Op Cert: Mechanical Systems

Thursday, June 22, 2023

SOUTHWEST ENVIRONMENTAL FINANCE CENTER

This program is made possible under a cooperative agreement with US EPA.

Email: ajbarney1@unm.edu

Weekly Wastewater Technical Assistance Office Hours

- Troubleshooting, operator certification, training, financials, FOG and other Pretreatment topics, etc.
- Tuesdays 11am-12pm (MST)
- Zoom
- Contact: A.J. Barney ajbarney1@unm.edu
  James Markham jmarkham@unm.edu

Or leave your email in the chat and we will send you a link

Operator Certification

Certification programs are regulated by the states
- Texas- TCEQ, New Mexico- NMED, Oklahoma- ODEQ

Certification levels (1-4, D-A, etc.)
- Complexity of the system
- Population
- Experience

Available resources
- California State University, Sacramento- Wastewater operation manuals
- State distributed resources and need to know lists

Certification exam- Study!!

Mechanical Systems

Pumps
Motors
Valves
Blowers
Chemical Feeders

Wastewater Pumps

Used in the movement of wastewater

Maintain the flow, pressure, and efficiency of the entire WWTP

Pump type depends on the characteristics of the wastewater and treatment needs

Pumping conditions also must be accounted for

Pump Types

Centrifugal Pump
- Submersible Pumps
- Axial-Flow
- Mixed-Flow

Positive Displacement Pumps
- Piston Pump
- Rotary Lobe
- Progressive Cavity Pump
- Peristaltic

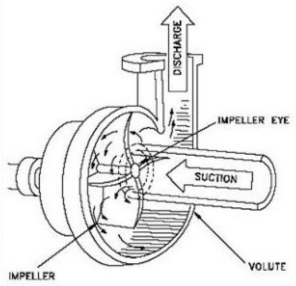
Centrifugal Pumps

Utilize centrifugal force created by an impeller

Kinetic energy is transferred to the fluid and pressure builds

The pressure pushes the wastewater towards the discharge point

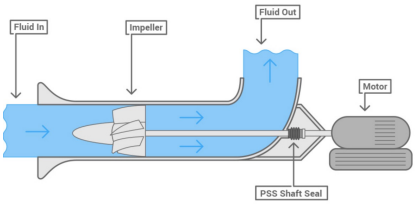
Centrifugal pumps require priming



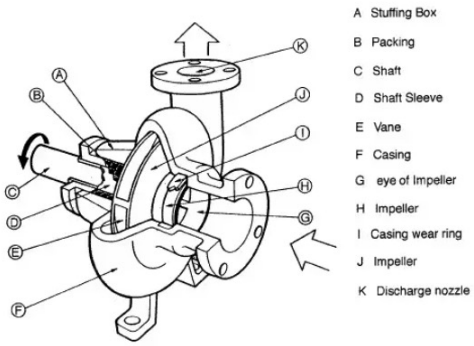
Propeller Pumps

Axial-Flow: Flow is parallel to the axis of the impeller

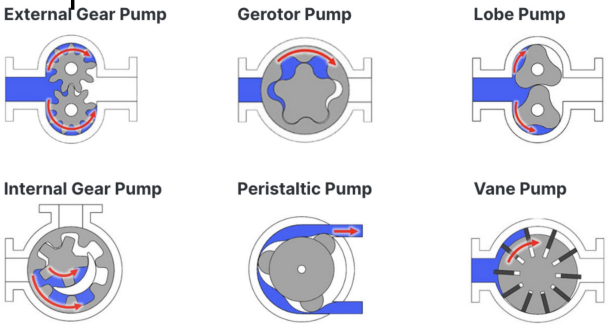
Mixed-Flow: Flow enters axially and leaves radially



Centrifugal Pump Components



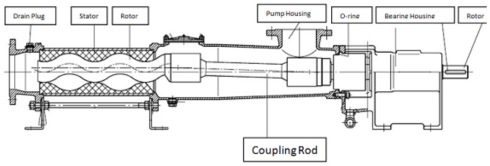
Positive Displacement Pumps



Positive Displacement Pumps

Utilizes distinct mechanism for moving flows

Components: Casing, inlet and discharge port, pumping mechanism and chamber, valves (suction and discharge), drive mechanism, seals and gaskets, bearings, priming mechanism.



Positive Displacement Pumps

Trap a specific volume of fluid and displaces it from the inlet to the outlet. Fluid form the source replaces the fluid displaced at the inlet.

Inlet phase is where the cavity is empty and the inlet valve opens allowing flow from the inlet to the cavity.

Pump mechanism compresses fluid and creates pressure that opens up outlet and the fluid flows out to the discharge.

Cycle is repeated continuously.

Positive Displacement Pump Mechanisms

Reciprocating or Piston: Moves water or sludge by a piston that moves back and forth

Inline Screw: A screw operating at a constant speed rotates, which moves wastewater up the housing/trough

Progressive Cavity: A rotor fits snugly a stator housing where the rotor makes contact with the housing walls. This moves the fluid through the cavities of the housing.

Peristaltic: A piece of flexible tube is arranged around a roller assembly that squeezes the fluid out as the motor moves.

Rotary Lobe: Two or more rounded lobes that creates chambers that trap and transport fluid form the inlet to the outlet of the pump.

Pump Maintenance

Alignment should be checked frequently.

Lubricate bearings, seals, gears, and piston or cylinder assembly.

Monitor vibration and noise.

Test and maintain seals.

Check that electrical connections are connected correctly and not exposed.

Monitor motor performance and gauges.

Pump Requirements

Check-Valve: Prevent backflow and damaging surges or water hammers.

Priming: The removal of air or gas from a pump and its suction line. Air can be vented through specially designed valves.

Pump Issues

Cavitation: Excessive air bubbles that damage the pump.

Vibration: Indicates the pump motor and axis is misaligned resulting in damage to the pipes.

Clogging: Solid debris and rags can lead to reduced flow and potential damage to pump parts.

Reduced Pump Flow: Indicated possible impeller damage or other issues.

Corrosion: Wastewater contains substances that can corrode and wear away equipment.

Motors

In WWTP convert electrical energy to mechanical energy.

Most common type is the (AC) induction motor.

Consist of a stator, ball bearings at the end of each shaft, a rotor assembly, an enclosure, and cooling system.

Most large motors are 3 phases.

Each mechanical system has their own power requirements.

Motors- Electricity Basics

Voltage: Force or pressure that drives electric current through a circuit.

Current: The rate at which charge (usually electrons) moves through a circuit.

Resistance: How easily or difficultly the current can flow through a circuit.

Ohm's Law: I = V/R

Power Supply Configurations

Single-Phase AC: Consists of a single sinusoidal waveform. Used in residential and small-scale commercial applications where the power demand is relatively low. Voltage is typically 120V or 230V.

Three-Phase AC: Used in industrial, commercial, and high-power applications. Consists of three sinusoidal waveforms that are 120 degrees out of phase with each other. Voltage is typically 208V, 380V, 415V, or 480V.

Motors

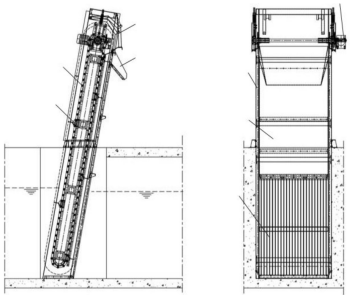
Pumps
Automatic Valves
Mixers
Rakes (Bar Screens) and Scrapers
Blowers and Aerators
Sludge Thickeners and Dewatering Equipment
Rotating Biological Contactors
Sludge Digestion Equipment

Pump Motors

Automatic Valves

Mixer/ Agitator Motor

Blowers



Aeration

Motor Math

.746 kW = 1 HP

$$\text{water horsepower (whp)} = \frac{flow\ (gpm) \times head(ft)}{3960}$$

$$\text{brake horsepower (bhp)} = \frac{flow\ (gpm) \times head(ft)}{3960 \times pump\ efficiency(\%)}$$

$$\text{motor horsepower (mhp)} = \frac{flow\ (gpm) \times head(ft)}{3960 \times pump\ efficiency(\%) \times motor\ efficiency\ (\%)}$$

Valves

Flow Regulation
Process Control
Isolation and Diversion
Safety and Emergency Shutdown
Pressure Regulation
Sampling and Monitoring

Valve Maintenance

Develop a regular inspection and exercise schedule.

Proper lubrication should be implemented.

Valve exercising should be implemented to ensure proper operation.

Blowers

Blowers operate under the same principle as centrifugal pumps.

Vital to providing dissolved oxygen for aeration processes.

Must move air to avoid overheating.

Air flow drops as pressure against blower increases.

Can cavitate if there is obstruction on the suction side.

Largest power requirements on the WWTP

Blowers Maintenance

Inspect for any signs of wear, damage, or leaks.

Lubricate bearings, gearings and other moving parts as necessary.

Clean and replace air filters regularly.

Monitor motor temperatures to avoid overheating.

Chemical Feeders

These can be small pumps, gravity-feed, or venturi based systems

Accurately and efficiently introduce chemicals into the wastewater stream.

Chemical Feeders

Applications

- Chlorine Feeders
- Polymer Feeders
- pH Adjusting Feeders
- Coagulant and Flocculant Feeders

CONTACT INFORMATION

SOUTHWEST ENVIRONMENTAL FINANCE CENTER

A.J. Barney: ajbarney1@unm.edu

Department of Civil Engineering MSC01 1070
1 University of New Mexico
Albuquerque, NM 87131
505-277-0644
swefc@unm.edu
http://swefc.unm.edu