PUMP SELECTION TRAINING SEMINAR

CONTRACTORS PUMP BUREAU PRESENTATION SERIES

ConExpo-Con/AGG 2017
OBJECTIVES

• Introduction to the CPB (Contractors Pump Bureau)
• Overview of Different Types of Construction Dewatering Applications
• Overview of the Types of Pumps Available
• Selecting the Right Type of Pump for your Application
• Selecting the Specific Model Pump within the Category Type
• Special Considerations for Pump Operation
WHAT IS THE CPB

• We are a subgroup of AEM serving the Pumping Industry Contractors Pump Bureau

• Working for over 80 years to Establish Clear and Consistent Standards and Guidelines for Safety, Operation and Product Testing

• Pump Market Statistics Program With AEM

• Cooperative Effort to Create Guidelines for End Users to Follow When Selecting the Right Pump for the Job
## Members of CPB

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Construction Pumping Applications

- Pond Drainage
- Open Pit or Quarry Drainage
- Trench or Ditch Drainage
- Well Point Dewatering
- Temporary Well Dewatering
- Bypass Pumping
- Directional Drilling or Boring Recovery Pumping
Pond Drainage

- Pond conditions may require different solutions
- Lined or unlined makes for different bottom conditions
Open Pit or Quarry Drainage

- High walls may require high head/pressure pumps
- Staging pumps or series connection may be needed
Trench or Ditch Drainage

• Dewatering as you move along a trench installing pipe
Well Point Dewatering

- Pump must be able to handle air mixed with the water
- Vacuum Assisted Pumps most common
Temporary Well Dewatering

- Submersible pumps in well casings used for this application.
Bypass Pumping

- Sewer or Water Line Bypass pumping
Directional Drilling/Boring Recovery Pumping

- Pumps must handle abrasives common in this application.
Classification of Pumps

**Positive Displacement (PD) Pump**
Operates by alternating or filling a cavity and then displacing a given volume of liquid.

**Variable Displacement (VD) Pump**
Produces head and flow by increasing the velocity of the liquid with the help of a rotating vane impeller.
Types of Pumps & How They Work

Classification of Pumps

Positive Displacement (PD) Pump
The positive displacement pump delivers a constant volume of liquid for each cycle against varying discharge pressure.

Variable Displacement (VD) Pump
The flow from a centrifugal pump varies with the discharge pressure.

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Types of Pumps & How They Work

Types of Positive Displacement Pumps

Rotary Lobe

Diaphragm
Rotary Lobe Pump

- In rotary lobe pumps, a low-pressure area is created when the rotors separate.
- The liquid is forced in by atmospheric pressure and is carried around the housing as the lobes rotate.
- One lobe does not mesh with and drive the other. This is accomplished by using an external gear set.
Rotary Lobe Pump

Advantages:
• Highly efficient (>90%)
• Low fuel consumption per gallon pumped
• Can handle both air and water

Disadvantages:
• Can’t run dry
• Limited solids handling capability
• Limited applications – well point and sock only
Diaphragm Pump

As the diaphragm starts upward, the suction flapper opens and the discharge flapper closes allowing water to enter the pump.
Types of Pumps & How They Work

Diaphragm Pump

As the diaphragm starts downward, the suction flapper closes and the discharge flapper opens allowing the water in the pump to be discharged.
Types of Pumps & How They Work

Diaphragm Pump

Advantages:
• Dry priming
• Can run dry
• Handles air and water
• Handles solids
• Handles abrasives
• No rotating parts in contact with the fluid

Disadvantages:
• Low capacity
• Low pressure
• High cost per gallon pumped
Types of Pumps & How They Work

Centrifugal Pumps

- End Suction
- Self Priming or Vacuum Assisted
- Submersible
Centrifugal Pumps

- A car’s tire turning in the rain will force water away from itself and into the wheel well by *centrifugal force*
- *The wheel well acts as a volute.*
A centrifugal pump’s impeller operates by using **centrifugal motion** to create a low pressure area on the suction side at the **eye** of the impeller.

- The incoming water is directed by the blades of the impeller into the volute where it exits out of the pump at the **cutwater**.
Standard Centrifugal Pump – Single Volute

Advantages:
• High Efficiency (80-90%)
• Simple to build
• Easy to maintain
• Handles solids
• Can run dry

Disadvantages:
• Not self-priming
• No air handling capability
• Not hydraulically balanced
• Inefficient at the extremes of the curve
Self-Priming Centrifugal Pumps (Wet Prime)

- Vacuum is produced as the impeller rotates and draws air into the pump where it is mixed with the liquid contained in the pump casing.
- The air/liquid mixture is driven into the priming chamber, where the air separates out and is expelled through the discharge port, while the liquid, due to its higher density, falls back and is re-circulated.
Types of Pumps & How They Work

Self-Priming Centrifugal Pumps
Advantages:
- No ancillary priming system required
- Will re-prime without adding water
- Can run dry
- Air-handling capability

Disadvantages:
- Must be filled with water initially
- Low efficiency due to recirculation (50%)
- Larger and more expensive to manufacture than a standard centrifugal
- Requires air release mechanism in discharge
Vacuum Assisted Centrifugal Pumps

• Centrifugal Pump with added vacuum pump and chamber
• Faster Priming
• Made to prime from dry condition and re-prime automatically
• Good for Well-pointing, Sewer Bypass and applications where pump may lose prime and is unattended
Vacuum Assisted Centrifugal Pumps

Venturi
Air Compressor
Vacuum Assist
Types of Pumps & How They Work

Vacuum Assisted Centrifugal Pumps

Rotary Vane Vacuum Pump
Types of Pumps & How They Work

Vacuum Assisted Centrifugal Pumps

Diaphragm Vacuum Assist
### Types of Pumps & How They Work

#### Advantages:
- Can Prime and Re-prime from dry condition
- Can run dry
- Air-handling capability Increased
- Can be left unattended

#### Disadvantages:
- Larger and more expensive to manufacture than a standard centrifugal
- Additional maintenance of Priming System
- Non Self-Priming in most cases
Types of Pumps & How They Work

- Centrifugal water and trash pumps are designed in many different ways.
  - Coupled to or driven by: gas, diesel, electric, hydraulic and even propane engines or motors
  - Trailer mounted or on a skid
  - Different materials of construction on pump ends such as cast and ductile iron, aluminum or stainless steel
  - Submersible centrifugal pumps come in many different styles and materials of construction as well.
Types of Pumps & How They Work

Submersible Centrifugal Pumps

- Submersible pumps typically belong in two categories: drainage or trash/solids handling.
Types of Pumps & How They Work

• Submersible Drainage pumps have certain characteristics which allow them to be more suitable for clean water to water mixed with light to medium abrasives.
Types of Pumps & How They Work

• Submersible Drainage pumps may be made in slimmer body styles so they fit into tighter spaces
Submersible Solids Handling or Trash Pumps are designed to allow solid materials to pass through without clogging the pump.
Types of Pumps & How They Work

- Submersible Pumps may be powered by electric motors or hydraulic motors.
- Electric Submersible Pumps require power supply such as a line power access or portable generator to operate.
- Hydraulic Motor Driven Submersible Pumps require a hydraulic power unit to operate.
- Both the generators and the hydraulic power units require gas or diesel engines to operate.
Submersible Pumps

**Advantages**
- No suction lift issues
- Higher efficiency
- Relatively Portable/Light wt
- Flooded site is not an issue

**Disadvantages**
- Pumps are submerged
- Need external power
Types of Pumps & How They Work

- Submersible Pumps are designed with different applications in mind
- Stainless Steel materials for applications with pH issues
- Light wt aluminum for applications requiring users to hand carry pumps
- Medium head, high flow versus low flow, high head
- Trash/solids handling versus clean water drainage
- Abrasive resistant metals on pumps in slurry and other abrasive laden liquids
Types of Pumps & How They Work

- Centrifugal Pumps, Submersible or End Suction, can operate in different applications by pump body and impeller design.
- Highly efficient clear water pumps will utilize impellers design for pumping water that does not contain solids or heavy abrasives.
- Trash pumps utilize impellers that will allow the passage of spherical solids or heavier abrasive content without clogging or excessive wear.
Types of Pumps & How They Work

- Vortex Impeller
- Open Impeller
- Semi-Open Impeller
- Closed Impeller
Selecting the Right Pump for the Job

• Questions that need answering:
  – What is the nature of the liquid being pumped
  – Description of the location and purpose for pumping
  – How much volume is to be moved and how quickly
  – What are the Static Head Conditions (suction and disch)
  – What is the overall distance from source to destination
  – What type and size is the suction/discharge hose or piping
  – Is power available or is the location remote
  – Are there any restrictions or regulations to be aware of
Selecting the Right Pump for the Job

• The Nature of the Liquid
  – Clean, Clear Water
  – Dirty, Muddy Water on an Excavation Site
  – Sandy, Gritty Water from a River or Creek
  – Waste Water from a Sewer Line with up to 3” Solids
  – Clear Water with a low pH of 2-3 (acidic)
Selecting the Right Pump for the Job

• Description of the location and purpose for pumping
  – Open excavation/trench for new sewer pipe-line

  – Digging footings for a new building

  – Well Point Dewatering Installation for Bridge Pilings

  – Temporary Well Dewatering Job for Storm Water Pipeline

  – Sewer Main Bypass Job
Selecting the Right Pump for the Job

• How much volume and how quickly
  – 100 gallons per minute
  – 60,000 gallons per hour
  – 200,000 gallons per day
  – 500,000 to 1 Million Gallons per Day
Selecting the Right Pump for the Job

• Static Head or Suction Lift and Distance to Discharge
  – 10ft Static Discharge Head and 200ft Horizontal Line
  – 50ft Static Discharge Head and 1000ft Horizontal Line
  – 15ft Suction Lift and 1500ft of Horizontal Line
  – 250ft Static Discharge Head and 100ft Horizontal Line
Selecting the Right Pump for the Job

• Type and Size of Discharge Pipe or Hose with Transitions
  – 4” PVC Suction Hose
  – 6” Coupled Lay Flat Hose with 2 Ninety Degree 6” Elbows
  – 6” Rubber Suction Hose with one 45 deg elbow then 6” PVC Pipe Horizontal Line with one 90 deg elbow and two 45s.
  – 8” HDPE Discharge Pipe with 1 Ninety Degree 8” Elbows
Selecting the Right Pump for the Job

- **Power Requirements/Availability**
  - Power Company Line Drop Electricity 480v, 3 phase
  - Generator 150KW Electric Power diesel engine driven
  - No Electric Power Available Remote Location

- **Restrictions**
  - None
  - Sound attenuation needed on engine driven equipment
  - Methane Gas Explosion Proof Environment, Enclosed Space
Selecting the Right Pump for the Job

- For Our Purposes lets use the information in Black for our application and Pump Selection Criteria
  - Dirty, Muddy Water on an Excavation Site
  - Open excavation/trench for new sewer pipe-line
  - 60,000 Gallons per Hour = 1000 Gallons Per Minute
  - 15ft Suction Lift and 1500ft of Horizontal Line
  - 30ft of 6” Rubber Suction Hose then 6” PVC Horizontal Line by 1500ft with Elbows
  - No Electric Power Available Remote Location
  - No Special Restrictions on Site
Calculating Total Dynamic Head

Typical Self Priming or Vacuum Assisted Centrifugal Pump Set Up
Calculating Total Dynamic Head

**Static Suction Lift**
Vertical distance from pump centerline to the free surface of the liquid.

15ft
Calculating Total Dynamic Head

Total Dynamic Suction Lift
The sum of the static suction lift plus all friction losses.

30ft + 8ft + 1 one 45 degree elbow all 6” diameter + 15ft Static
Calculating Total Dynamic Head

Static Discharge Head
Vertical distance from pump centerline to the highest elevation in the discharge line.

20ft
Calculating Total Dynamic Head

Total Dynamic Discharge Head
The sum of the static discharge head plus all friction losses.

6ft + one 90 deg elbow + 20ft + 45 deg elb + 15ft + 45 deg elb + 1500ft horizontal all 6” Dia + 20ft Static
Calculating Total Dynamic Head

Total Dynamic Head
The sum of the total dynamic suction lift plus the total dynamic discharge head.
Calculating Total Dynamic Head

- Remember that we are using 1000gpm as our flow
- Flow rate is an essential part of the Friction Loss Calc
- Hoses, Pipes and elbows are all 6” on the suction and discharge side of the pump
Calculating Total Dynamic Head

**Static Suction Lift** – vertical distance from pump centerline to the free surface of the liquid. 15ft

**Total Dynamic Suction Lift** – the sum of the static suction lift plus all friction losses. 15ft + 3ft = 18ft

**Static Discharge Head** – vertical distance from pump centerline to the highest elevation in the discharge line. 20ft

**Total Dynamic Discharge Head** – the sum of the static discharge head plus all friction losses. 20ft + 108ft = 128ft

**Total Dynamic Head** – the sum of the total dynamic suction lift and total dynamic discharge head. 18ft + 128ft = 146ft TDH
Pump with a match for 1000gpm @ 146ft TDH
Things to Consider During Pump Operation

- Too far left or right of Best Efficiency Point (BEP) for long periods will cause damage
- Minimum Continuous Stable Flow (MCSF)
- NPSH (Net Positive Suction Head) is important to pump operation.
  - Need sufficient inlet pressure
  - Large enough pipe. Don’t choke your pump
  - Elbows at the suction inlet are not a good idea
  - Keep air out of the suction line
  - Make sure your strainers are not clogging up
An Interesting Note:

- Changing your discharge pipe to 8” from 6” is very significant.
- Total Dynamic Discharge Head is approximately 46ft with 8” PVC instead of the 128ft with 6” PVC.
- Total Dynamic Head then becomes approximately 64ft instead of 146ft.
- This can make a lot of difference in the cost of the job over the long run if you are using less hp to move the water.
Summary

• There are many types of pumps from which to choose
• Choosing the Right Pump is Critical to the Job
• Having the answers to a few key questions gets you on the right track
• There are guidelines and pump selection calculators to help you design your system
• CPB members are interested in providing the knowledge, training and products you need to get the job done
• Visit our website for more information on Pump Selection
Any Questions or Comments?