

Solids Handling

What is it all about ?

Why worry about solids?

What happens to the solids?

Presented By Lyman Waller

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What is it all about?

Where do the solids come from?

They come from the human body and from food scraps; kitchen, bathroom and laundry room drains is how many people explain this. Most books refer solids coming from homes and non-industrial businesses.

Percentage of Solids in Wastewater

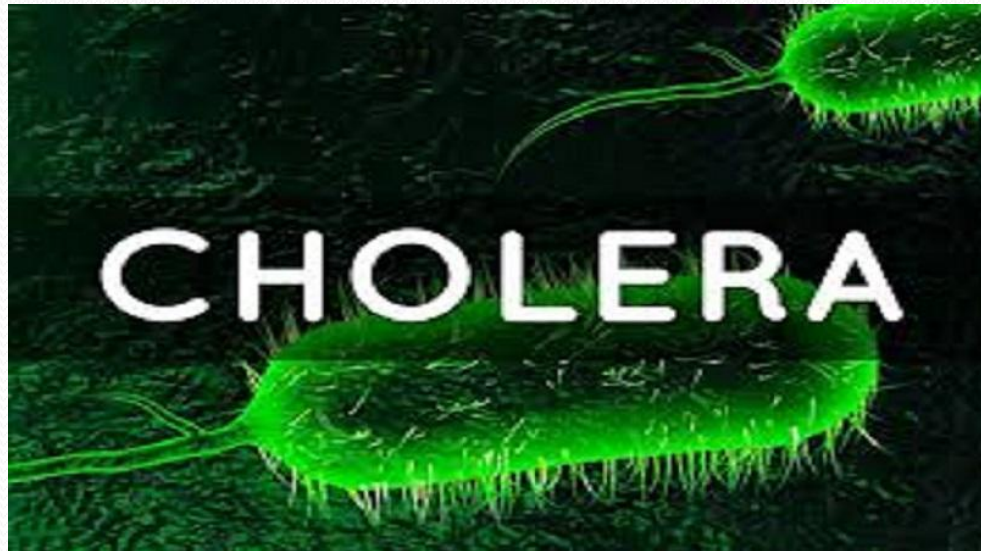
- What is the percentage of solids in wastewater?
- 0.1% or less



Why worry about solids?

- If solids were not removed properly from the wastewater stream then rivers and lakes would be destroyed.
- Irrigation of farm lands would have to stop.
- There would be less drinking water.
- People would die.

Protect Public Health



Dysentery



Protect Aquatic Environment

Algae blooms



Fish Kills

Solids in the Collection System

- What flow rates are needed to keep solids from settling in the collection lines?
- 2 ft / second to keep inorganic solids or grit moving to the treatment plant.
- 1.5 ft / second to keep organic solids moving to the treatment plant.

Changes on flow rates

- Can you think of anything that may change the designed flow rates in collection systems?
- What about communities allowing Home owners or large commercial areas to use Grey Water systems?
- These changes will lower the designed flow rates of the collection system.

Less Water in Collection Lines

- If there is less water in the collection lines then the flow rates will drop.
- When flow rates drop then grit will settle and slow the rate even more until the head level builds up to push the grit down the line.
- Until the grit is pushed out then organics will settle out.
- When organics settle out is when the real issues will start to be known.

Less water flow issues

- Now if organics have settled what happens next?
- Septic conditions will start happening.
- Gasses such as Methane, Carbon Dioxide and Hydrogen Sulfide will form and be released out of the water.
- Hydrogen Sulfide mixed with water creates Sulfuric Acid.
- Sulfuric Acid will slowly destroy the tops of the concrete pipes and any steel ladder rungs in manholes.













Cost of collection line repairs

- Nobody can guess on what exact costs are to repair sewer lines.
- Each system is to have contingency plans for such occurrences but costs can get crazy.
- It all depends on when and where such line breaks occur.
- Don't forget to think about Safety issues on every part of dealing with solids and the damage that can happen because of them.

Now back to Solids Handling

- Now solids will arrive at a treatment facility.
- There are many steps to handling wastewater solids.

What happens to the solids?

- Solids are removed and handled in different steps at a wastewater treatment facility.
- Solids are rendered harmless once the volatile solids are reduced in amount before being sent to a landfill, land applied or composted.

Preliminary Treatment

- Need to remove any large debris, rags and such with a Bar Screen or grinded down so it can be removed in Primary Settling; this is a mechanical treatment.
- Need to remove inorganic solids (Grit)
- Grit removal can be done with a variety of systems. Can you name some?
- Do all systems need to have the flow slowed down?
- Mostly a physical treatment.

Preliminary Treatment

Screening



Manual Bar Screens



Mechanical
Bar Screens



Fine Screens



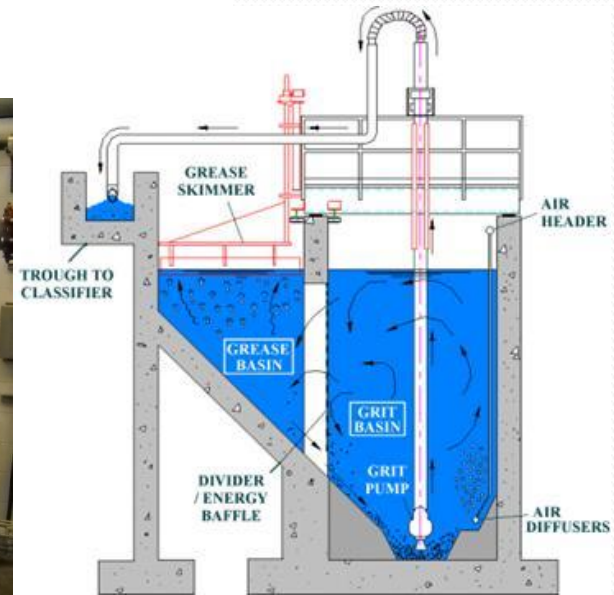
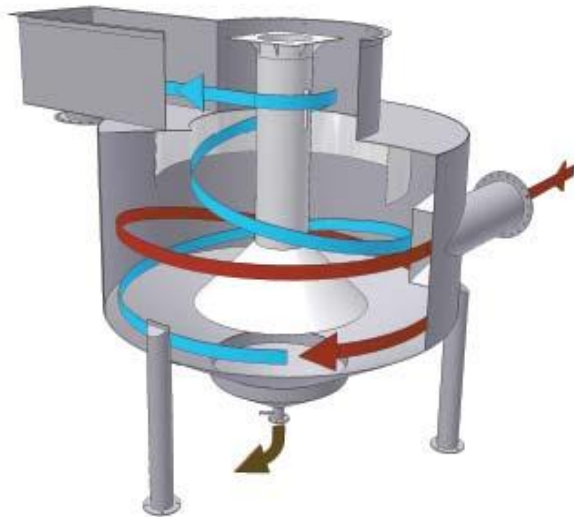
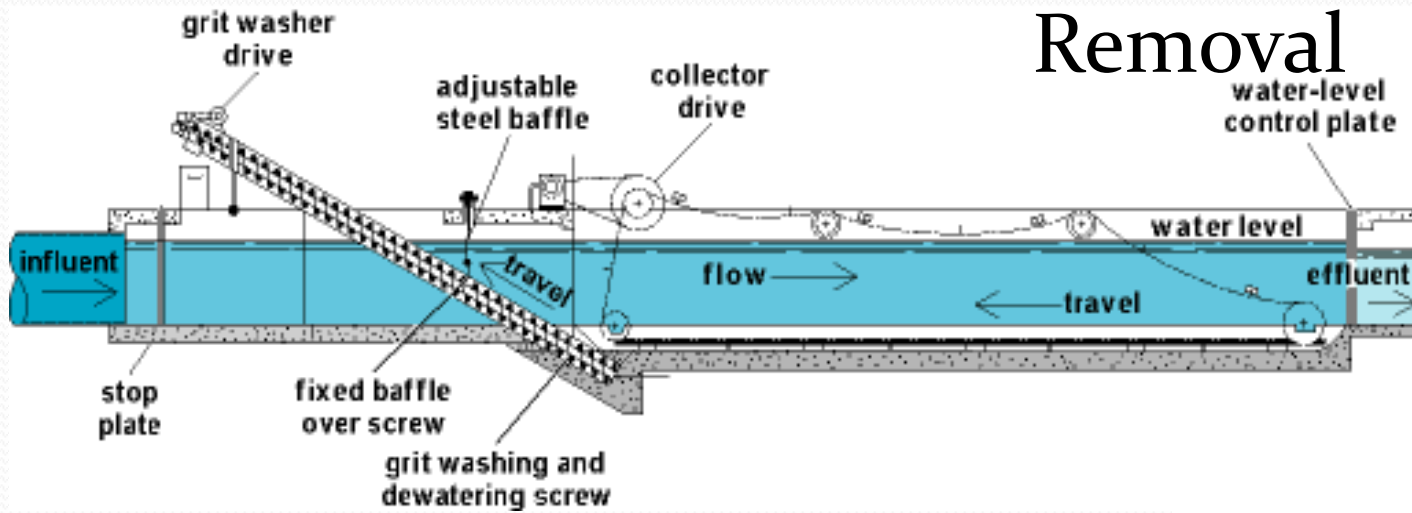




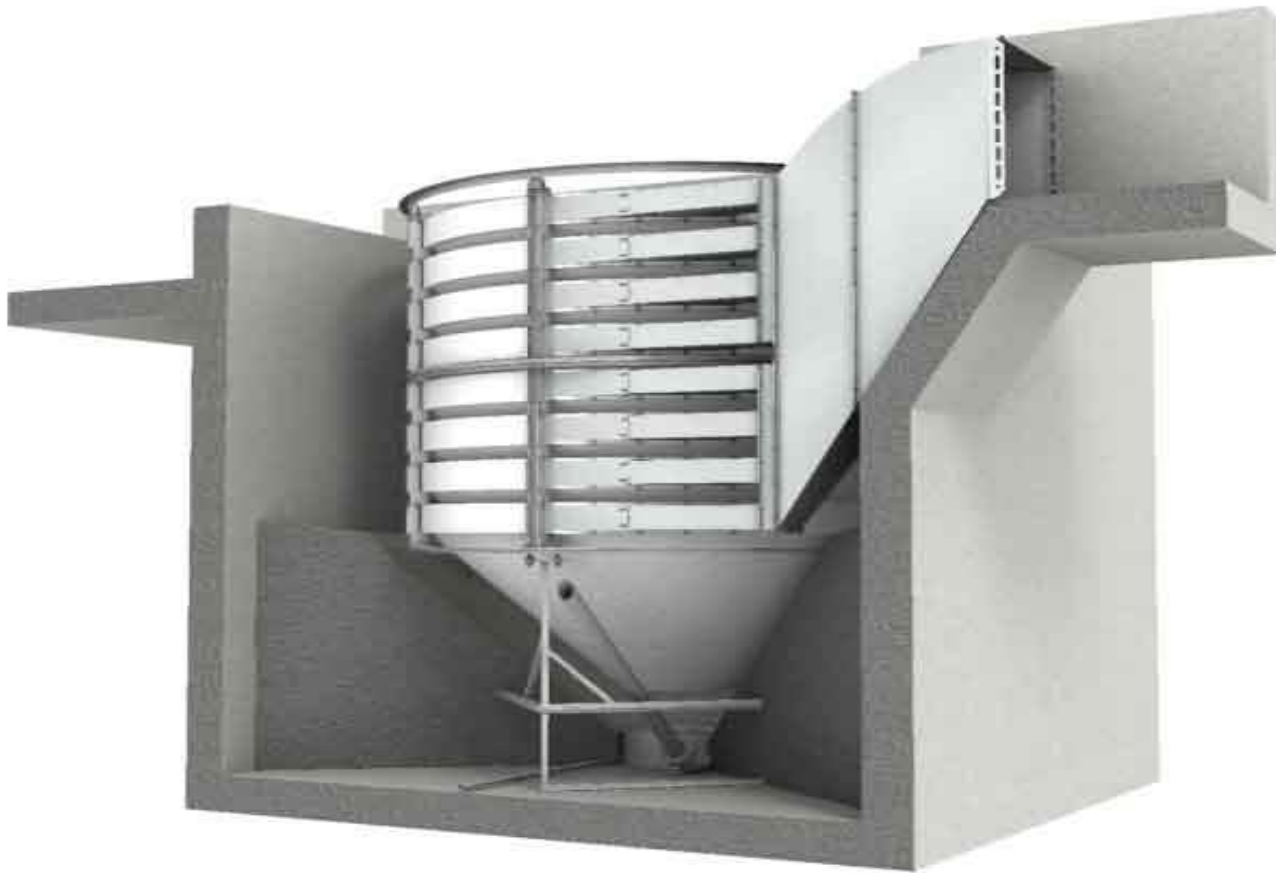


Preliminary Treatment

Grit Removal



SWRP - Conical Tray Vortex Separator





**GRIT/
SCREENING
HANDLING
BUILDING**





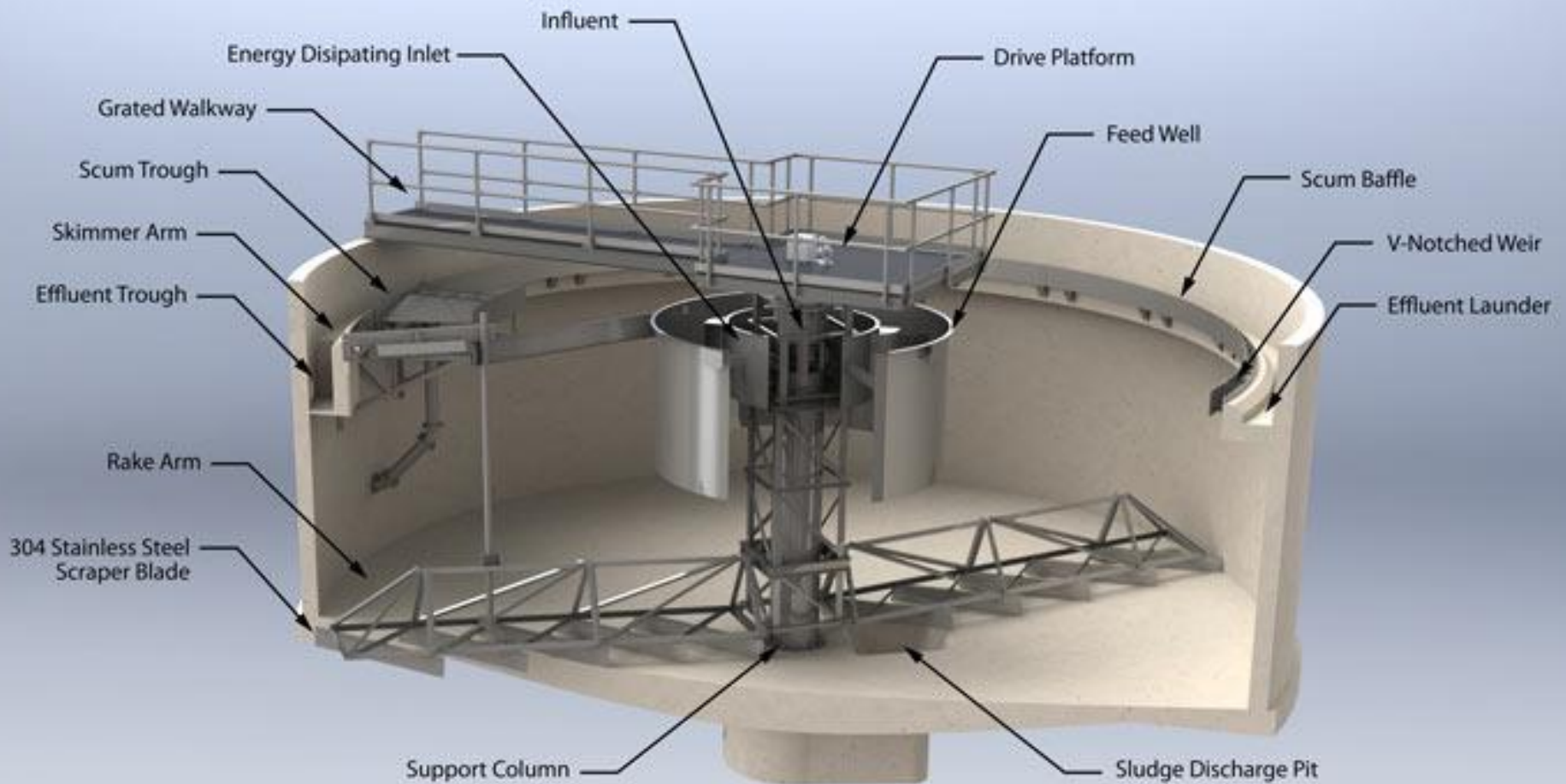


Practice Questions

- When taking rags and grit to a landfill what must be done by the landfill operator?
- The debris and grit must be covered under 6” of soil.
- What gas gives off a rotten egg smell?
- H_2S
- Is it okay to go back in if you don't smell the rotten egg anymore?
- No, because Hydrogen Sulfide is an olfactant.

Primary Clarifiers

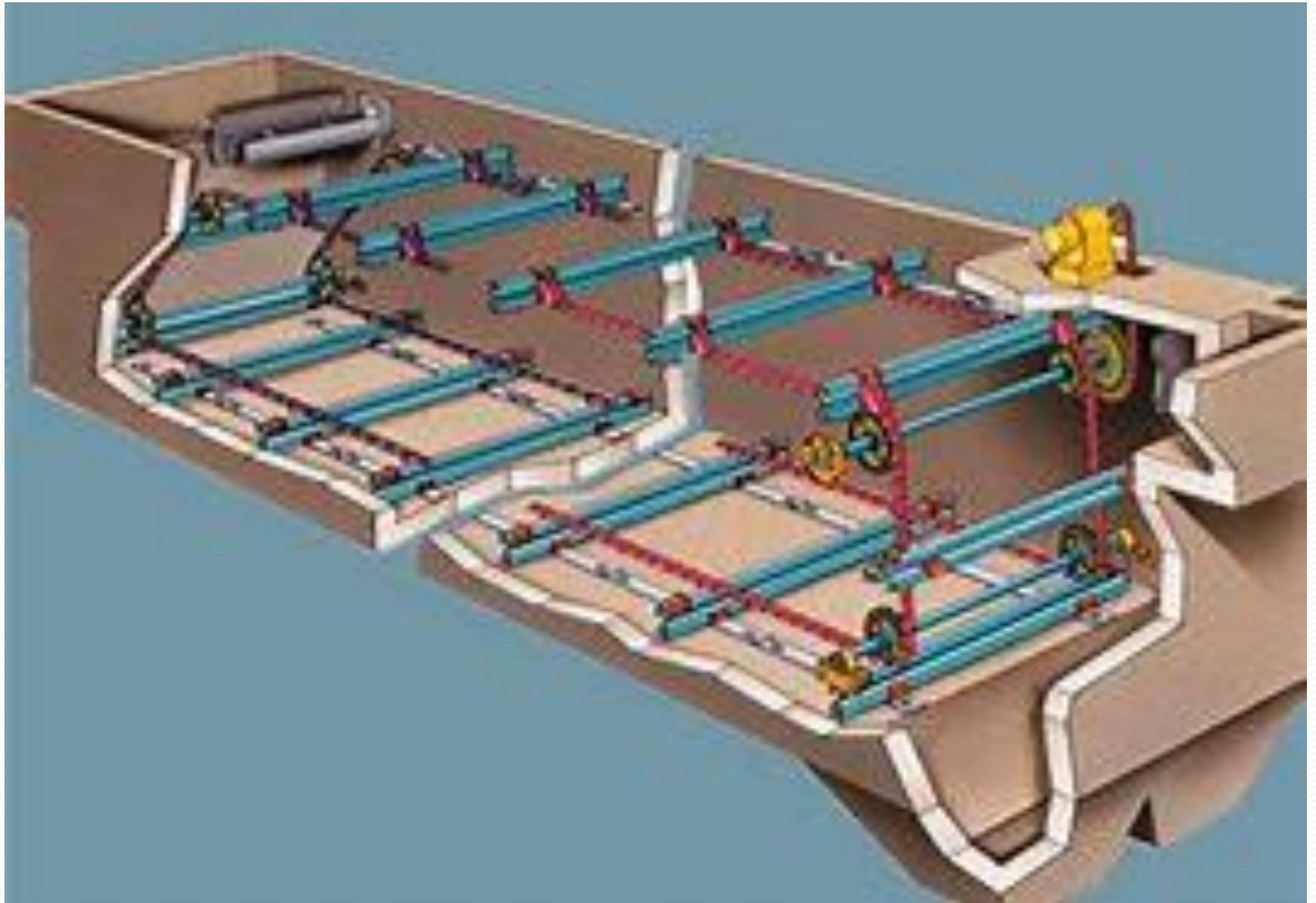
- Flow is allowed to slow down so that the settleable and suspended solids can settle to the bottom of the clarifier.
- Physical process.
- Detention time of primary clarifiers is what?
- Too short then there is a chance of carryover
- Too long allows for septic conditions and poor settling which also leads to carryover of septic water going to secondary treatment.













Albuquerque Bernalillo County Water Utility Authority

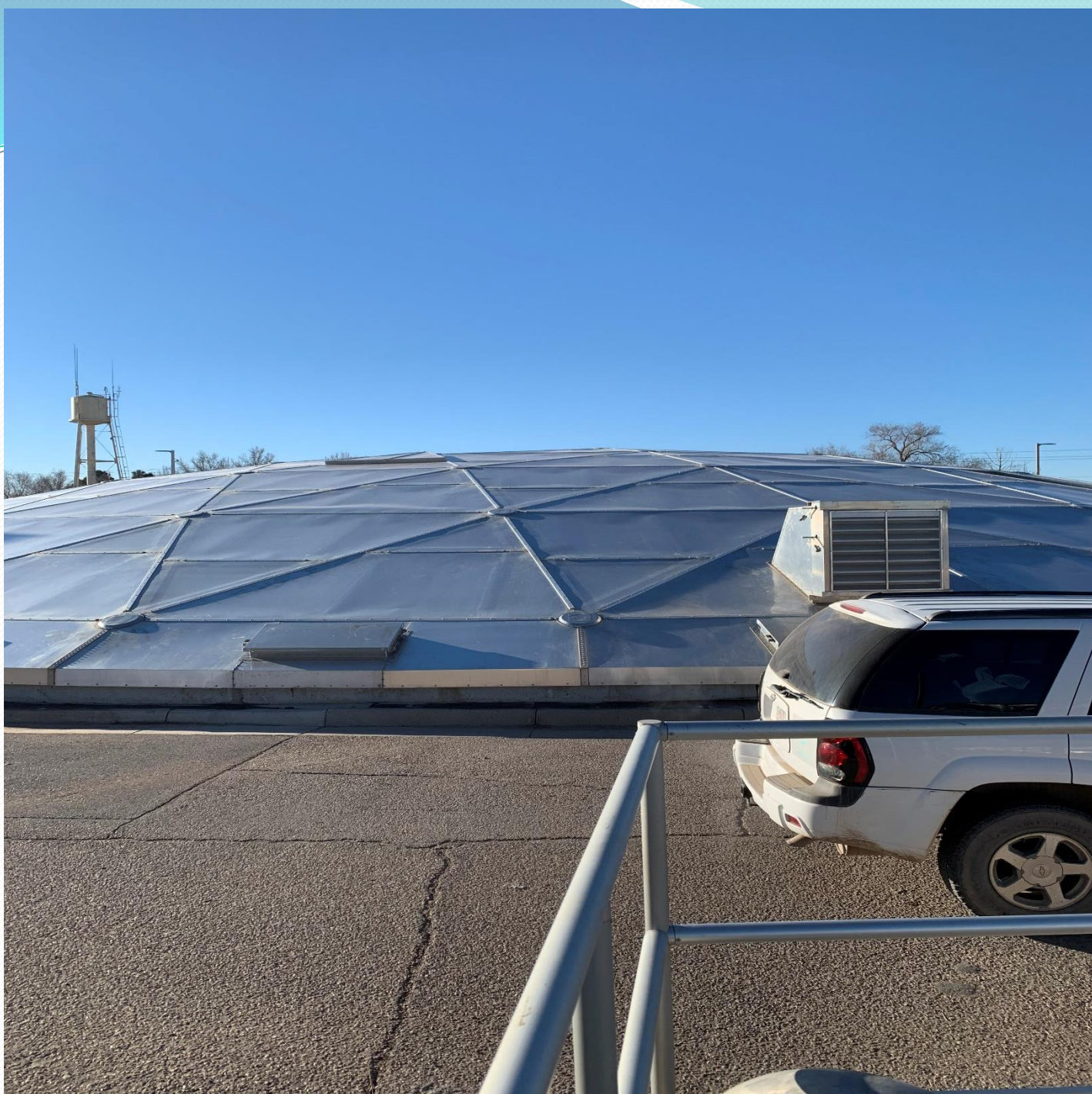


IE
INC.

Crane Group
60,000 LB. ALUMINUM
R. GROVE CMT 750
T. A. WERDING CO. INC.
DECEMBER 2018

SWRP Primary Clarifiers





Detention Time

$$DT = \frac{\text{Tank Volume, MG} \times 24}{\text{Flow into Tank, MGD}}$$

D.T. is usually around 2-3 hours with 2 being ideal.

Weir Overflow Rate

$WOR = \text{Total flow} / \text{length of weir}$

20,000 – 25,000 gpd/ft

Surface Overflow Rate

$$\text{SOR} = \text{Influent flow} / \text{surface area}$$

800 – 1400 gpd/sqft

Solids Loading

- $SL = \frac{\text{Solids, lbs/day}}{\text{Surface Area, ft sq}}$

Settled Sludge

- Most often is pumped to a digester.
- What kind of pumps are used for sludge pumping?
- How can you tell what the Density of the sludge is?

Primary Sludge

- In many plants, Primary sludge is mixed with Waste Activated Sludge and then pumped to digesters.
- 4-6% is the range for sludge going into digesters. Why? Because you can still pump the sludge with a positive displacement pump and not have as much water as with a 2% sludge.

Practice Questions

- What is normal primary clarification detention time?
- 2 – 3 hours with 2 being ideal.
- How do you measure the amount of sludge on the bottom of a primary clarifier?
- With a Depth of Blanket (DOB) measuring device.
- What kind of pump is used to pump primary sludge?
- Positive Displacement Pump
- What is the desired % solids on primary sludge?
- 4 – 6 %

Processes for Solids Handling

- Gravity Thickeners
- Aerobic Digesters
- Anaerobic Digesters
- Dissolved Air Flootation
- Belt Filter Press
- Drying Beds
- Centrifuges

Gravity Thickeners

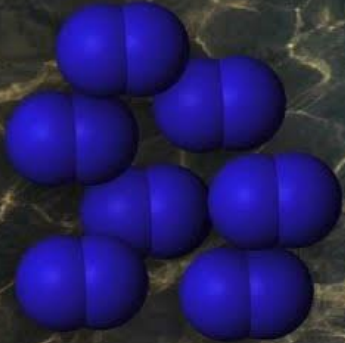
- This is a scaled down clarifier.
- Designed for heavier sludges.
- Detention times from 1-2 days.
- 35 – 50% solids by weight.



Aerobic Digesters

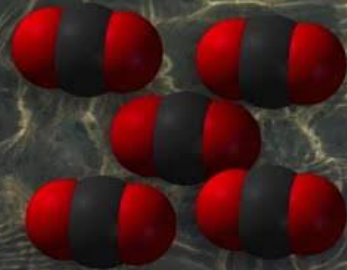
- Acts like an extended aeration plant.
- A DO level of 1-2 mg/l must be maintained.
- Solids are retained until nearly all of the volatile solids have been stabilized.
- Detention time of 25-45 days.
- Batch Operation.
- No continuous feed, this forces the volatile solids bacteria to die off and become food.

AERATION REQUIREMENT

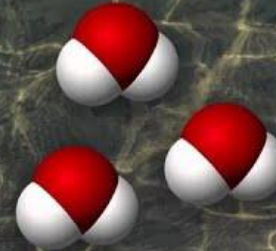


$7O_2$
(Dissolved
Oxygen)

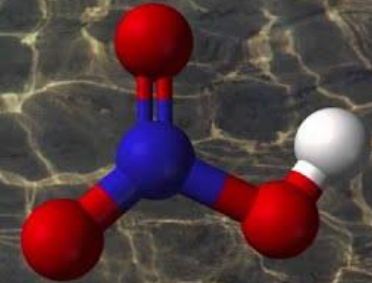
BYPRODUCTS



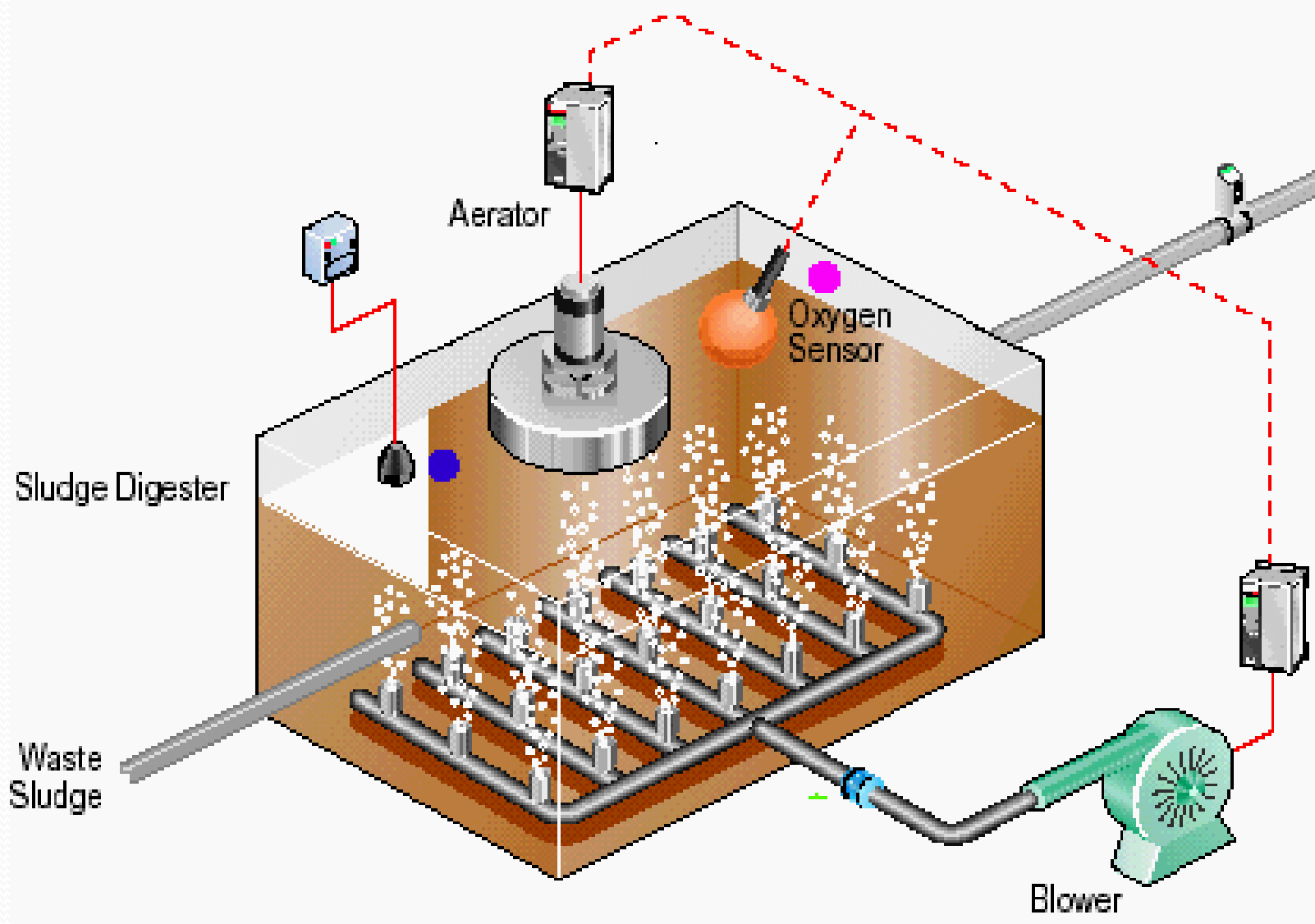
$5CO_2$
(Carbon Dioxide)



$3H_2O$
(Water)



HNO_3
(Nitric Acid)



Practice Questions

- What is the detention time for Aerobic Digesters?
- 25 – 45 days

- What is the best Dissolved Oxygen level for Aerobic Digesters?
- 1- 2 mg/l

Anaerobic Digesters

- Must occur in the absence of dissolved oxygen.
- Bacteria
 - a) Acid Formers
 - b) Methane Fermenters
(Gas Formers)

Acid Formers

- Take complex raw organic compounds like sugars and starches and break them down into organic acids.
- Production of some carbon dioxide.
- The acid formers then have acid escape their cell walls and attract the other type of bacteria for the next phase of digestion.
- Produce more organisms as well.

Gas Formers

- Consume the acids and produce Methane, water and more organisms.
- Will not work if the pH is lower than 6.6 or greater than 7.6

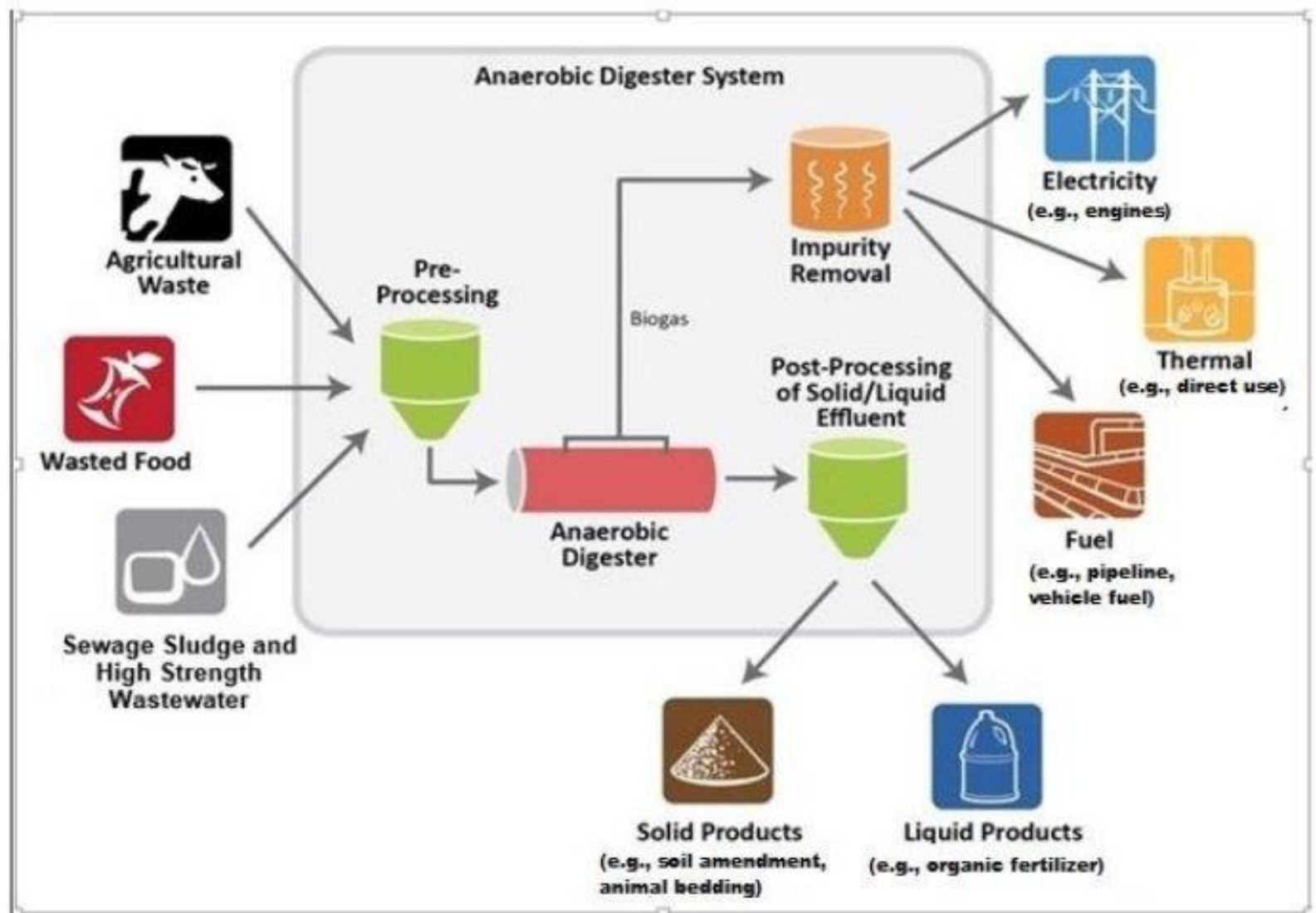


Figure 1. Anaerobic System Components









Environmental Benefits

- **Climate Change**
- Anaerobic digestion facilities help reduce harmful so-called “greenhouse gas” or carbon emissions—a contributing factor to global warming—by capturing and combusting methane, preventing its ascension into the atmosphere and preventing it from trapping additional sunlight and heat. Anaerobic digestion generates renewable energy, thus reducing dependence on pollutant and climate-warming fossil fuels.
- Nutrient-rich digestates applied to the soil sequesters carbon emissions. Overall, anaerobic digestion diverts decaying organics from landfills, consequently decreasing methane gas production and release.

Clean Water

Anaerobic digestion helps keep our waterways and bodies safe from contaminants by providing an environmentally sound avenue for sewage and wastewater treatment, thus diverting such substances and its toxic properties from entering the aquatic environment, while simultaneously recovering and repurposing beneficial nutrients.

The process by nature consolidates those, which in large quantities, would otherwise cause eutrophic conditions and harmful algae growth in water bodies, such as phosphorus and nitrogen, thus helping prevent oxygen depletion and its consequential mass marine life die-off, such as those witnessed more and more throughout the world. These, too, can be recovered and repurposed for more beneficial uses.

Overall, the utilization of anaerobic digestion therefore improves water quality, and, with energy recovery systems, many anaerobic digester facilities can offset their own energy consumption! This is a win-win, all around.



Sustainable Development

Anaerobic digestion supports sustainable communities by reducing the consumption of fossil fuels and producing localized sources of renewable electricity, heat and fuel. This can generate much-needed revenue for local economies, reduce associated energy costs and wasted food volumes, and through the further repurposing of solid and liquid byproducts as fertilizer, replace harmful, traditionally used chemicals.



Pollution Prevention

Through its diversion of organic waste away from landfills, anaerobic digestion reduces hauling costs and nutrient runoff—whereby detrimental nutrients leech into nearby waterways, bodies, and even groundwater drinking supplies. Implementing byproducts into the soil can help scale back, or even eliminate the use of pesticides and related products, and even help improve water retention.

Anaerobic Digester Essentials

- Proper pH levels, works best between 7.0-7.2 Not a good idea to use pH as a control parameter.
- Acid/Alkalinity ratio is a great indicator of how the digester is doing. The ratio must be kept below 0.4 If ratio starts to rise then the alkalinity will need to be raised. Soda ash works well to do this.

Mixing of anaerobic digesters

- Ways to mix digester sludge. Tube style mixers, Linear Motion mixers, pump and nozzle mixers.
- This is needed so that the gas formers can get to the acid and do their job.
- What else is needed for proper digestion?

Heating

- Needed for breakdown of volatile solids.
- Three Groups of anaerobic bacteria.
- Psychrophilic (cold-loving) 50-68°F. Takes 50-120 days to stabilize the sludge.
- Mesophilic (medium heat loving) 68-113°F. Most digesters maintain 95-98°F. 25-30 days to digest the sludge.
- Thermophilic (heat-loving) 113-135°F. Most at 124-126°F. Takes 5-12 days to digest the sludge.

Gas Production

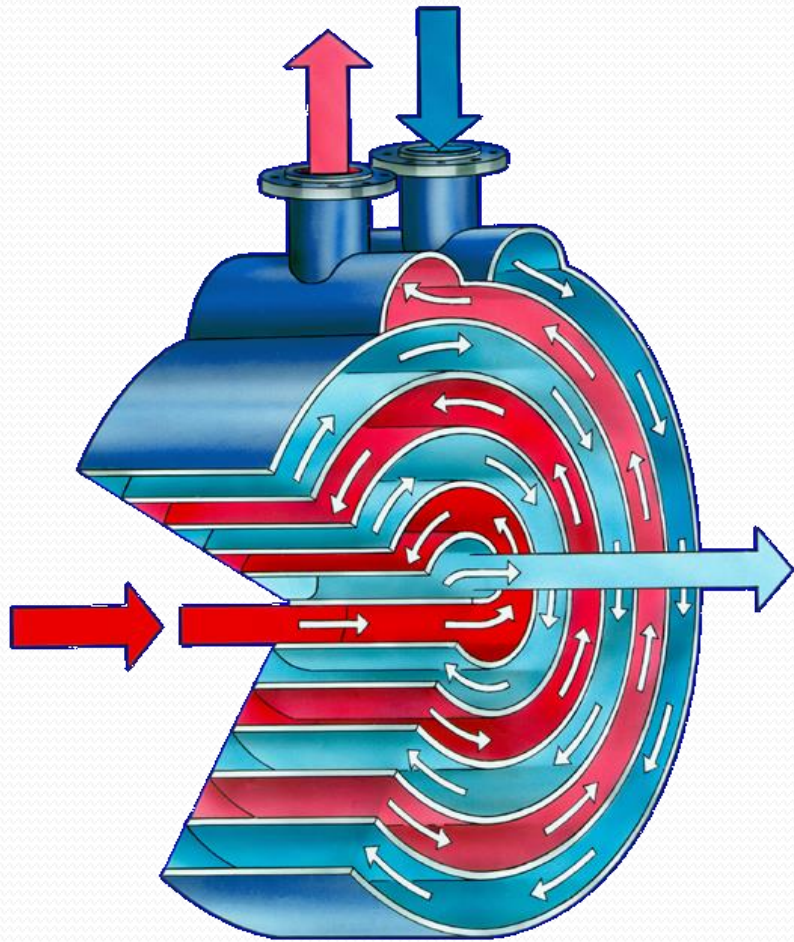
- Mesophilic anaerobic digestion produces 8 – 12 cubic feet of gas for every pound of volatile matter added and 12 – 18 cubic feet for every pound of volatile matter destroyed.
- Digester gas contains a heat value of 500 – 600 BTU per cubic foot. Nat gas contains 900 -1200 per cuft.

Volatile Solids Reductions

- Volatile solids reduction of the sludge is a key indicator of digester performance.
- VSR of 50 -60% are not uncommon.

One more note

- 503 Regs state that you must have at least 15 days of digestion over 95°F
- This might be on your test, it was on mine. 😊



Recirculation pumps

- Recirculation pumps help with the heating of digesters. The sludge can be pumped through a heat exchanger to keep the desired temperature.
- Digesters should not be allowed to change more than 1°F per day.

Gas Handling

- Anaerobic digesters produce 65% Methane 30% Carbon Dioxide and 5% Trace gasses with Hydrogen Sulfide as the lead trace gas.
- H_2S is a killer, don't take chances. If you smell rotten egg odor that is your brain telling you to get out of where you are. There is no second chance on the warning because H_2S is an olfactant and will deaden your sense of smell.
- Safety issues?

Digester Gas

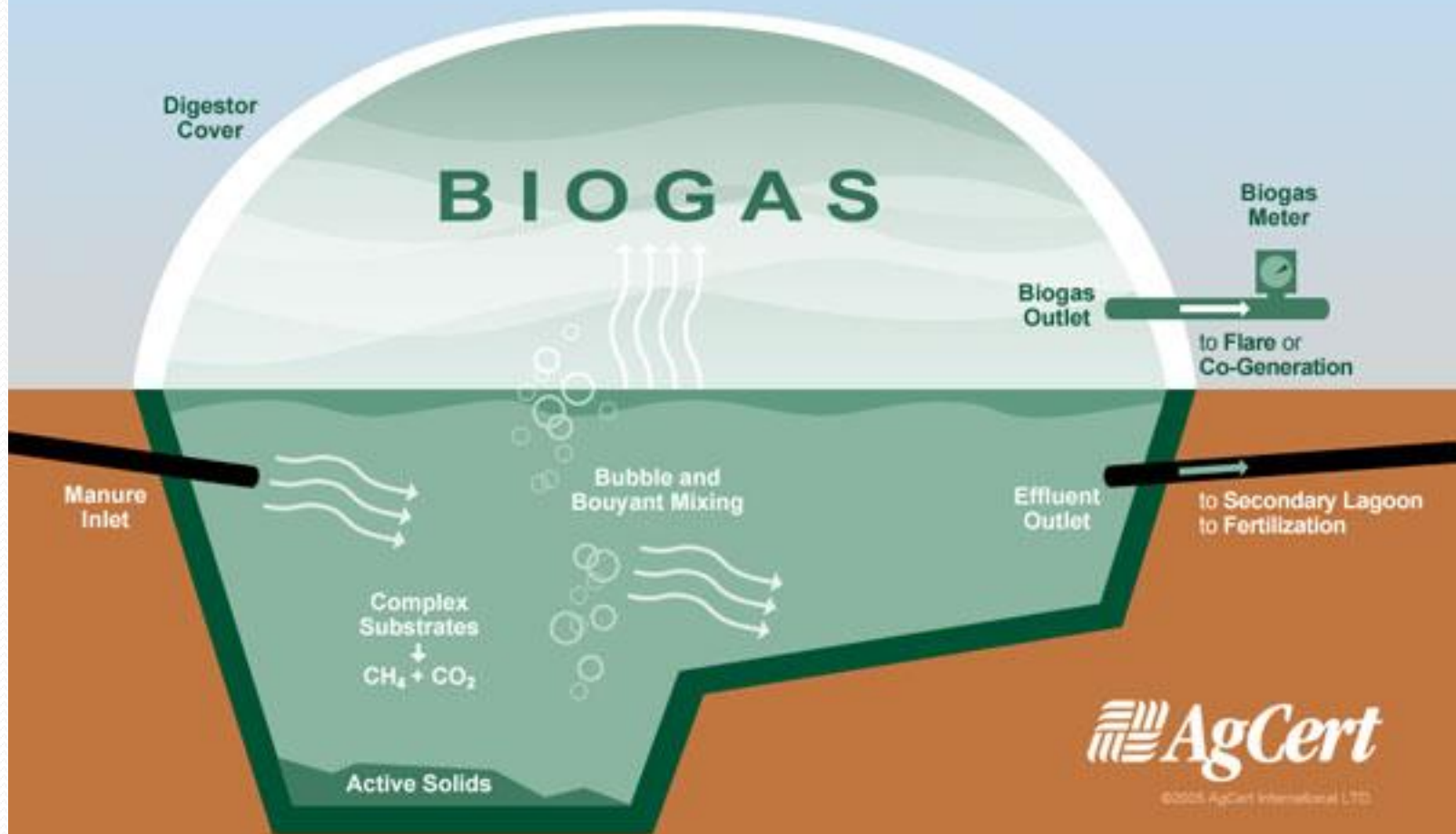
- Digester gas can be used to run generators to help power your plant.
- Can be cleaned up and put into Natural gas pipelines.
- Production amounts will depend on if the cost of Cogeneration is worth the investment.



Feed rates and removal

- Feed rates can effect the operation of a digester. Better to feed at low flow rates for a longer period so that temperatures and acid/alkalinity ratio is not adversely affected
- Larger plants can feed digesters a little at a time on a rotating basis.
- Smaller plants send supernatant from the digester back to the head of the plant, this helps to keep the temperature at selected range.

Anaerobic Digestion



AgCert

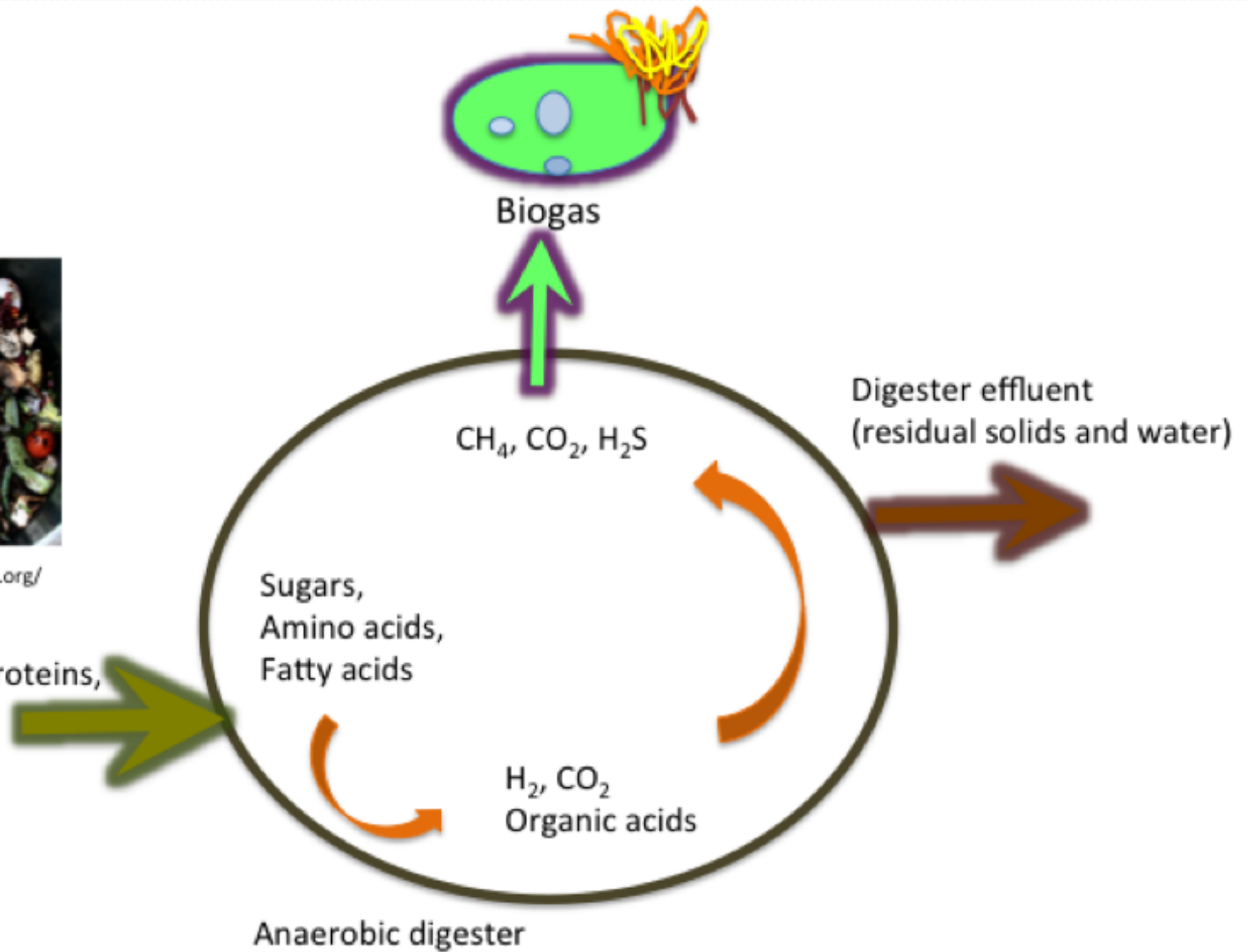
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Digesters are designed by optimizing the retention time (typically between 22-28 days) to maximize CH₄ capture.



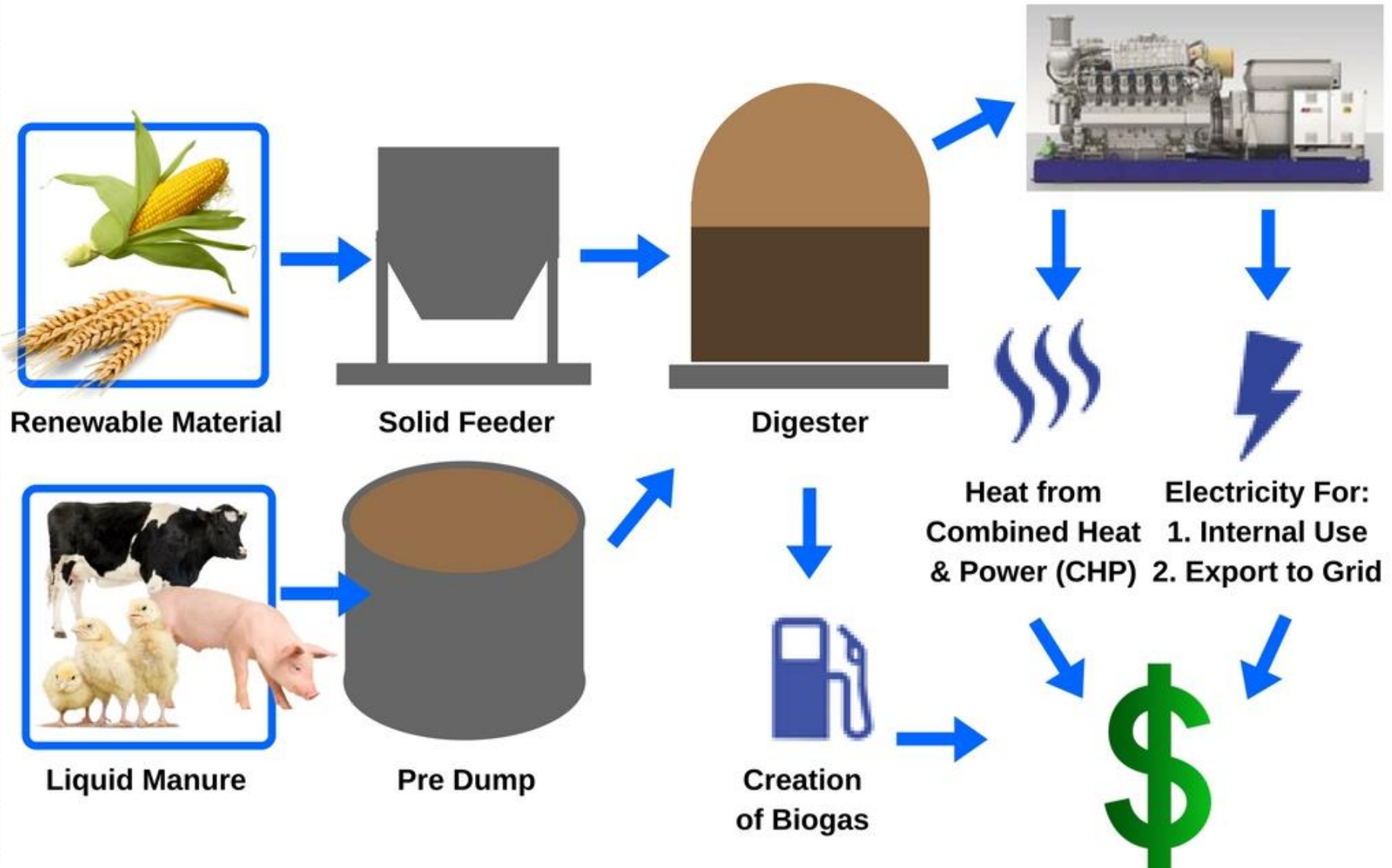
<http://www.howtocompost.org/>

Organic materials
(carbohydrates, proteins,
fats, oils, etc.)



ANAEROBIC DIGESTION:

The biofuel & biogas plant process



Practice Questions

- What are the two types of bacteria in an Anaerobic Digester?
 - Acid Formers
 - Methane Fermenters (Gas Formers)
- What is the best range of pH for AD?
 - 7.0 – 7.2 pH
- What is the temperature range of 68 – 113 degrees F called?
 - Mesophilic

Dissolved Air Flootation

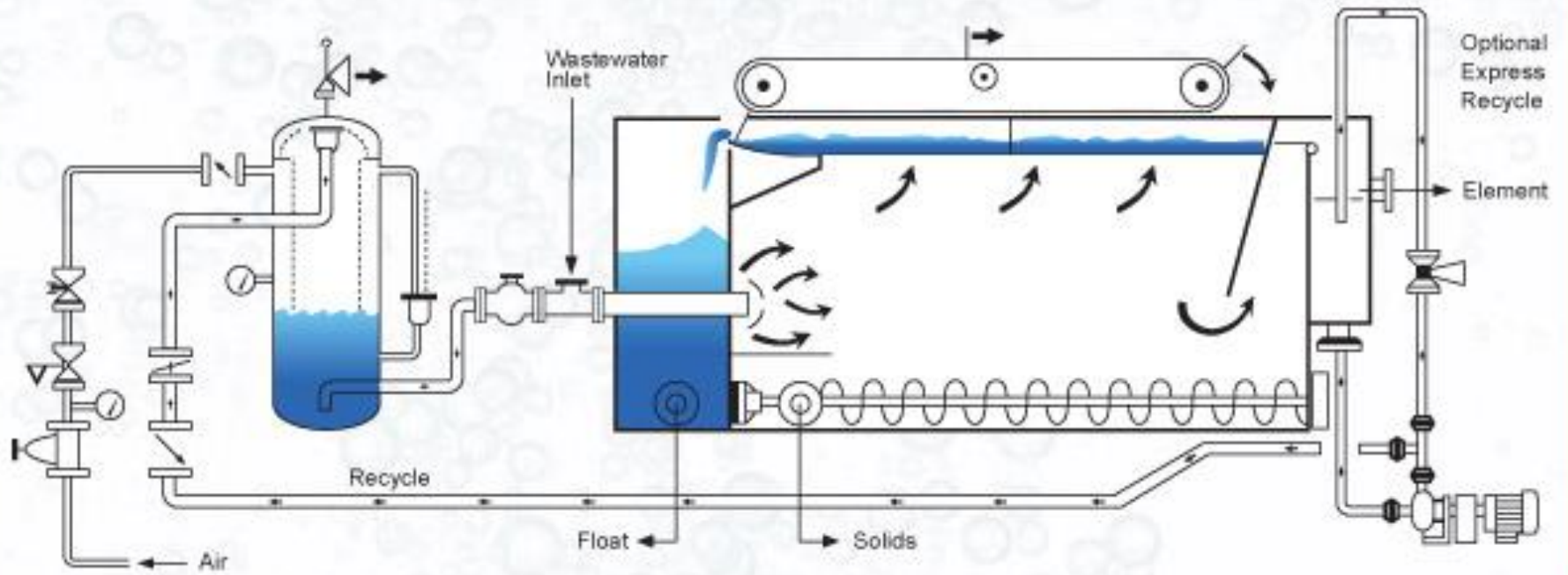
- Removes biological solids from secondary treatment.
- This sludge must be thickened to keep from sending too much water to the digesters.
- Polymer is used to help coagulate the solids and air is used to float the coagulated solids to the top of the tank where a skimmer pushes the thickened waste activated sludge to a hopper that is then pumped to the digesters. Cationic polymer is positively charged and dirty sludge is negatively charged to attract each other.



By Dissolved Air Flotation

OLD DAF SYSTEM

[Click to see larger image](#)



SWRP DAF PROCESS



Belt Filter Presses

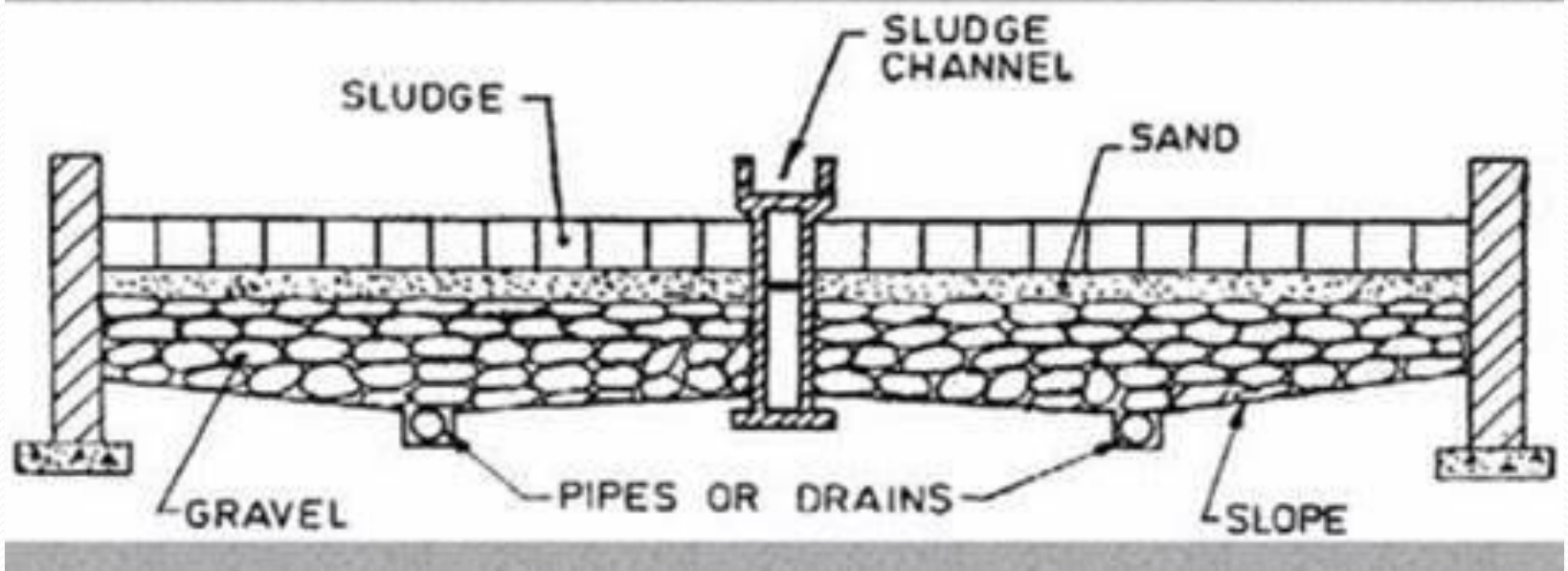
- The most simple and least expensive way to dewater digested sludge.
- The sludge is mixed with polymer and then squeezed between a wide belt that allows the water to go through but not the sludge.
- The sludge can then be sent to either a landfill, go to land application or composted.





Drying Beds

- Most widely used across the United States
- Used more than a hundred years
- Not good for areas with close neighbors
- Can be very large and can be very small
- Must be able to drain water off but hold the sludge on the top to dry out
- Dried sludge is skimmed off and then sent to landfill, land application or composted.









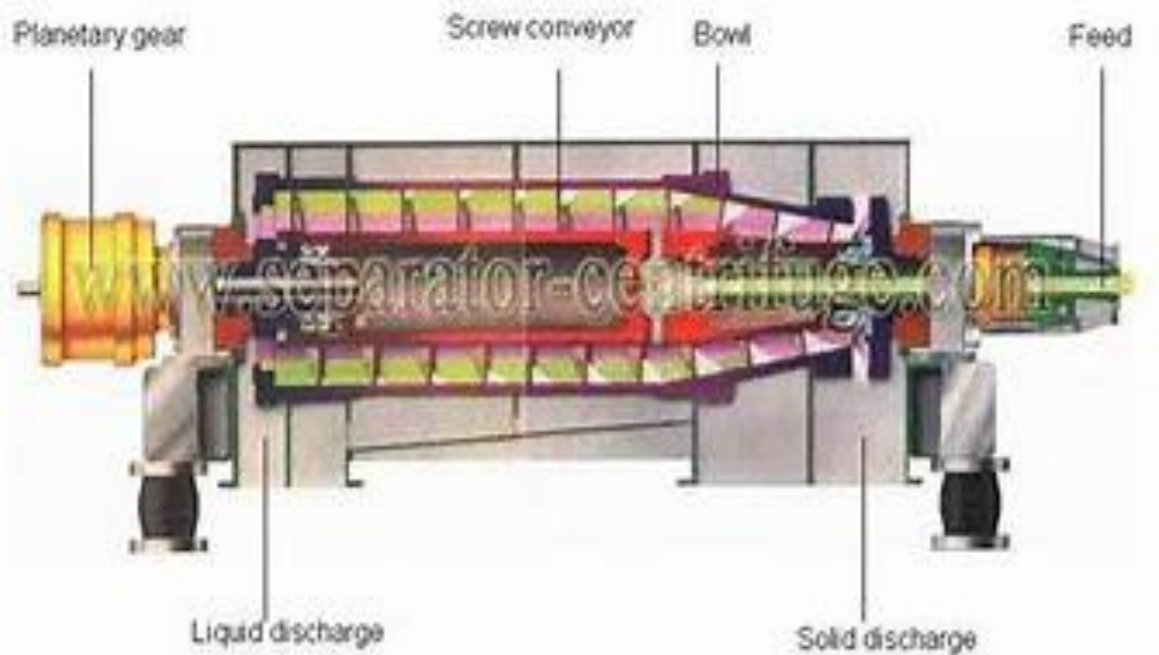
Centrifuges

- Remove water from Digested Sludge
- Less water means lighter loads to haul the sludge off
- Reduces volume of sludge being hauled
- Easier to compost
- Better for landfill operations

SWRP Centrifuges



Centrifuge Components



What to do with Dewatered Sludge? (Disposal)

- Landfill
- Land Application
- Compost

Landfill

- Always check with local landfill for regulations and restrictions.
- The more water there is the more water that the landfill has to deal with. Some don't like that.

Typical Landfill



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Land Application

- Must follow the 503 Regs
- Three parts
 - The presence of pollutants (arsenic, metals, and more)
 - The presence of pathogens (e.g. bacteria, viruses, parasites)
 - The sewage sludge attractiveness to vectors (e.g., rodents, flies, mosquitoes)

Biosolids Land Application



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During



Tractor with bio-solids injector. Typical injection rates are @ 18,000 - 25,000 gallons per acre.



Good Food from the Heartland™





OXBO – Land application SAF



Composting

- Biosolids is the public relations name for sewage sludge.
- Dewatered digested sludge usually is sent to composting containing 15 – 25⁰% solid matter (i.e., 75 – 85⁰% water).
- Composted sludge can be used in yards and gardens.

Composting Basics

- There are five main areas that must be “controlled” during composting.
- **Feedstock and Nutrient Balance**
- **Particle Size**
- **Moisture Content**
- **Oxygen Flow**
- **Temperature**

Feedstock and Nutrient Balance

- Composting requires a balance of green (Nitrogen) and brown (Carbon) waste.
- Obtaining the right nutrient mix requires experimentation and patience. It is part of the art and science of composting.

Particle Size

- Grinding, chipping, and shredding materials increases the surface area on which microorganisms can feed.
- Smaller particles also produce a more homogeneous compost mixture and improve pile insulation to help maintain optimum temperatures
- If the particles are too small, however, they might prevent air from flowing freely through the pile.

Moisture Content

- Microorganisms living in a compost pile need enough moisture to survive.
- Water is the key element that helps transports substances within the compost pile and makes the nutrients in organic material accessible to the microbes.
- Organic material contains some moisture in varying amounts, but moisture also might come in the form of rainfall or intentional watering.

Oxygen Flow

- Turning the pile, placing the pile on a series of pipes, or including bulking agents such as wood chips and shredded newspaper all help aerate the pile.
- Aerating the pile allows decomposition to occur at a faster rate than anaerobic conditions. Care must be taken, however, not to provide too much oxygen, which can dry out the pile and impede the composting process.

Temperature

- Microorganisms require a certain temperature range for optimal activity.
- Certain temperatures promote rapid composting and destroy pathogens and weed seeds.
- Microbial activity can raise the temperature of the pile's core to at least 131° F.
- If the temperature does not increase, anaerobic conditions (i.e., rotting) occur. Controlling the previous four factors can bring about the proper temperature.

Aerated (Turned) Windrow Composting

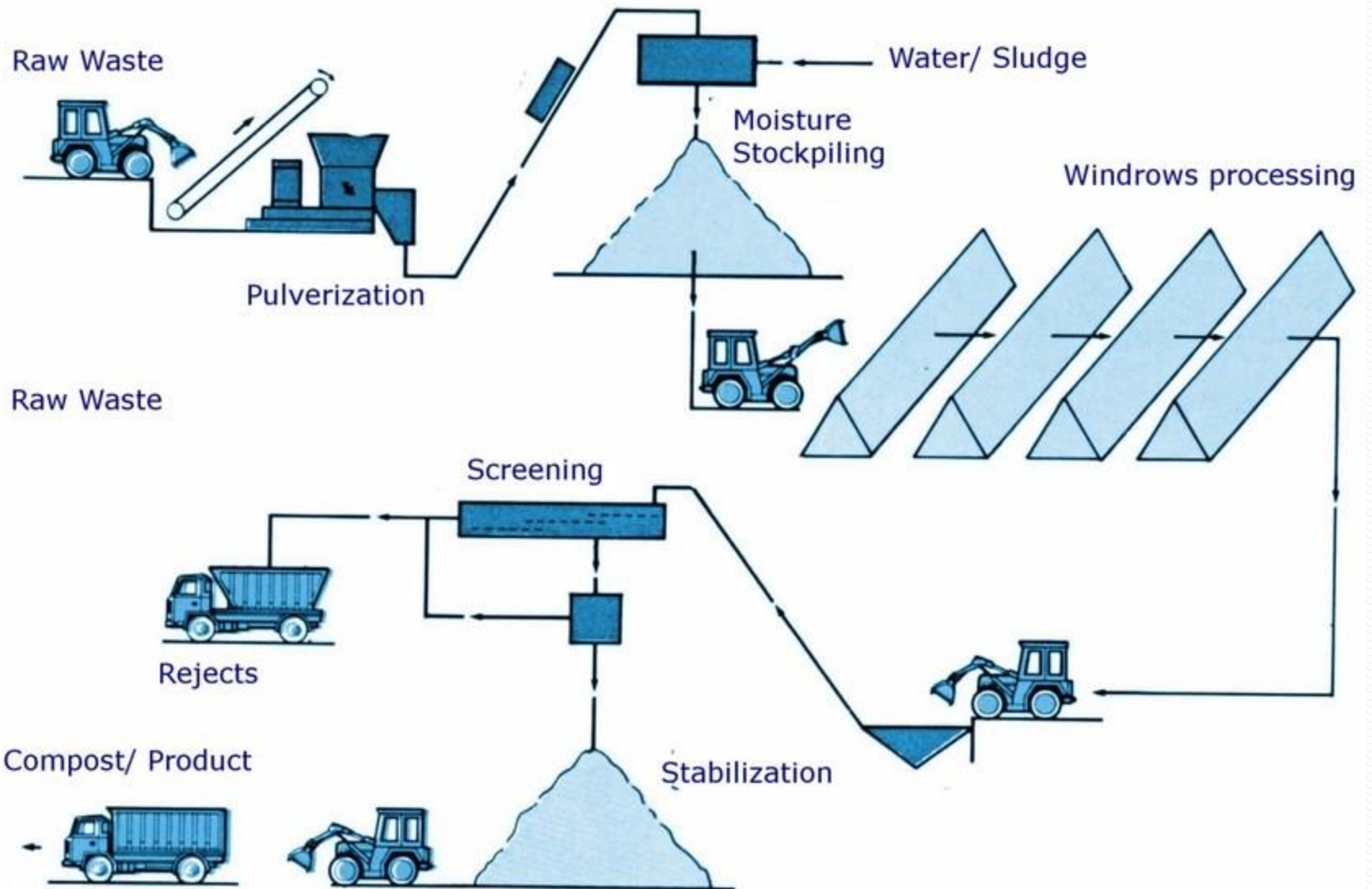
- Aerated or turned windrow composting is suited for large volumes such as that generated by entire communities and collected by local governments.
- This type of composting involves forming organic waste into rows of long piles called “windrows” and aerating them periodically by either manually or mechanically turning the piles.

More on Windrows

- The ideal pile height is between four and eight feet with a width of 14 to 16 feet. This size pile is large enough to generate enough heat and maintain temperatures. It is small enough to allow oxygen flow to the windrow's core.
- Large volumes of diverse wastes such as yard trimmings, grease, liquids, and animal byproducts (such as fish and poultry wastes) can be composted through this method.

Start to Finish

- Setting up a windrow and keeping it turned properly until it is ready for sale takes 8 – 9 weeks.









Biosolids Composting - SAF



Questions? Comments?

- Thank you for your time and input.
- Please be safe and enjoy your job.
- Information on this presentation came from the Ragsdale Wastewater System Operator's Manual, Sacramento State book and from the EPA website.
- Through experience and co-workers.