OPPORTUNITIES FOR OPTIMIZATION AND O&M REDUCTION AT WWTPS

2019 Central West Texas Regional School

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Presentation Topics

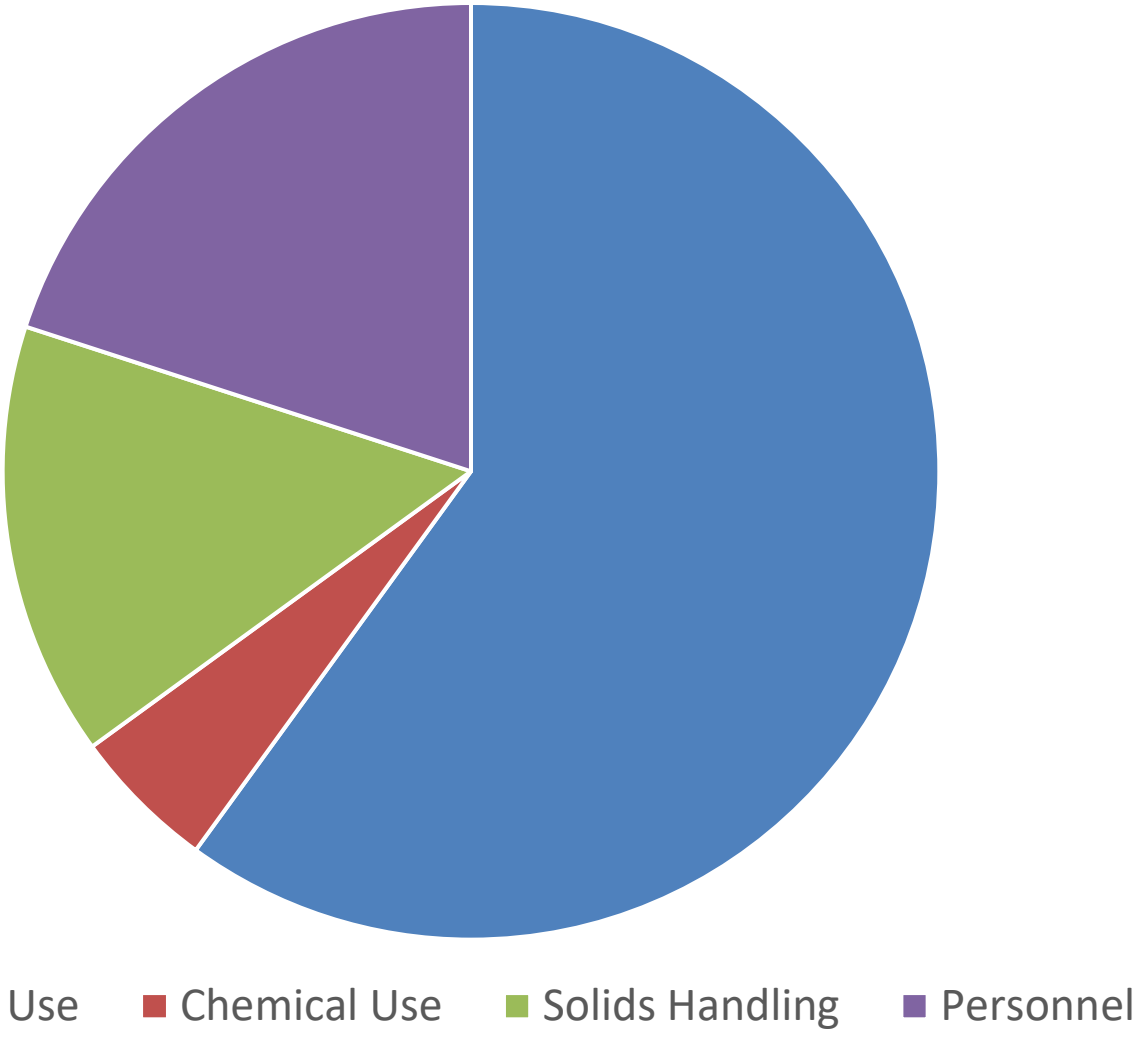
- Background
- Common Areas of WWTP O&M Cost
- Energy Use – Aeration Control
- Energy Use – Other Opportunities
- Solids Handling
- Chemical Use
- Power Cost Reduction Options
- Alternate Power Opportunities
- Enhanced Automation

Background

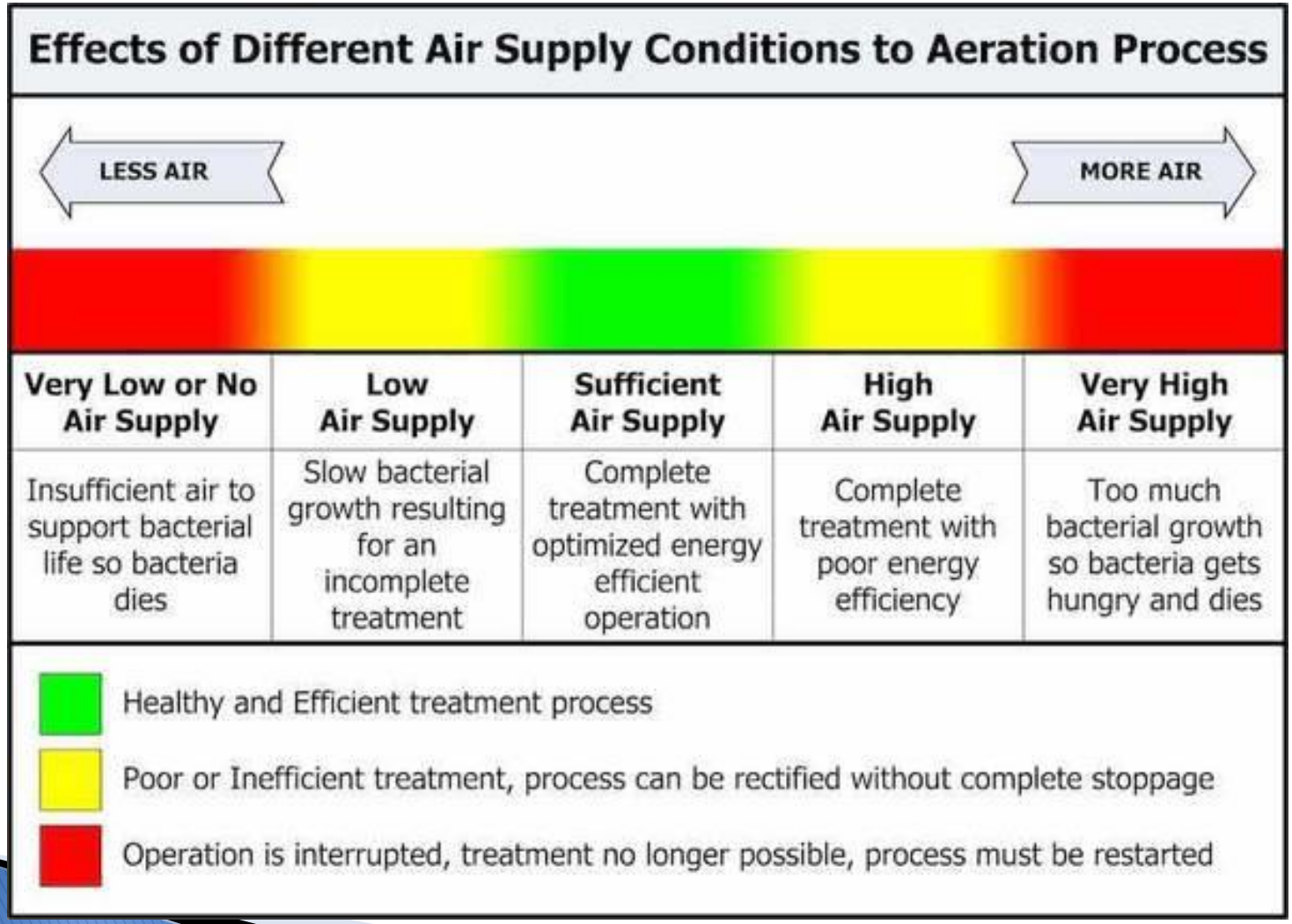
- Focus - mechanical wastewater treatment plants
  - Natural treatment plants have much lower energy and chemical cost

- Most mechanical plants have several major requirements:
  - Aeration to reduce BOD/cBOD and/or Ammonia
  - Clarification or solids separation to reduce TSS
  - Solids handling to dispose of waste solids as cost effectively as possible
  - Chemical use for disinfection and/or solids handling
  - Personnel costs to operate and maintain the facility

Common Areas of WWTP O&M Cost

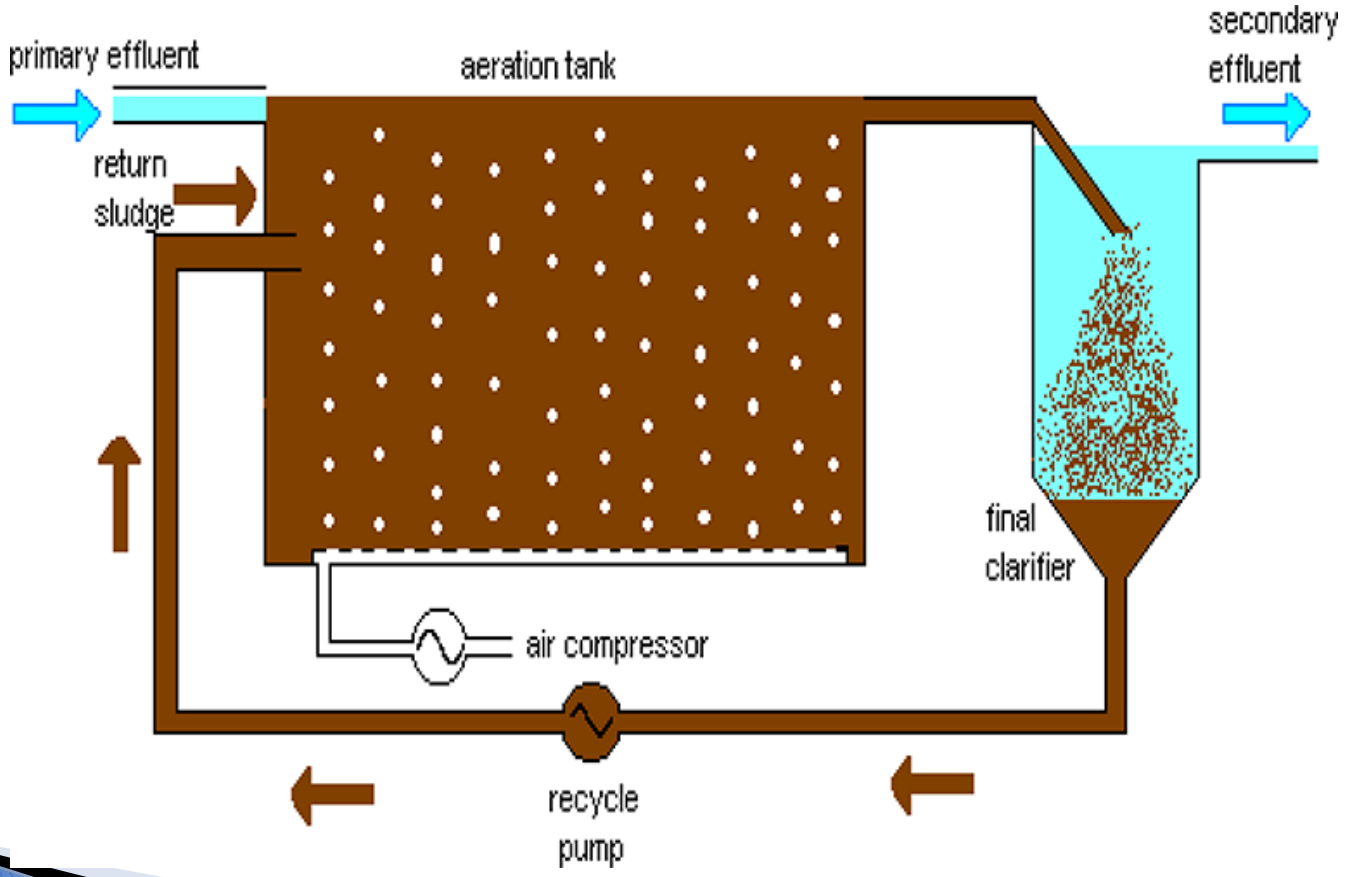


Energy Use – Aeration Control



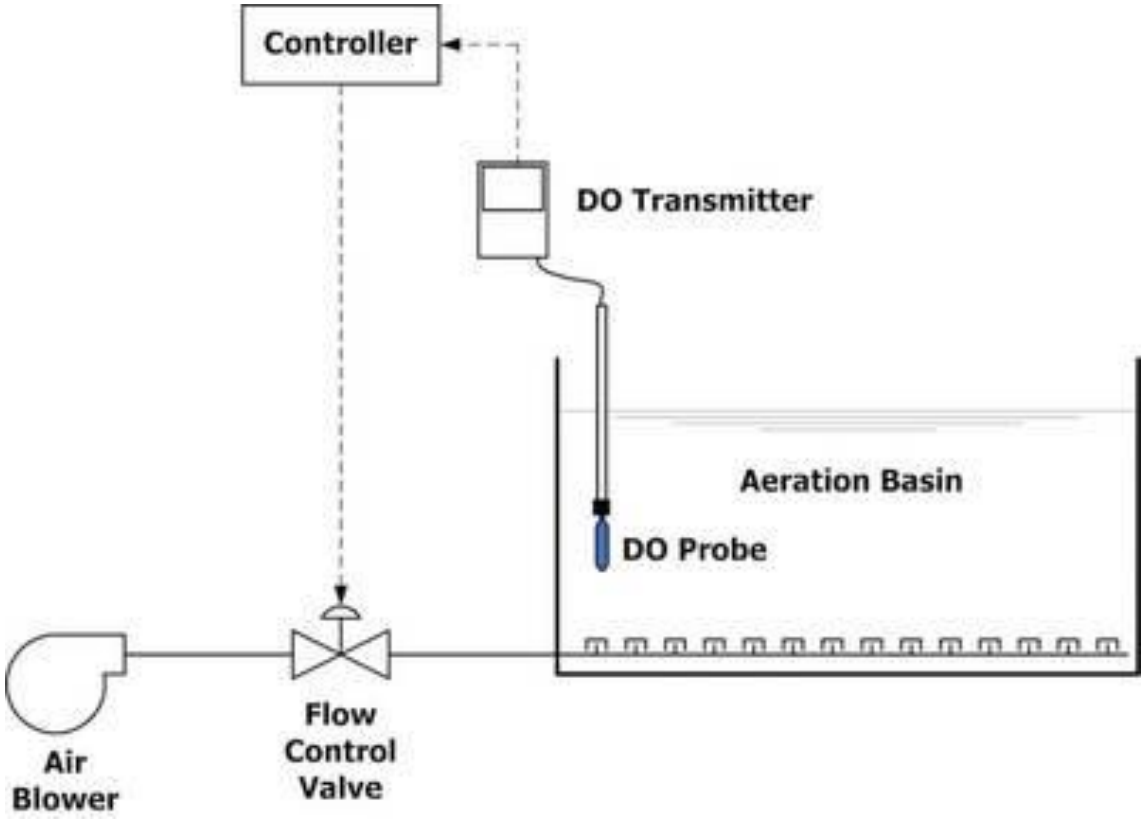
Energy Use – Aeration Control

- Typical “Manual” Aeration Control



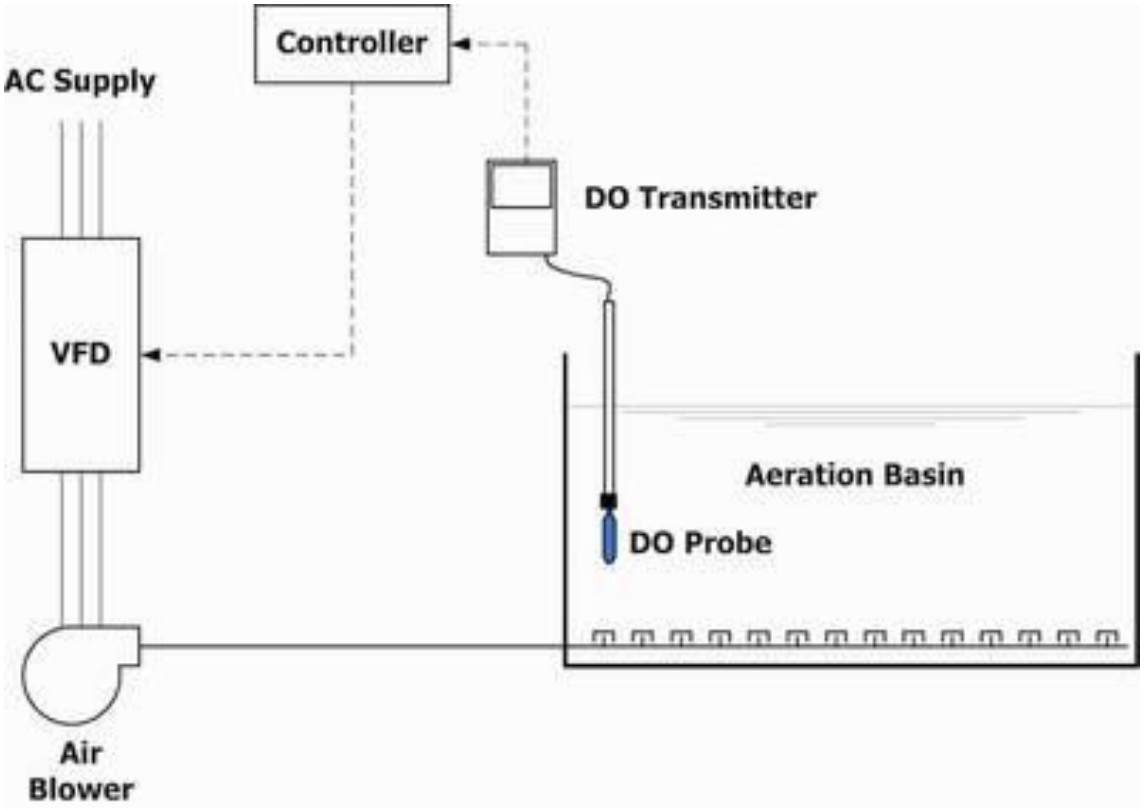
Energy Use – Aeration Control

- Typical “Modulating Valve” Aeration Control



Energy Use – Aeration Control

- Typical “VFD Modulating” Aeration Control

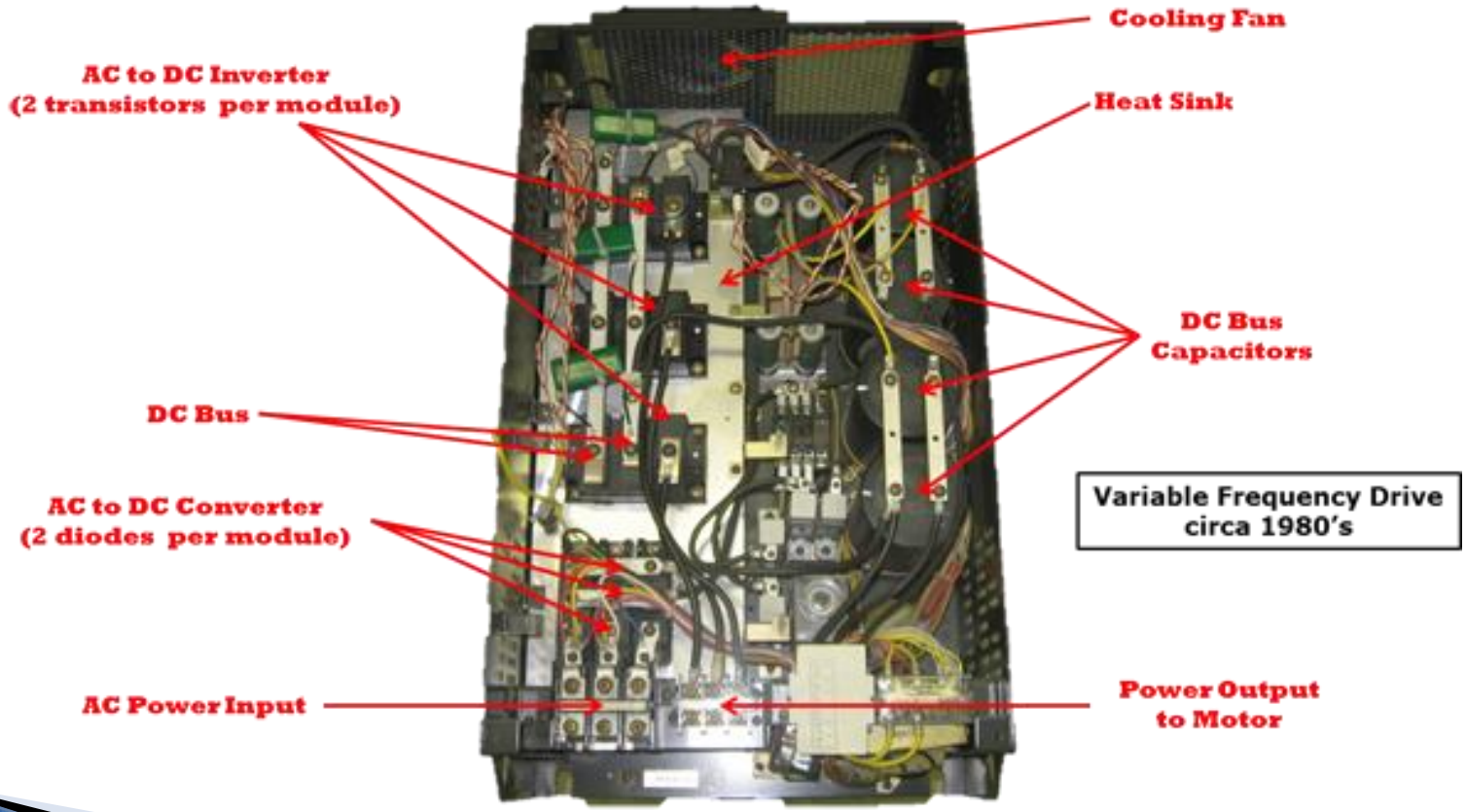


Energy Use – Aeration Control

- VFD – Variable Frequency Drive
  - A VFD is a type of motor controller that drives an electric motor by varying the frequency and voltage supplied to the electric motor
  - Also referred to as an inverter, an adjustable frequency drive, a Microdrive, or a variable speed drive

Energy Use – Aeration Control

- VFD – Variable Frequency Drive

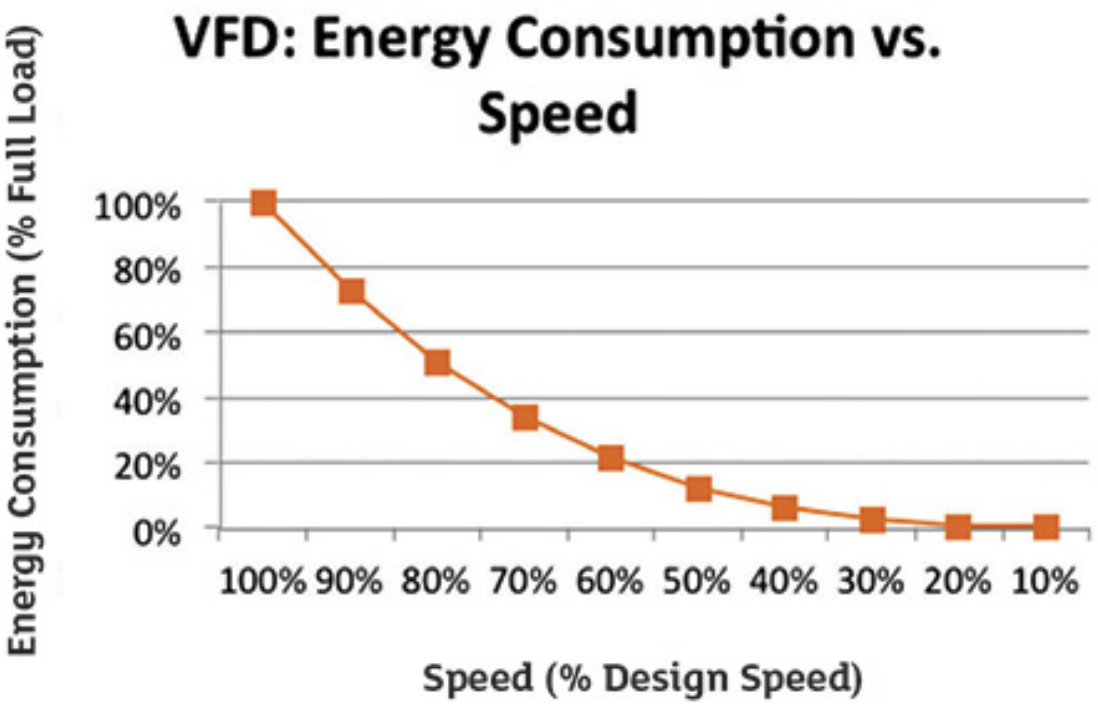


Energy Use – Aeration Control

- VFD – Variable Frequency Drive

Energy Use – Aeration Control

- VFD Energy Savings Example



Flow is proportional to speed directly.

Power is proportional to the cube of speed.

$$\frac{P1}{P2} = \left(\frac{N1}{N2}\right)^3$$

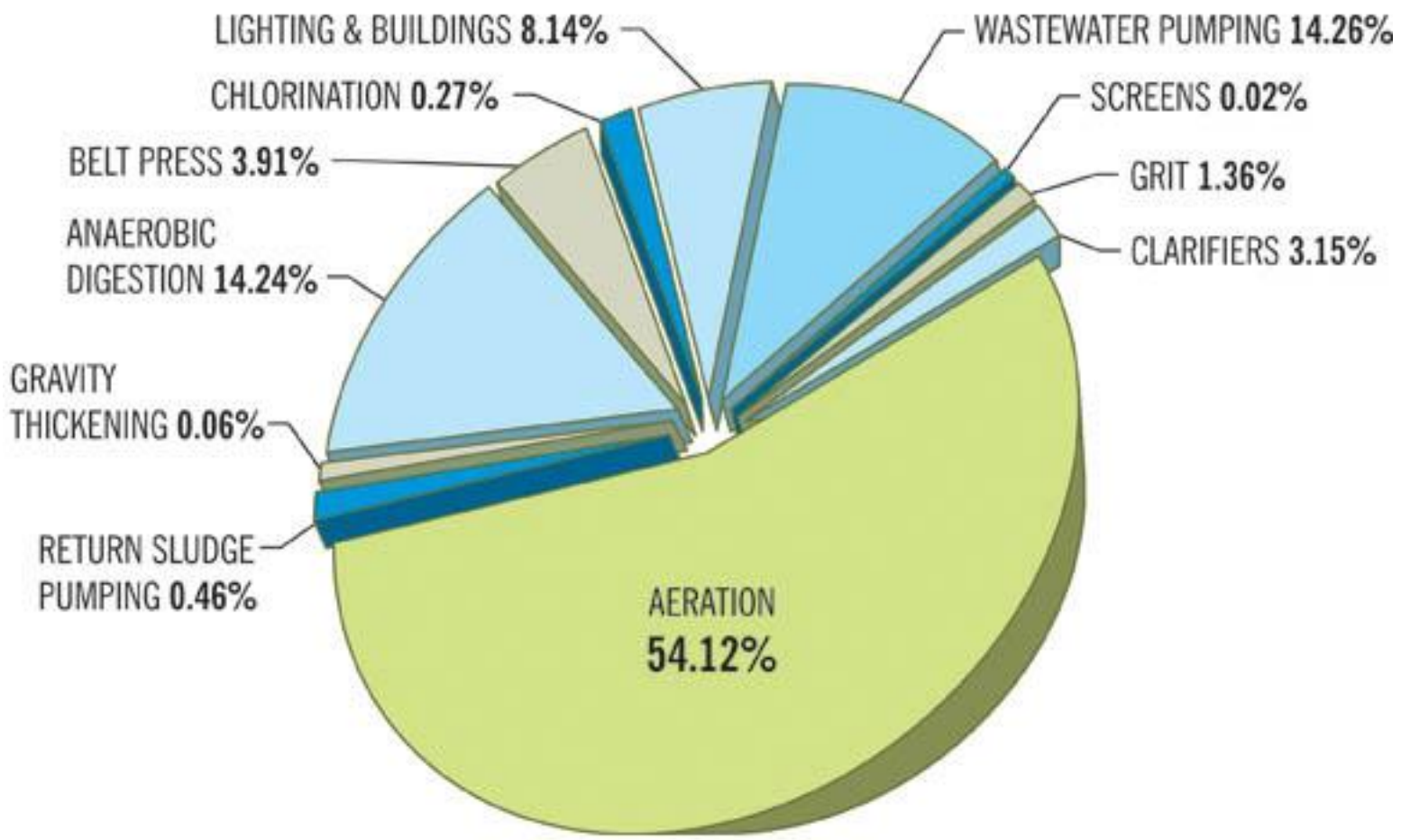
Example: 80% flow

$(0.8)^3 = 0.512$ *or* 51% *HP*

Energy Use – Aeration Control

- VFD Energy Savings Example
  - 50 hp blower
  - VFD allows 80% speed / air flow ~~ 51% of hp
  - Annual power use at full load
    - 50 hp x 0.75 kW/hp x 24 hrs/day x 365 days/yr x $0.1 / kWh
    - = $33,000 per yr
  - Annual power use at 80% speed/flow
    - 51% x 50 hp x 0.75 kW/hp x 24 hrs/day x 365 days/yr x $0.1 / kWh
    - = $17,000 per yr
- Cost for 50 hp VFD ~~ $20,000 (including installation)
- Break even within 2 years
- Net savings over 10 years ~~ $150,000

Energy Use – Other Opportunities

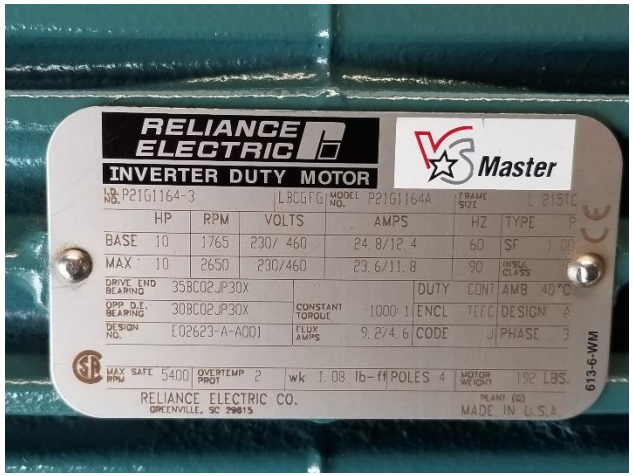


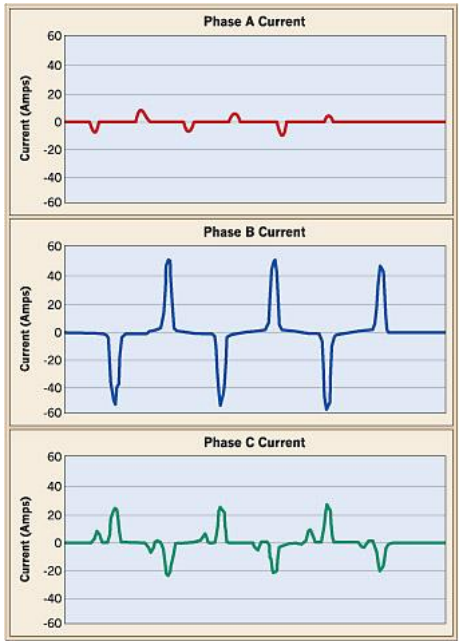
Energy Use – Other Opportunities

- Add VFDs to pumps and/or blowers
- Replace across the line starters with “soft starters”
- Replace older motors with NEMA “premium efficiency” motors

Energy Use – Other Opportunities

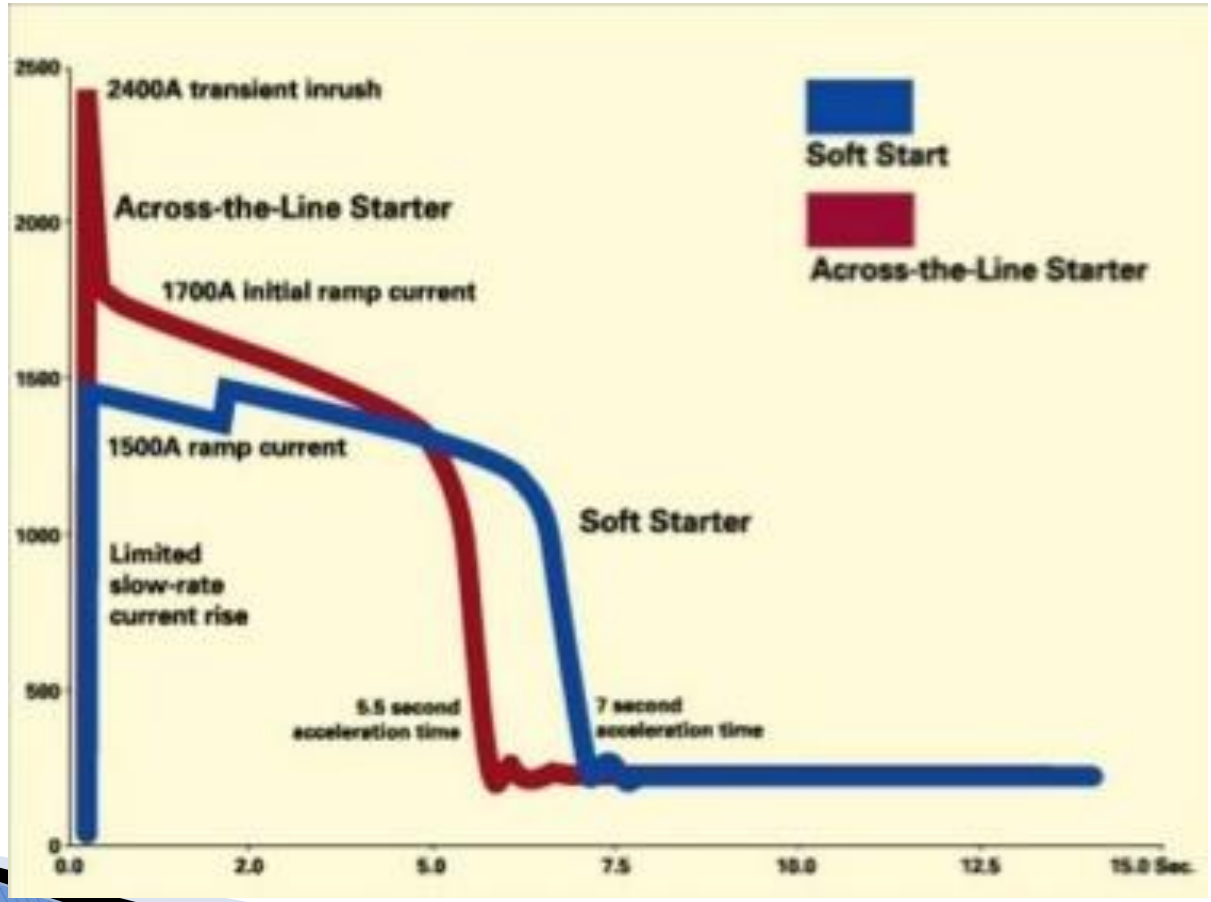
- Add VFDs to pumps and/or blowers
  - Items to consider:
    - Do the existing motors have inverter duty rated bearings?
    - Is there adequate climate control area for VFDs?
    - Are there any issues with “dirty power”?





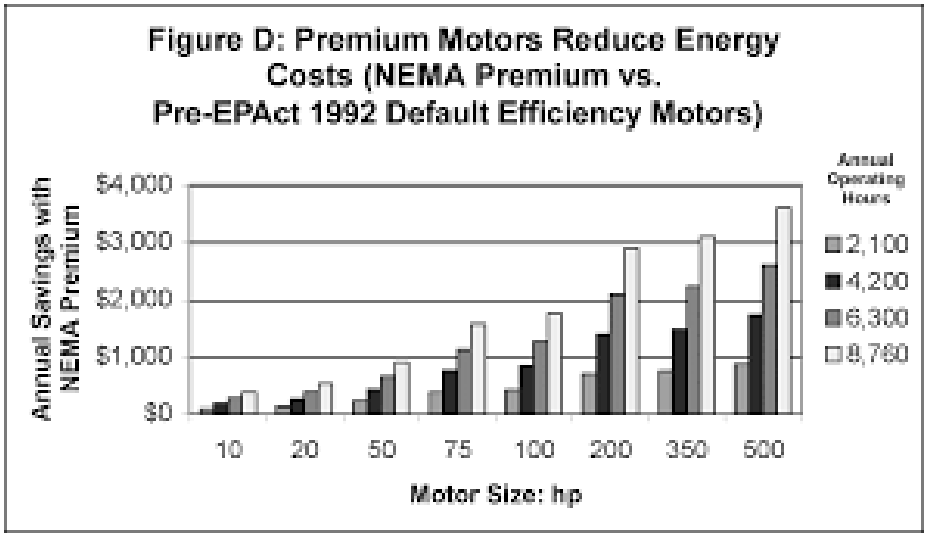
Energy Use – Other Opportunities

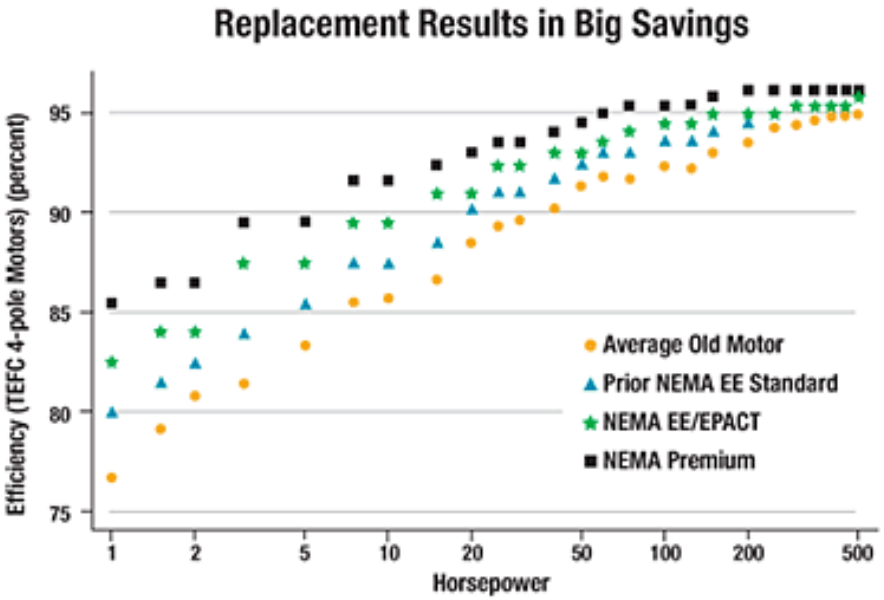
- Replace “across the line starters” with “soft starters”



Energy Use – Other Opportunities

- Replace older motors with NEMA “premium efficiency” motors





Solids Handling

- Simplest, lowest capital cost are drying beds

- Other Options?
  - Dewatering Containers
  - Mechanical Screw Press
  - Mechanical Volute Press
  - Mechanical Centrifuge
  - Mechanical Belt Press

Solids Handling

- Dewatering Containers

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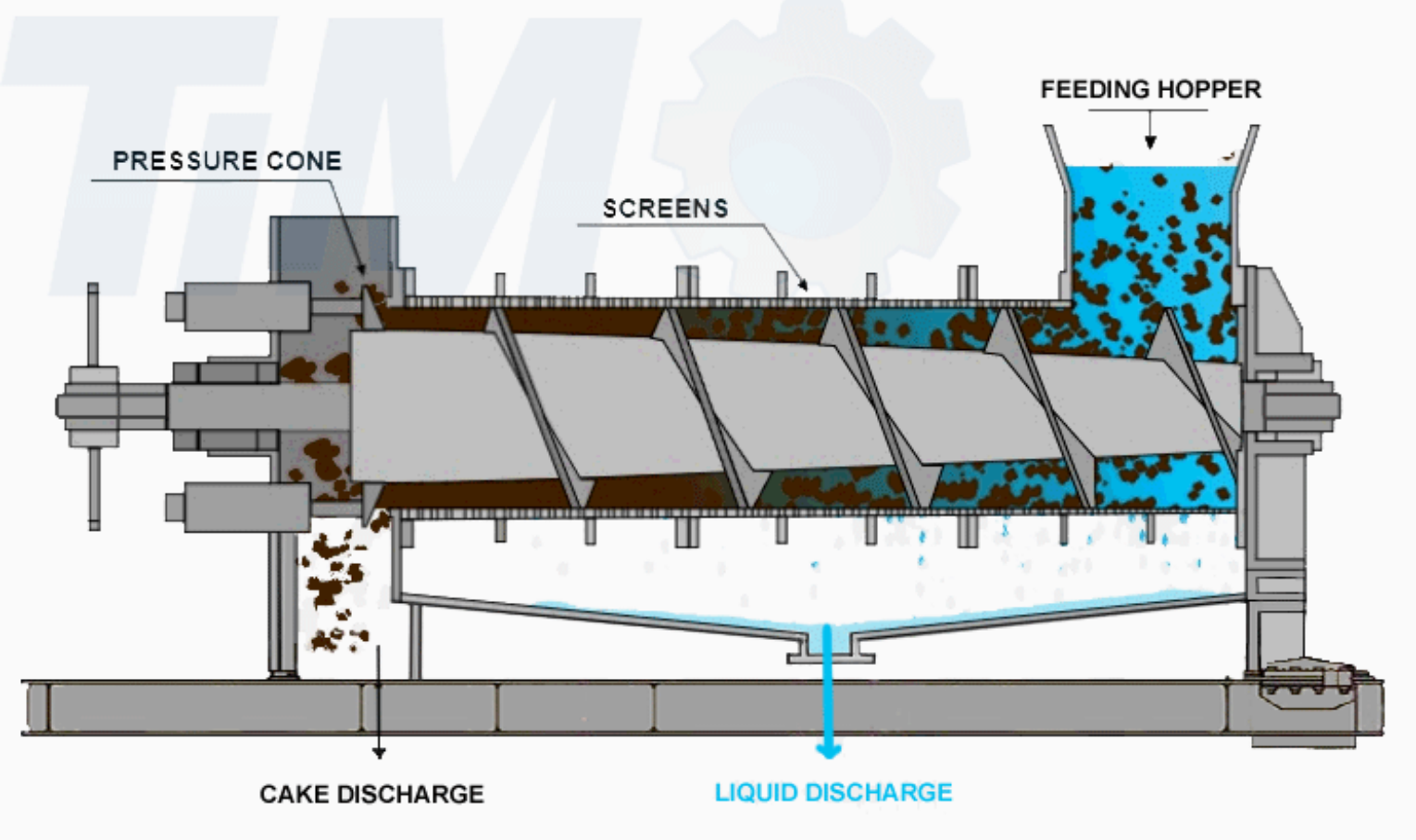
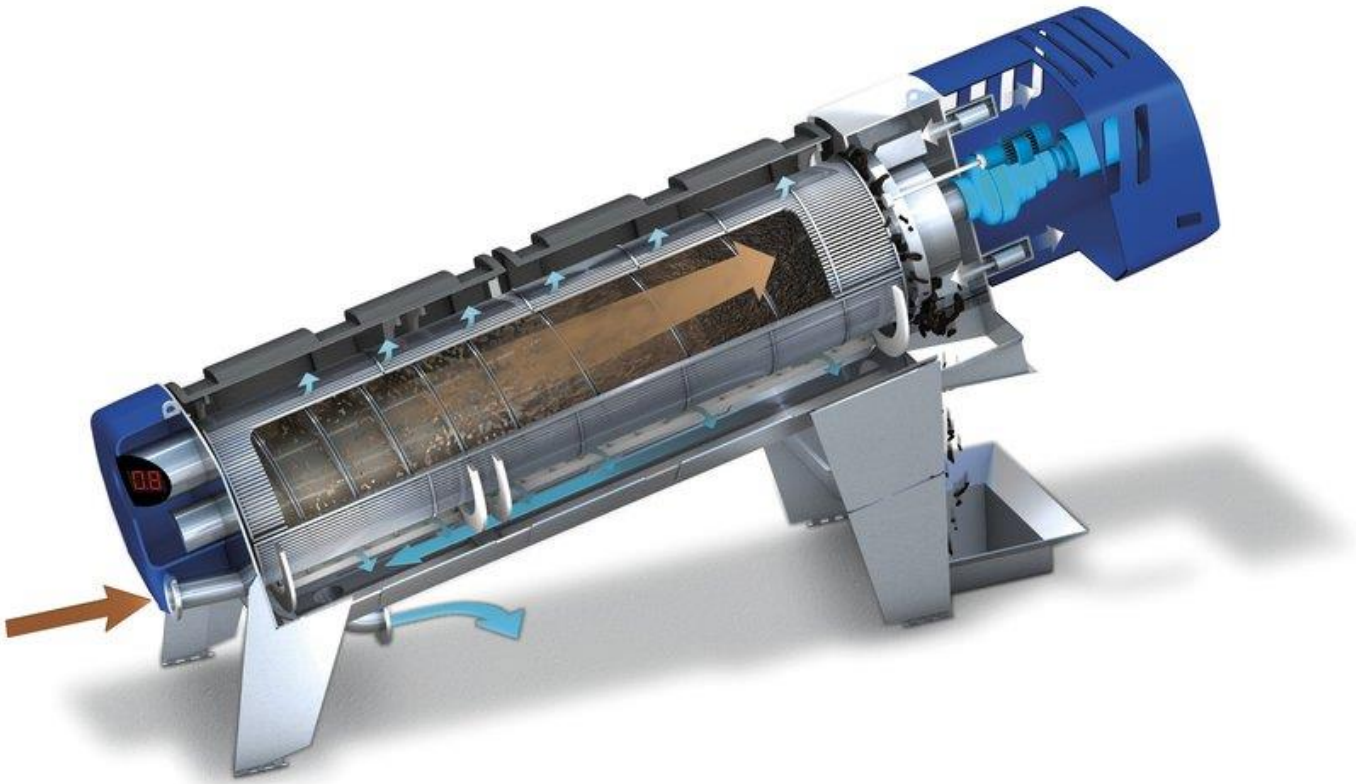
Solids Handling

- Mechanical Screw Press



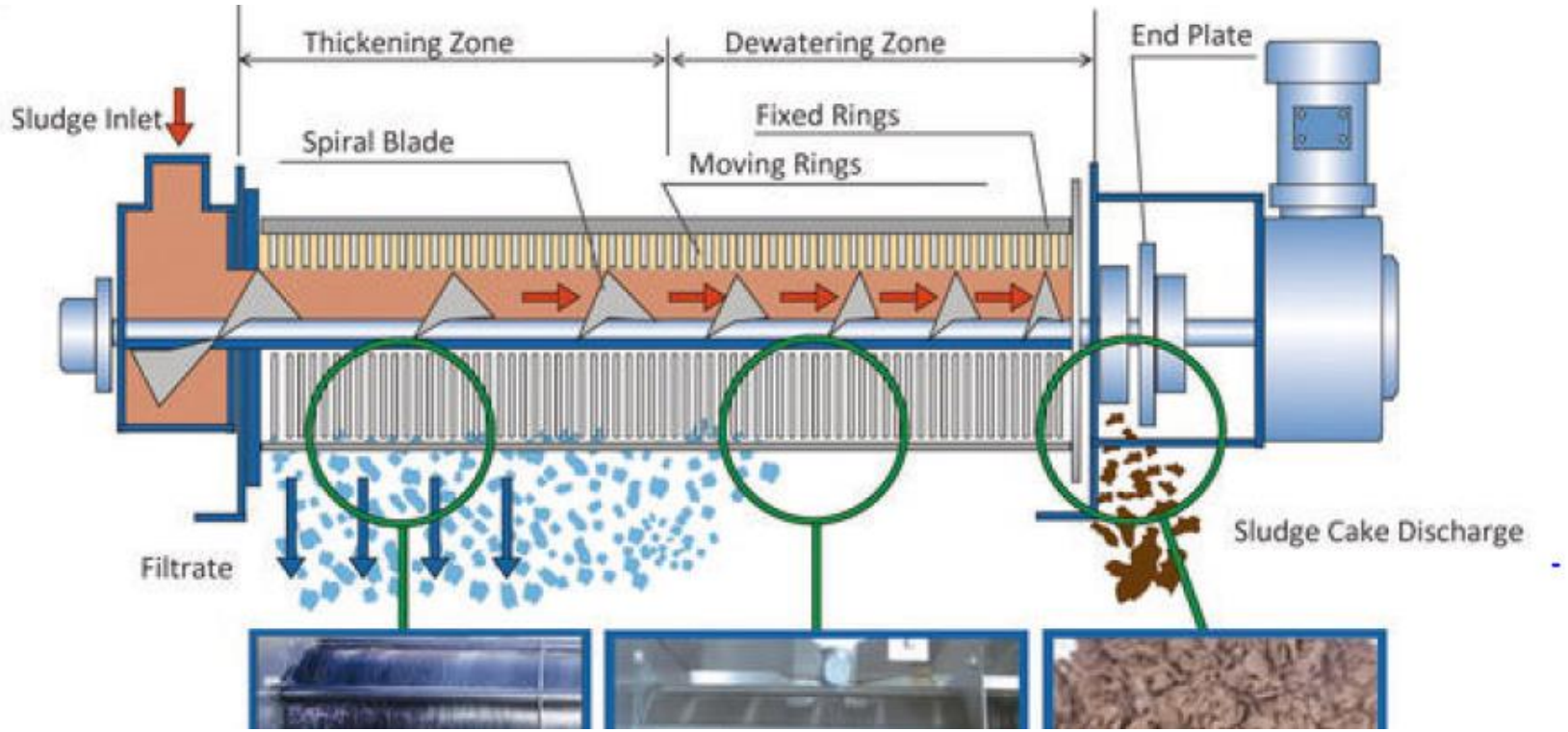
Solids Handling

- Mechanical Screw Press



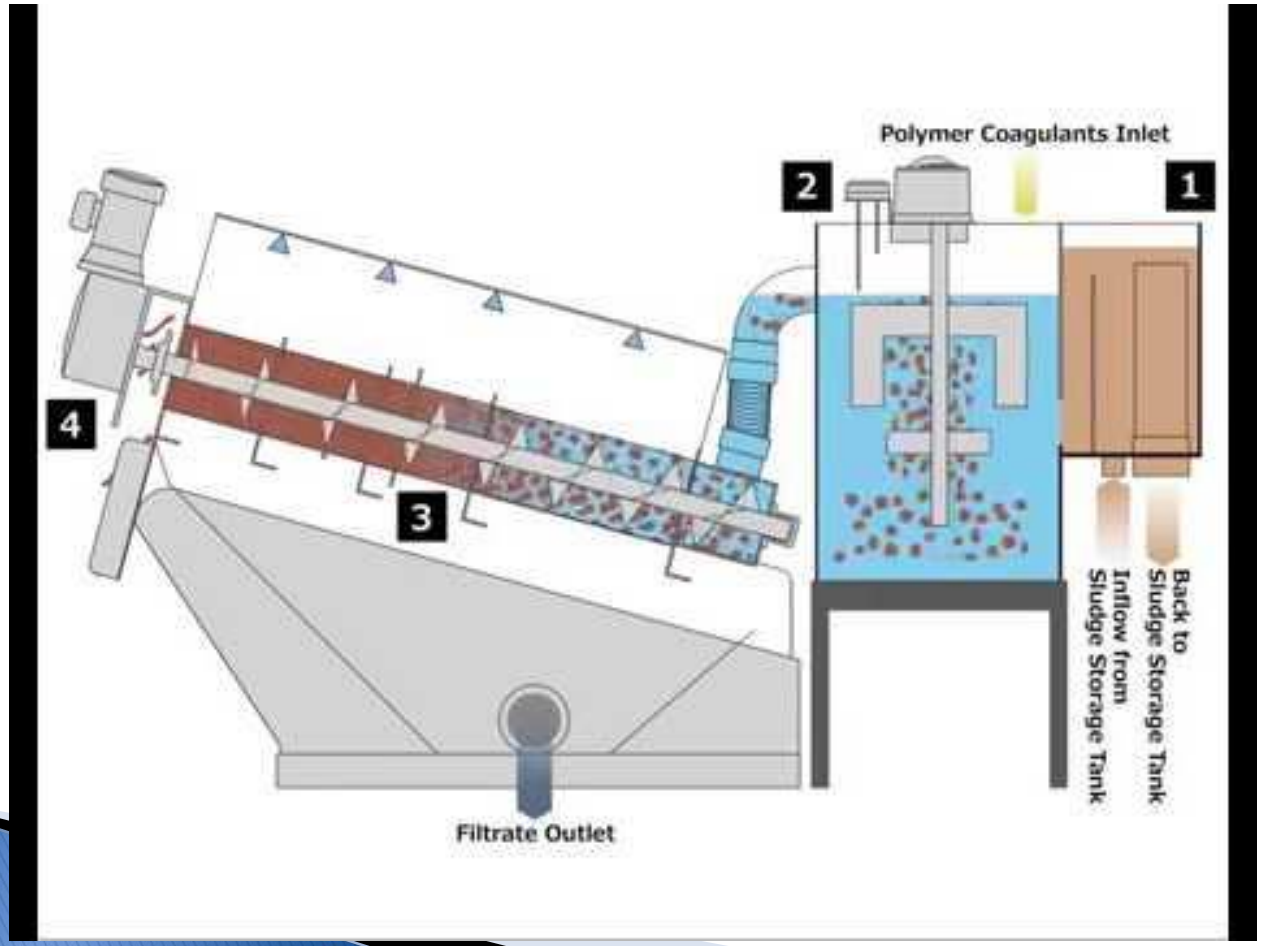
Solids Handling

- Mechanical Volute Press



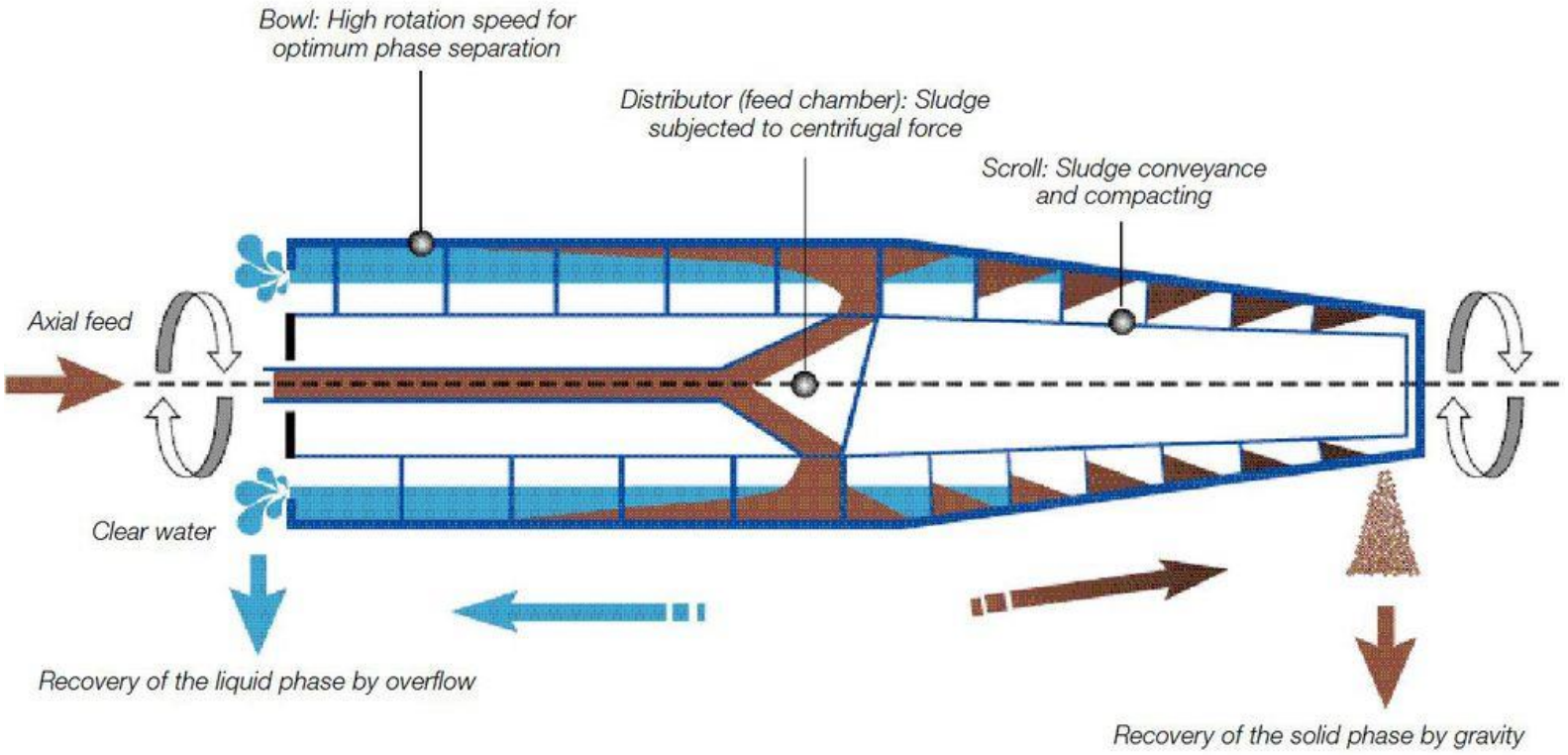
Solids Handling

- Mechanical Volute Press



Solids Handling

- Mechanical Centrifuge

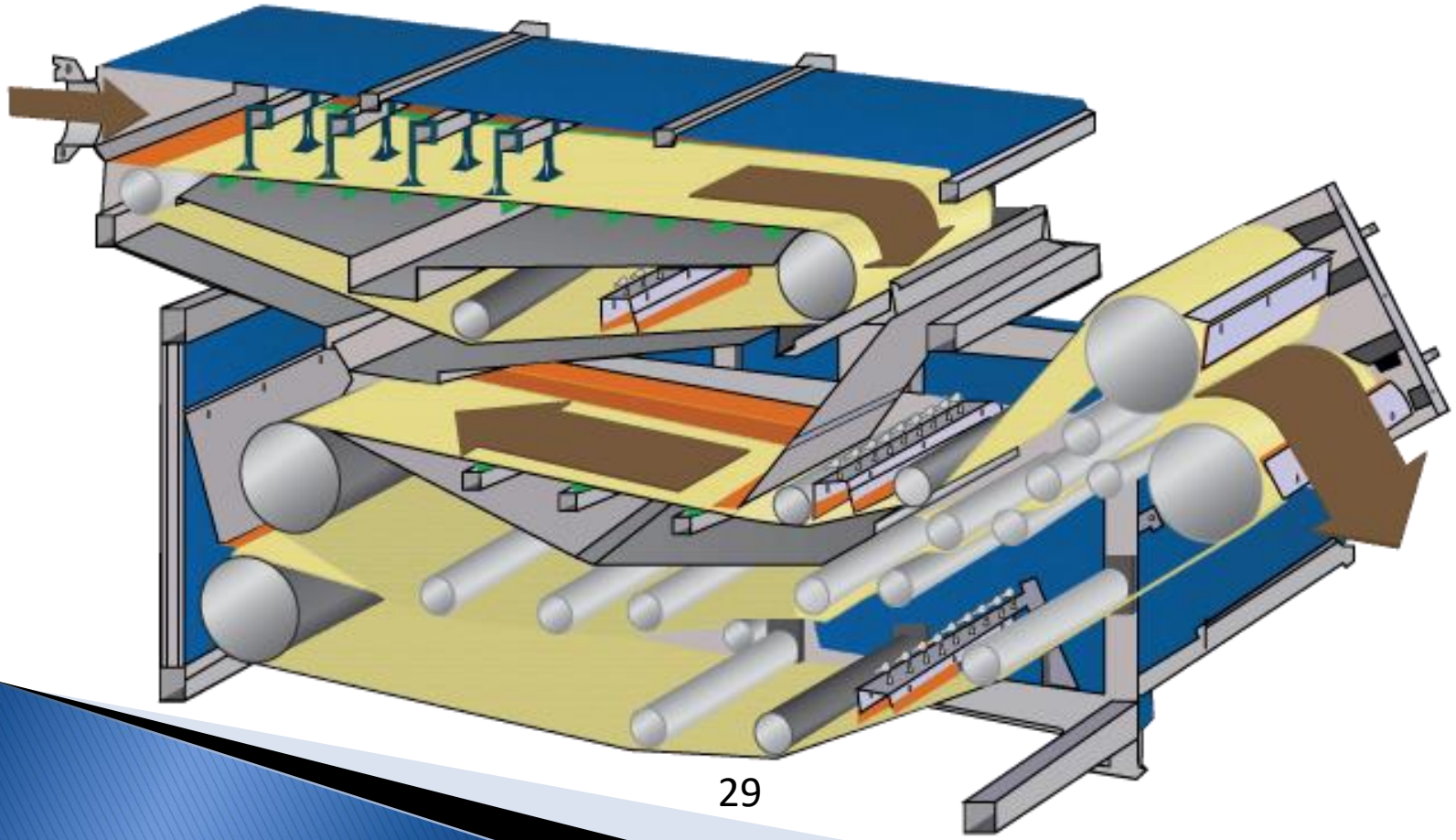


Solids Handling

- Mechanical Centrifuge

Solids Handling

- Mechanical Belt Press



Solids Handling

- Mechanical Belt Press

Chemical Use

- Disinfection
  - Chemical or UV?
  - Chlorine gas or Hypochlorite?
  - Sulfur dioxide or sodium bisulfite or sodium thiosulfate?

- Solids Dewatering
  - Polymer use for mechanical dewatering
  - What is your target dewatered percent solids?

Chemical Use

- Disinfection
  - Chlorine vs UV
    - 1 MGD Facility
    - Chlorine dose - 6 mg/L
    - Daily chlorine demand – 1 MGD x 6 mg/L x 8.34 CF = 50 ppd
    - Annual chlorine demand – 50 ppd x 365 days/yr = 18,250 lb / yr
    - ~~ 122 150-lb cylinders @ $100 / cylinder = $12,200

    - UV dose – 30 mJ/cm2
    - 9 kVA @ 70% Efficiency = 13 kW
    - 2 banks x 13 kW x 24 hrs/day x 365 days/yr x $0.1 / kWh = $22,800

Chemical Use

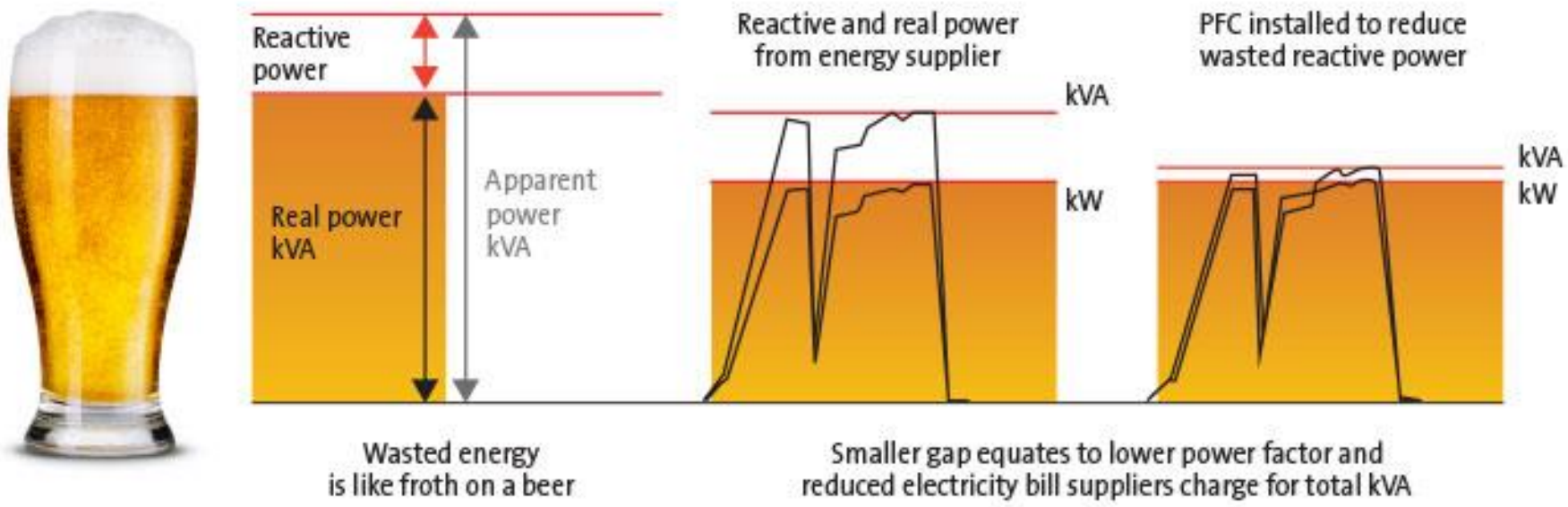
- Disinfection
  - Chlorine Gas vs Hypochlorite (Bleach)
    - 1 MGD Facility
    - Chlorine dose - 6 mg/L
    - Daily chlorine gas demand – 1 MGD x 6 mg/L x 8.34 CF = 50 ppd
    - Annual chlorine demand – 50 ppd x 365 days/yr = 18,250 lb / yr
    - ~~ 122 150-lb cylinders @ $100 / cylinder = $12,200

    - Hypochlorite dose – 6 mg/L
    - Assume 10% strength, S.G. of 1.2
    - 50 ppd / 10% / 1.2 / 8.34 = 50 gpd
    - 50 gpd x 365 days/yr x $1.00 / gal = $18,250

Power Cost Reduction Options

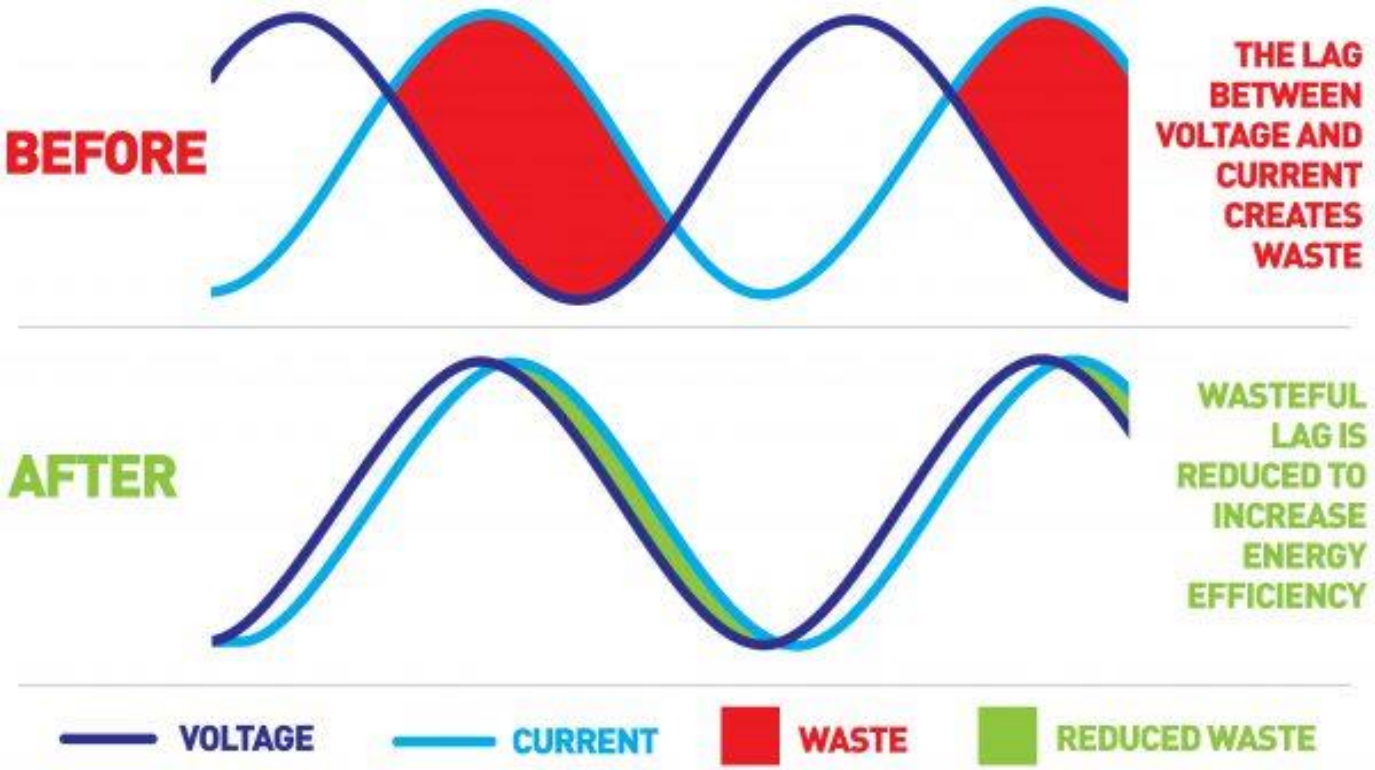
- Many older plants utilize across the line starters for pump and blower motors

- As an alternative to using VFDs for soft starters, use Power Factor Correction?



Power Cost Reduction Options

- Power Factor Correction



Power Cost Reduction Options

- Power Factor Correction Example
  - Example cost per kVA - $13 / kVA
  - 50 hp blower -> 37.5 kW @ 70% PF = 53.6 kVA
    - = $700 per month, $8,400 per year
  - 50 hp blower with PFC
    - -> 37.5 kW @ 95% PF = 39.5 kVA
    - = $520 per month, $6,200 per year
  - Cost savings of $2,200 per year
  - PFC equipment cost of $3,000
  - Break even in 16-18 months
  - Savings over 10 years ~~ $19,000

Alternate Power Opportunities

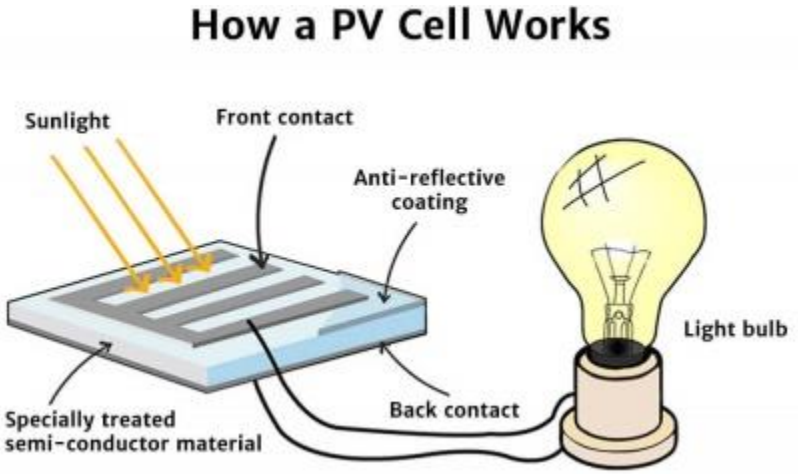
- Onsite energy generation?
- Storage and delay treatment?

Alternate Power Opportunities

- Onsite energy generation?
  - Photovoltaic generation (solar)
  - Wind generation
  - Opportunities for state/federal grant funding?

Alternate Power Opportunities

- Photovoltaic generation (solar)
  - Can reduce daily power consumption during daylight hours
  - If oversized, can reduce annual power costs to “net zero”

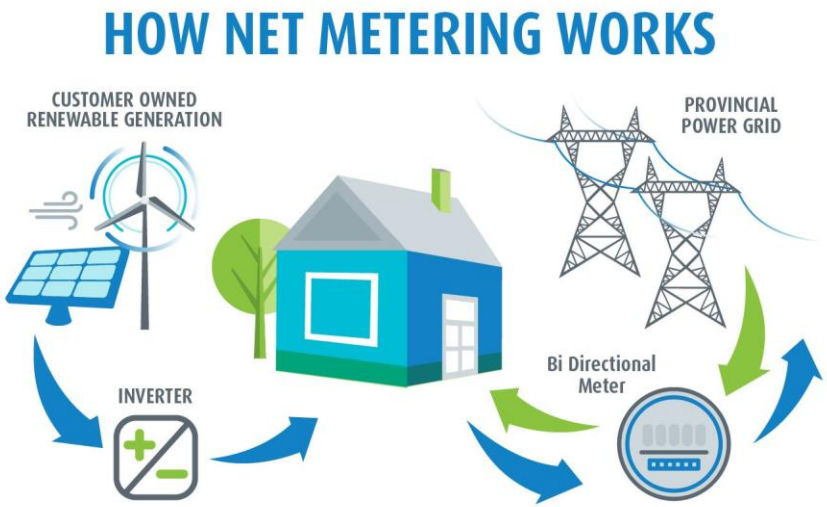


Alternate Power Opportunities

- Photovoltaic generation (solar)
  - Example project – Lometa WWTP, Lometa, TX
  - 100 kW system ~~$500,000 grant from USDA
  - 100 kW x 24 hr/day x 365 days/yr x $0.1 per kWh = $88,000 per year
    - 5-6 year break-even point on power savings

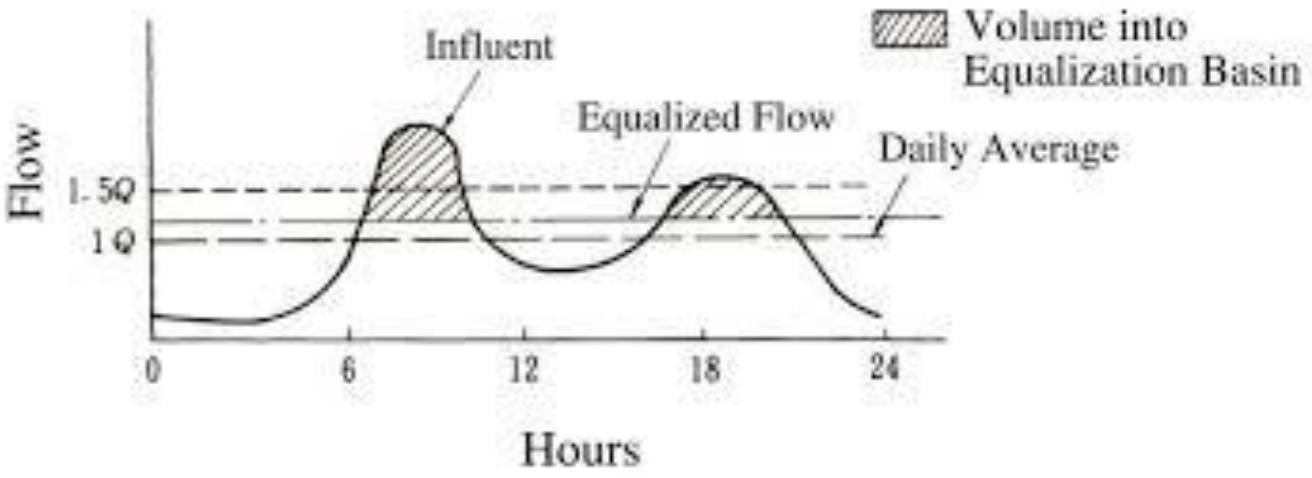
Alternate Power Opportunities

- Wind generation
  - Can reduce daily power consumption when the wind is blowing
  - If oversized, can reduce annual power costs to “net zero”



Alternate Power Opportunities

- Storage and delayed treatment?
  - Peak power demand occurs from 10 am – 2 pm
  - Configure WWTP to store wastewater in flow equalization basins and treat at night and early morning when power costs are lowest

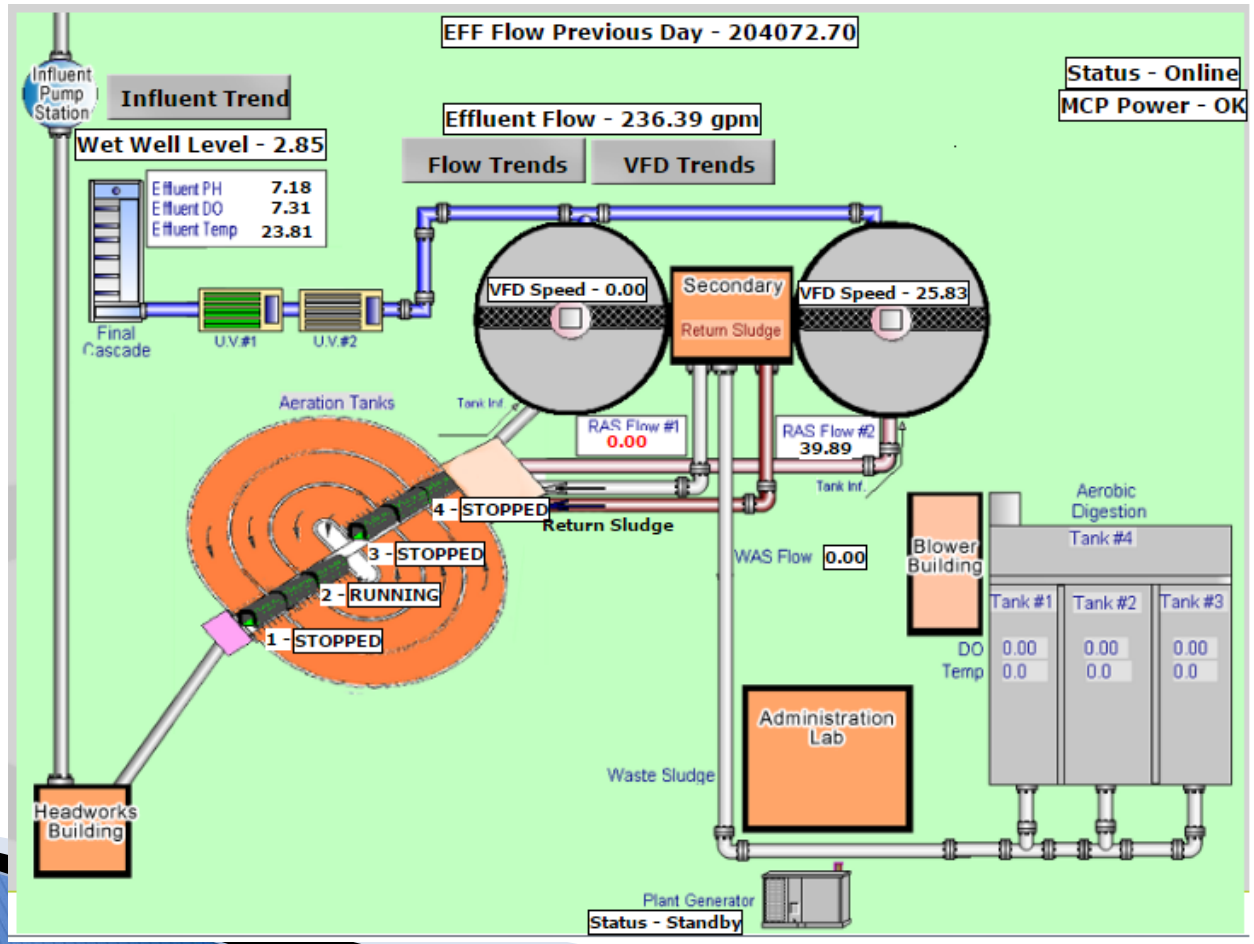


Enhanced Automation

- SCADA – Supervisory Control and Data Acquisition System
  - Can allow for complete automation of a plant, or limited to certain plant functions
  - Automated data collection
  - Automated adjustments of pump and blower starts/stops
  - Caution – SCADA works just as well as “cruise control”!

Enhanced Automation

- SCADA System



Questions?

Thank you for your time!

For additional information, please contact Joshua Berryhill at
joshua.berryhill@e-ht.com

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