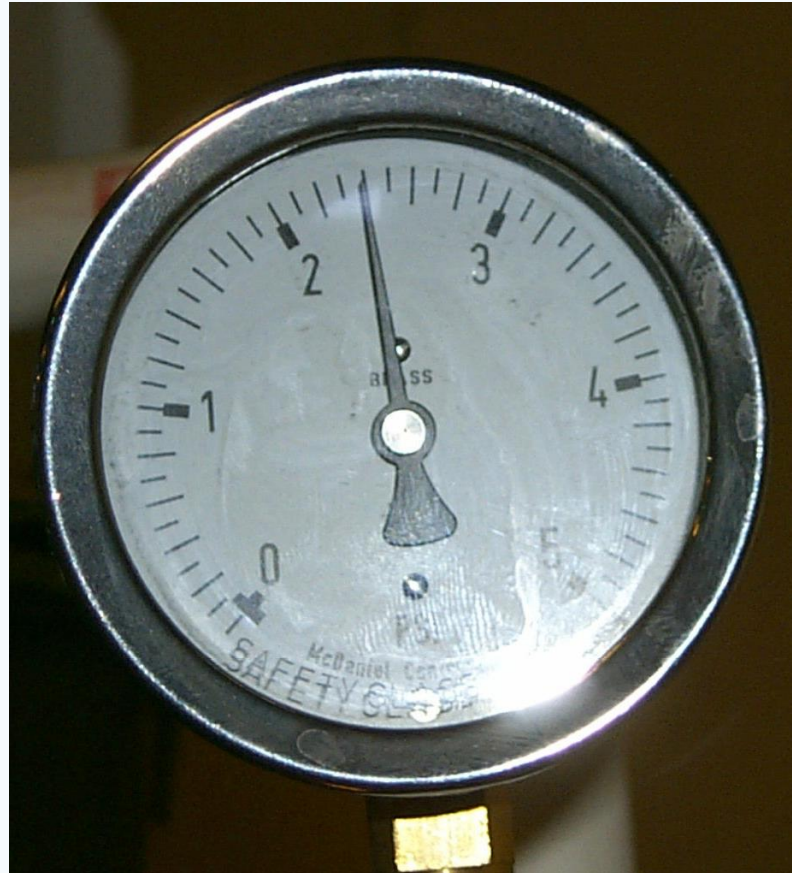


Model
0323



Aeration System Pressure

- What is the correct air pressure in the distribution lines



Air Pressure Monitoring

Decreased Pressure:

- Loose fitting in the air distribution system
- Broken air line
- Broken diffuser
- Aerator is not performing

Increased Pressure:

- Blockage in Distribution Line
- Crushed Distribution Line
- Plugged Diffuser
- Increased water level in the aeration chamber

Air flow rate (CFM)

- Measured at the supply unit
- Positive pressure
 - Compressor
 - Blower
- Vacuum
 - Aspirator





Air filter/screen

Maintenance

- Cleaned
 - *Washed/Dried*
- Replaced
 - *Yearly*

Filter Locations

- Internal
- External



Venting



- Air exchange must occur
- Air entering system
- Air must exit somewhere
 - Unit
 - House vent
 - Biofilter

Visual Evaluation - Color

- Bright versus Dull or greyish
 - Rich color
 - Rich brown chocolate
 - Black – Anaerobic or dead
- Aeration chamber dissolved oxygen
- DO concentration of 2 mg/l



Low Dissolved Oxygen

- Aeration system
 - Air supply impact
- Organic loading
 - Waste load impact

Water Clarity

- Hydraulic overload
 - Clear zone below outlet
 - Settling blanket at bottom
- Milky color
 - Separation
 - Toxic Event
- Colored water



Odors

- Hydraulic overload
- Organic loading
- Poor venting of aeration chamber
- Odors from house vent
- Low pH
- Upset microbial population
- Time for biomass wasting



Dissolved Oxygen (DO)

- Concentration of O₂ dissolved in water
 - Measured with meter and probe or colorimetric kit in field
 - DO expressed as mg/L
 - DO low in septic tank <0.3 mg/L
 - DO >2 from treatment systems



Microbial Biomass Management

- Sludge wasting is required to reduce the quantity of biomass in the system.
- Frequency depends on the waste load into the system. High organic loading requires larger microbial population to transform waste
- 30-minute settleability test is used to determine when system needs pumping.

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.



Aeration management for denitrification

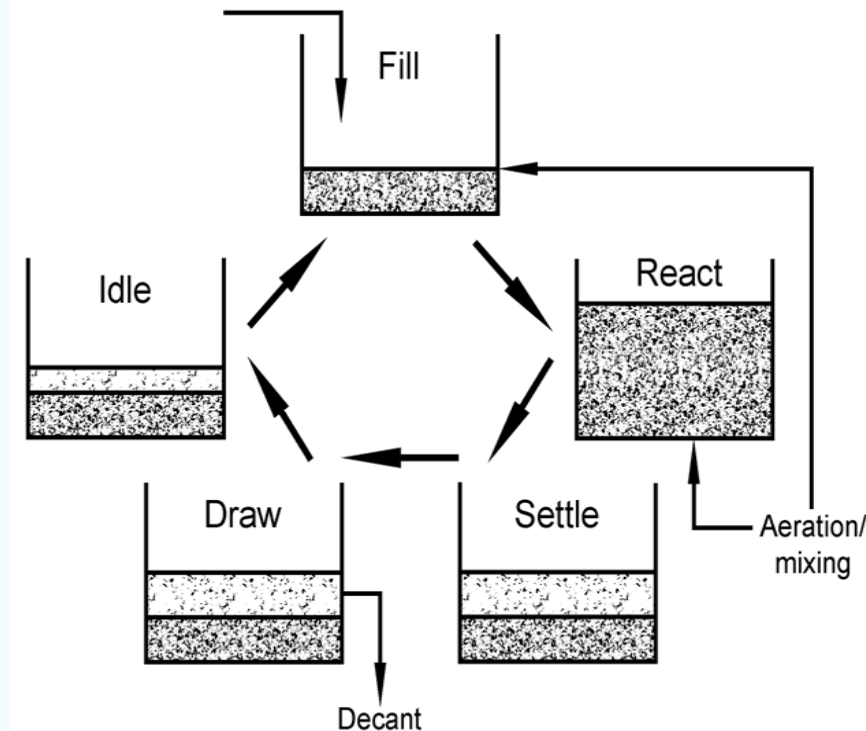
- Identify anoxic treatment location
- Aeration treatment tank
 - Sequencing batch reactor or aeration tank
 - Aeration on a timer
- Septic tank or recirculation tank
 - Circulate nitrified liquid to upstream tank

Why This Is Important

- Goal of circulation regime is to create anoxic conditions:
 - *Low dissolved molecular oxygen ($DO < 0.5$ ppm)*
 - *Bound oxygen in nitrate form*
- If ratio is too high (too much volume recirculated):
 - *DO increases in the anoxic treatment tank*
 - *Denitrification does not occur*

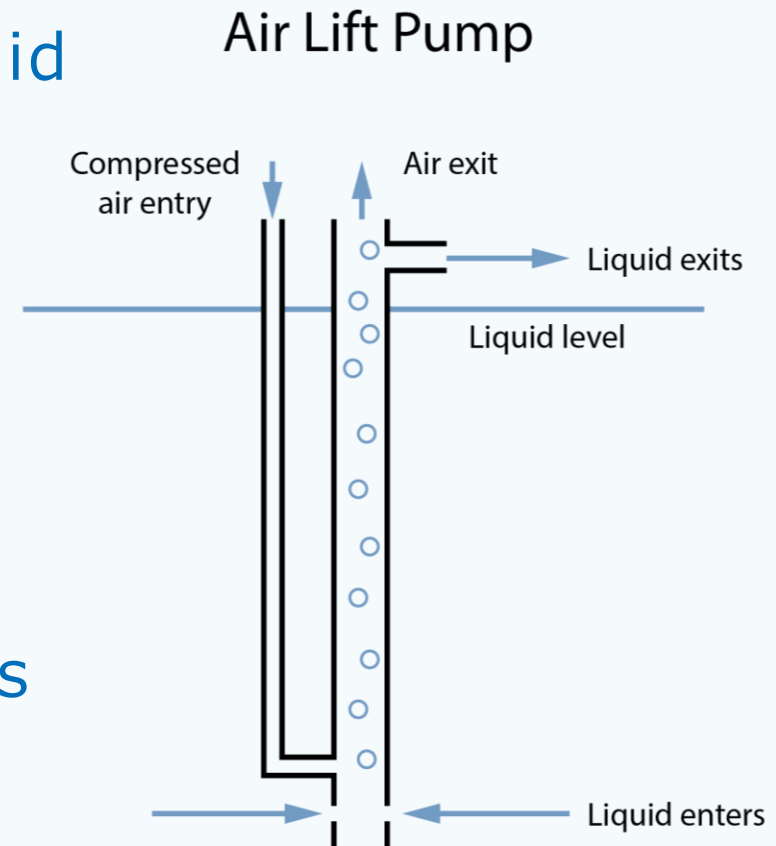
Timer controlled aeration

- Sequencing batch reactor
 - Measure DO during idle cycle
 - Change time in “idle” stage
- Aeration tank
 - Timer control of mechanical aeration
 - Time “ON” and Time “OFF”



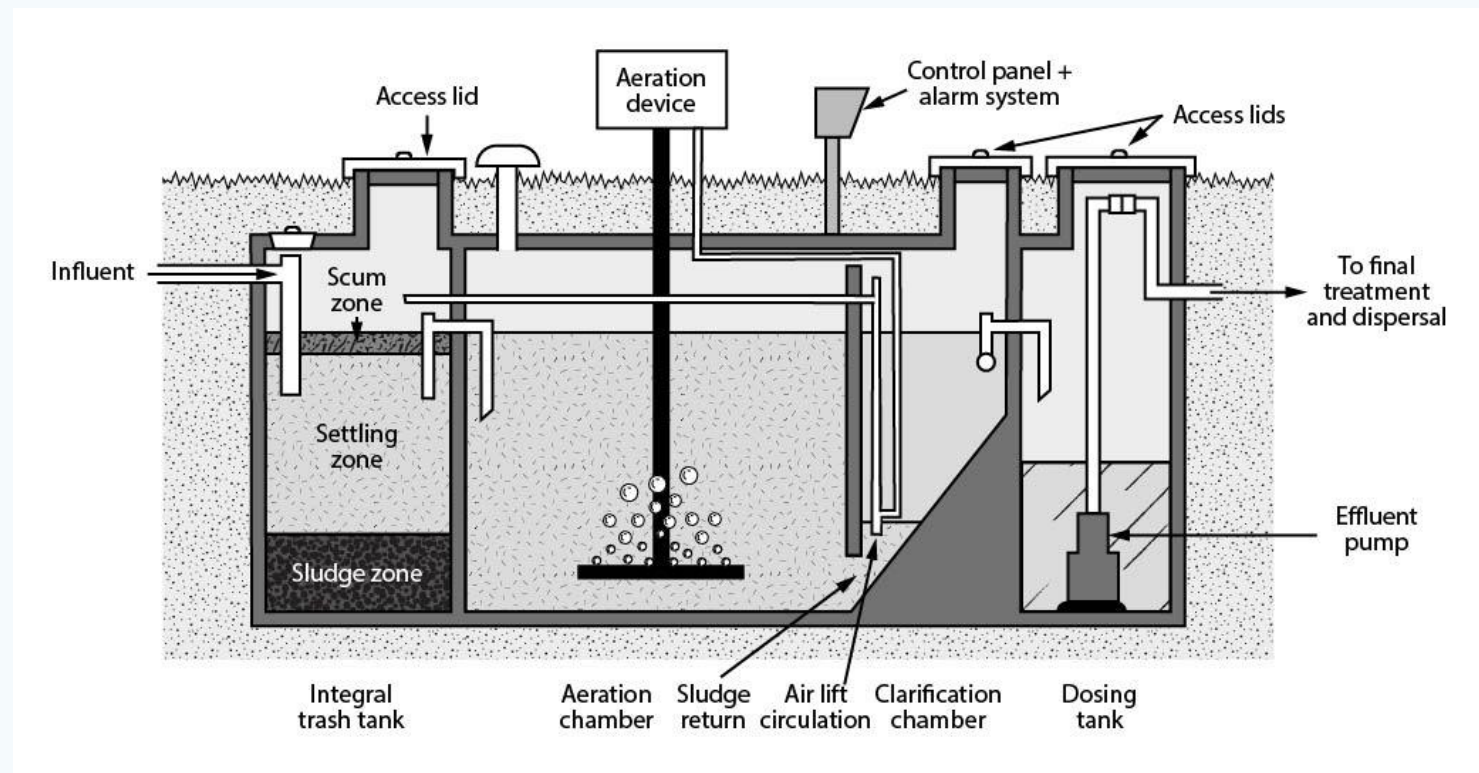
Air lift pump system

- Bubbles rising in liquid column raise liquid level above static liquid level
- Air enters at bottom of stand pipe ("pump")
- Air vents from top of stand pipe
- Liquid exits at discharge point
- Air flow (CFM) defines volume of bubbles rising and liquid movement rate



Control circulation rate – air flow

- Greater air flow equals greater liquid flow
- Change liquid flow rate (GPM) by changing air flow rate (CFM)



Circulation ratio

- *Forward flow* is the average flow generated at the dwelling that passes completely through the system to the soil treatment area “STA”
- *Circulated flow* is the average volume applied to the media over a specific period
- Circulation ratio is adjusted by changing the returned flow rate

Circulation Ratio

- The ratio between the volume circulated through the treatment train and the 'forward flow'

$$\text{Circulation Ratio} = \frac{\text{Circulated volume}}{\text{Forward flow}}$$

Summary

- Use of recirculation in media filters.
- Assessing pump operation using control panel data.
- Measuring drawdown to calculate the dose volume.
- Determining forward flow rate and circulated flow rate to calculate circulation rate.

QUESTIONS?

*Instructor's Contact information
here*