Pump and Motor Training Objectives

To gain an understanding of:

- The construction and operation of velocity type pumps
- The function of the main components of a centrifugal pump
- The theory of operation and common uses of positive displacement pumps
- The differences between the various types of single and three-phase motors

Velocity Pumps

**Centrifugal Pump**

Water is drawn in the center of the impeller.
Impeller rotating at high speed transfers velocity to incoming water by throwing the water outwards.
Velocity is converted to pressure in the increased volume of the volute or by the veins of a diffuser type pump.
Theoretical suction lift at sea level is 34 feet.
Practical suction lift is 15-25 feet.
75%-85% efficient.
**Velocity Pumps**

**Axial Flow Pump**
- Often referred to as propeller pumps
- Don’t have volute or diffusers like centrifugal pumps
- Moves water by the lifting action of a propeller shaped impeller
- Water moves parallel to shaft
- Used in high volume but low head applications
- Not self priming

**Vertical Turbine Pump**
- Impeller rotates in a channel of uniform cross-sectional area
- Impeller imparts radial velocity to water
- Velocity is converted to pressure by diffuser guide veins
- Flow is directed to pump discharge or to the next stage
- Used in high head/large system applications
- Internal tolerance are very tight which improves efficiency
- Pumps are 90-95% efficient

**Velocity Pump Operation**

**Starting**
- Ensure impeller is submerged prior to starting (primed)
- Avoid hydraulic shock by starting pump with discharge valve closed
- Slowly open discharge valve once pump is up to speed

**Stopping**
- Slowly close discharge valve
- Secure pump once valve is closed
Velocity Pump Operation

Monitoring
Suction and discharge pressure monitored regularly and recorded
Bearing and motor temperatures frequently checked and recorded (max bearing temp. if not water cooled: 160°F)
Excessive grease will cause a bearing to run hot
Vibration is an indication of shaft misalignment or bearing failure
Noise coming a pump casing may be the result of cavitation
Packing leakage around the pump shaft is required to prevent packing failure

Centrifugal Pump Parts

Impeller
Prime mover of water
Most are made of bronze
Cast iron and stainless steel are alternative materials
Single suction pumps have semi-open or closed designs
Closed design is most common
Double suction pumps use closed design
Centrifugal Pump Parts

Wear Rings
Restrict flow between the impeller discharge and pump suction
Single wear ring applications have the ring mounted in the case
Double wear ring applications have rings mounted in the case and on the shaft
Rings will wear over time and need to be replaced when pump efficiency drops off

Shaft
Rotates the impeller
Usually made of steel or stainless steel
Impeller is keyed to the shaft on double-suction pumps
Impeller is attached to the end of the shaft with a key nut on end suction pumps
Centrifugal Pump Parts

**Shaft Sleeves**
Placed on shaft for packing rings to wear against
Intended to protect the shaft from damage and are replaceable when worn
Usually made from a bronze alloy
Centrifugal Pump Parts

**Packing Rings**
Prevents excessive leakage where the shaft goes through the pump case
Made from graphite impregnated cotton, flax or synthetic material
Multiple rings are installed in the stuffing box
Packing ring ends should be staggered at least 90 degrees when installed (180 degrees if only 2 rings used)
Packing gland can be adjusted to reduce packing leakage

**Lantern Rings**
Used in applications where the pump is operating under a suction lift condition
Designed to prevent air from entering the pump due to shaft leakage
Pump discharge water is fed to the lantern ring and flows in two directions:
- towards pump suction
- away from packing gland
Prevents air leakage and lubricates packing
Centrifugal Pump Parts

**Mechanical Seals**
Used in applications where the pump is operating under a high suction head (> 60 psig)
Excessive pressure will compress packing rings
Seal consists of two parts:
- one connected to the shaft
- one connected to the case
Contact between the surfaces is maintained by spring pressure
Leakage is an indication of a problem and requires immediate attention
Centrifugal Pump Parts

**Bearings**
Most common are ball-type radial and thrust bearings
Lubricated with grease or oil depending on type
Noise level from bearings increases as they begin to fail
Over lubrication with grease will cause the bearing to run hot and fail prematurely
Centrifugal Pump Parts

**Couplings**
Primary function is to transmit the rotational energy from the motor to the pump shaft
Also allow for slight misalignment between the motor and pump shafts
Absorbs start-up shock when pump motor is turned on

Positive Displacement Pumps

Used primarily for chemical feed (hypochlorinator)
Discharge a fixed amount of fluid for each cycle
Discharge valve must be open prior to starting
Discharge pressure does not affect flow through positive displacement pumps

Single Phase Motors

Generally used in fractional horsepower applications. (120 V – 240 V)
Three Types:
- **Split-phase**
  Low starting torque – high starting current
- **Repulsion-induction**
  High starting current
- **Capacitor-start**
  High starting torque – high starting current
  Used for infrequent but quick start applications
Three Phase Motors

**Squirrel Cage Induction Motor**
- Simplest of all AC motors
- Rotor windings consists of bars placed in slots in the rotor
- Stator windings are in the frame and connected to the power supply
- Current flowing through stator windings induces a rotating magnetic field
- Rotor rotates with the moving magnetic field

**Synchronous Motors**
- Power applied to windings in a way that creates a rotating magnetic field
- Rotor has same number of poles as the stator and is supplied with DC through slip rings and brushes so the rotor’s magnetic field is constant
- Used in applications where motor speed must be held constant

**Wound Rotor Induction Motor**
- Stator is similar to squirrel cage motor
- Speed and torque output is controlled by varying the resistance of the rotor circuit
- Starting current is seldom greater than full-load operating current
- Squirrel Cage and Synchronous motors have starting currents 5 to 10 times their fully loaded values
- Speed can be varied by controlling the resistance of the rotor circuit
Review the lecture handout and then complete the quiz. This will help you remember the information we just covered.