Fall Seminar

Pump Station Maintenance

November 1, 2012
YCUA

Tim Sullivan, PE.
Presentation

- Types of Pumps
- Pump Selection
- Pump Installation
- Types of Pump Stations
- 10 Ways to Murder Your Pump
- Operation and Maintenance
General Pump Classification

Kinetic vs. Positive Displacement Pumps
PD Pumps will not be discussed today

- Kinetic Pumps
  - Vertical Turbine
  - Lineshaft
  - Submersible
  - Axial Flow
- Centrifugal
  - Split Case
  - Overhung Impeller
General Pump Classification

Axial Split Case vs. Overhung Impeller
Typical Overhung Impeller Pump Types

Frame Mounted

Close Coupled

Submersible
Special Impeller/Pump Types

Centrifugal
Screw

Vortex
Special Impeller/Pump Types

Self Priming
“Trash”

Chopper
Basic Considerations

- Flow and head conditions (avg, min, max)
- Current vs. projected future flows
- Liquid being pumped (rags, grit, grease, chemical additives?)
- Site constraints (space, power availability, aesthetics)
- Other challenges (retrofit, forcemain network, terrain)
Flushable Products

CLEAN IT UP AND
FLUSH IT AWAY

DISINFECTING FLUSHABLE
BATHROOM WIPES

Disinfect all of your bathroom surfaces, from sink to tub to toilet, and flush all the dirt and bacteria away for good!

CLOROX ToiletWand

Value Pack

REDI WIPES

Flushable Wipes

Scrubbing Bubbles

Flushable Wipes
Important Details

- Look closely at suction and discharge conditions
  - NPSHa > NPSHr
  - Potential for hydraulic transients
- Pump speed (1200-1800 rpm)
- Motor selection
  - Continuous vs. intermittent duty
  - Inverter duty (if VFDs are to be used)
  - Size motor for run-out condition
- Packing vs. mechanical seals
- Discuss/consider hardened materials?
Trial Pump Selection

Allowable Operating Region
Preferred Operating Region
Affinity Law Parabola

Best Efficiency Point
System Head Curve

- Friction head
- Low wet well
- Max: 1500, 48.6
- High wet well
- Static head
- Min
- Typ

Total Dynamic Head (ft)

Flow Rate (gpm)
Pump Curves (parallel operation)
Trial Pump Selection

Diagram showing flow rate and total dynamic head for one pump and two pumps, with labels for min, typ, and max flow rates.
Common Types of Wastewater Pump Stations

- Wet Well/Dry Well Pump Stations
- Submersible Pump Stations
- Suction Lift Pump Stations
- Factory Built or “Package” Pump Stations
Common Types of Wastewater Pump Stations

Wet Well/Dry Well

Basic Considerations:
- Flooding
- Accessibility/Security
- Grit
- Safety
Common Types of Wastewater Pump Stations

Wet Well/Dry Well
Common Types of Wastewater Pump Stations

Wet Well/Dry Well
Common Types of Wastewater Pump Stations

Wet Well/Dry Well
Common Types of Wastewater Pump Stations

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Wet Well/Dry Well
Common Types of Wastewater Pump Stations

Wet Well/Dry Well
Common Types of Wastewater Pump Stations

Submersible Pumps

Consider:
- National Electrical Code
- Ease of pump removal
- Seal failure detection
- Separate valve pit
- Basic Considerations discussed previously
Common Types of Wastewater Pump Stations

Submersible Pumps
Common Types of Wastewater Pump Stations

Factory Built or “Package” Pump Stations

**Suction Lift**
- FRP enclosure
- Valves accessible
- Control panel inside
Common Types of Wastewater Pump Stations

Suction Lift Pumps (vacuum primed)

Consider:
- National Electrical Code
- Suction lift capability
- Dual vacuum pumps
- Valves accessible
- Basic Considerations discussed previously
Common Types of Wastewater Pump Stations

Suction Lift Pumps (vacuum primed)
Common Types of Wastewater Pump Stations

Suction Lift Pumps (self-priming)
Common Types of Wastewater Pump Stations

Factory Built or “Package” Pump Stations

Submersible
- FRP enclosure
- Valves accessible
- Control panel inside
Common Types of Wastewater Pump Stations

Factory Built or “Package” Pump Stations

**Submersible**
- Dry pit “Can”
- Factory Built - FRP or steel construction
- Package – concrete construction
- Control panel inside or in weatherproof panel at grade
Common Types of Wastewater Pump Stations

Factory Built or “Package” Pump Stations
Factory Built Pump Stations

**The Good**
- Easy to install (even your brother-in-law can do it)
- Standardized design (competitive price point)

**The Bad**
- Low price = poor quality components
- System may be compact (tight quarters)

**The Ugly**
- Can be difficult to maintain (confined space?)
- Challenging to modify/upgrade in future
“Can” Pump Stations
- Baseplate should be anchored and grouted to the foundation
- Pump foundations should be robust (HI Std. 1.3.4)
- There should be no piping strain on pump nozzles
- Use good piping practices especially on suction
- Provide vent valves on high spots of pump/piping
- Provide suction and discharge pressure gauges
- Provide isolation valves and (possibly) flexible couplings
Mechanical Displacement - dial indicators

Check pump/motor alignment (angular alignment)

Eyesight – straight edge & feeler gauges
Check pump/motor alignment (parallel alignment)

Eyesight – straight edge & feeler gauges
FIGURE 3a: Suction Piping.
Seal Water System

Installation
What do all pumping systems have in common?

- All pumps require care and maintenance
- Here are ten ways to “Murder” your pump:

  #10 Overwork It  #5 Stress It
  #9 Starve It      #4 Shake It To Pieces
  #8 Choke It       #3 Poison It
  #7 Fry It         #2 Drown It
  #6 Stab It        #1 Neglect it
Frequent Starts

- Can damage motor winding insulation
- High mechanical stress during starting period

Ignoring Allowable Operating Region

- Increases potential for damaging hydraulic forces, vibration and flow separation/cavitation
- Routine operation should be within Preferred Operating Region of the curve
“Less than 0.5% of a plant’s maintenance budget is spent purchasing lubricants, but the downstream effects of poor lubrication can impact as much as 30% of a plant’s total maintenance costs each year.”

ExxonMobil Case Study

**Lubrication**

- Reduces friction between two surfaces
  - Mitigates wear (loss of metal)
  - Decreases heat generation at moving elements
- Lubricant does not last forever
  - Moisture, dirt and heat degrade lubricants with time
  - Adhere to manufacturers’ lubrication schedules
- Keep good records
Net Positive Suction Head

- Make sure NPSH(R) is less than NPSH(A)
- Typical conditions that increase NPSH(A):
  - Lowering the shut off level in the wet well
  - Clogged suction line or partially closed valve
- Audible cavitation is a strong indicator of a serious problem
- Collapse of vapor cavities causes erosion of the impeller and other internal components
Operating at Shutoff Head

- If pump is operating near shutoff, a problem exists
  - Partially closed valve
  - Clogged discharge line
  - Surcharged conditions upstream
- Pump will overheat since water is circulating within volute
- Condition must be corrected immediately to prevent damage to the pump and motor
Unusual Grit Quantities or Sizes

- If excessive grit is “normal” pumps should be constructed of hardened (Ni-Hard) materials or glass lined
- If unusual grit is detected in the wet well look upstream for collapsed pipes or erosion around manholes
- Periodic manhole/wet well cleaning can detect problems and protect the pumping system
Piping Misalignment

- External stress at inlet and discharge nozzles can cause distortion of bearing frames and pump casings
- This condition may occur during installation or through thermal expansion or differential settlement
- Make sure that heavy valves and piping are supported independent from the pump suction and discharge nozzles
- If thermal expansion and/or differential settlement is anticipated or detected, provide rubber expansion joints in piping
Vibration

- There are numerous potential sources of vibration
  - Pumps operating outside of the AOR
  - Machine imbalance or shaft misalignment
  - Resonance with natural frequency of system
- Vibration may be unavoidable but can be mitigated
  - Start with proper selection (operate near BEP)
  - Set up with good balancing and alignment
  - Provide proper pump and piping support
  - Securely anchor pump base plate to strong foundation
Corrosive Fluids

- Not typically encountered in municipal wastewater
- Intermittent industrial discharge or spills may occur
- Metal salts (ferric chloride) can be extremely damaging to pump metal components
- Coordinate with IPP personnel to report detection of low pH
- The presence of corrosive fluids will also cause damage to sewer and forcemain piping so must be corrected immediately
Seal Leakage Management

- Seal water from the packing gland or mechanical seal should be carried away from the pump, especially the rotating elements.
- Make sure that gland is adjusted to minimize leakage (about a drop of water every second is adequate for cooling).
- The stuffing box drain pipe should be directed to a floor drain or hub and maintained in flowing condition.
- Properly install packing to maintain backpressure on the pump casing/shaft interface.
- Promptly replace failed mechanical seals.
Manufacturer Recommended Service

- Closely follow the preventive maintenance practices outlined in the pump O&M manual including operational “check-ups”
- Take careful note of any abnormal sound or vibration and take action to promptly correct any problems
- Check motors and rotating elements of pumps for higher than normal temperature, using a thermometer at least quarterly
- Visually inspect pumps and motors for coating failure and oxidation and reapply protective coatings/paint as necessary
What can we do to monitor and prevent “Murdering” our pumps?

- Pay close attention to 4 areas:
  - Selection (as discussed previously)
  - Installation (as discussed previously)
  - Operation
  - Repair & Maintenance
Operation

- Monitor pump flow rate
  - Don’t throttle the suction
  - Don’t run it dry
  - Don’t run at excessively low flow/high flow
- VFD – Keep within POR
- Alternate pumps
- Do not cycle pumps
- Observe flushing/cooling water
- Visit your pumps routinely (daily or weekly)
- Look/Listen/Feel/Smell
Perform manufacturer recommended PMs
Take care when dismantling
Examine all metal to metal fits and recondition with care
Always use new gaskets, O-rings & lip seals
Check the clearances & run out of all shafts, sleeves and wear rings/plates
Keep equipment clean, dry and painted
Inspect stuffing box and pump casing for corrosion
Inspect impeller and internal wear components for corrosion, erosion and cavitation
Keep good records of inspections and repairs
Check all electrical connections & components
Keep Records of the critical data about your equipment:

**PUMP RECORD CARD**

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**Nameplate Data and Pump Info**

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**Pump Materials**

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24 Jul 95

11005-24
Work Order: 66806

Equipment Name & Number: High Wet Well
Location: Rambling Road

Date Reported: 4/20/2006
Reported By: Control Room
Date Submitted: 4/20/2006
Submitted By: R Dupek

Problem Description:
High wet well float tipped

Assigned To:
Date Assigned:
Completed By: R Dupek
Date Completed: 4/20/2006

Parts:
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Search For Equipment Name

Record: 10547 of 10624
The Pressing Of The Buttons On The Right Will Print Those Preventive Maintenance WorkOrders And Automatically Insert Them Into The YCUA 2003 Database.

After Pressing The Button, Enter The Date In The Box Beside The Button To Avoid Duplications.

Weekly
4/19/05

Monthly
4/01/05

Quarterly
February 05

Twice Yearly
February 05

Annual
January 04

Hoists
02/05/2004

The Dates Listed To The Left Are The Dates Those Particular Preventive Maintenance WorkOrders Were Last Produced.

NOTE: Press Each Button Only ONCE!

Open Data Entry Form

MAINTENANCE USE ONLY!
Preventive Maintenance Job Schedule

Code: 50

Equipment: Hand Chain Hoist (Dresser)

Quantity: All

Location: Maintenance Building

Contract Number: 77-S-1

Eng Spec Section: 16

- **Daily:**
  - 

- **Weekly:**
  - 

- **Monthly:**
  - MONTHLY
  - 1. Clean chain for inspection
  - 2. Inspect chain and all mating surfaces for wear distortion or other damage. If chain wear is observed, check

- **Quarterly:**
  - 

- **Bi-Anually:**
  - 

- **Annually:**
  - ANNUALLY
  - [Chain block must be partially disassembled to perform the following inspections.]
  - 1. Inspect load brake and overload device. Replace any parts broken, scored, damaged or badly worn.
Maintenance – O&M Manuals

- Have Supplier Annotate O&M Manuals
- Review for completeness (must include all components)
- Have them identify the PM for all components
- Request O&M Manual in the P.O.
Utilize O&M Manuals During Training
  • Have them point out the page
  • Have them revise as required

Request Additional Training – 8 hours at a later date

Request Training in the P.O.
Electrical Maintenance

- Safety First
- Lock Out – Tag Out
- Short Circuit – Coordination Study (SC/CS)
- Arc Flash
Electrical Maintenance

- Infrared Camera
- Tighten Lugs
- Clean Contacts
- Adjust Electro-mechanical Components
Panel VFD Maintenance

- Located at Pump/Equipment
- Corrosion
- GAC Air Conditioning
Questions/Comments?

Thanks,

Tim Sullivan, P.E.