Performance Under Pressure: Troubleshooting Problem Pump Installations
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Agenda

01 Introduction/Purpose
02 Centrifugal Pump Basics
03 Pump Testing Basics
04 Problem Pump Case Studies
Why Test?

- Certified pump testing
- Start-up / field testing
- Testing for preventative maintenance
- Optimizing operational efficiency
- Maximize operational life
- Find problems before damage occurs
Typical Centrifugal Pump Curve

System Head Curve

- Static head
- Pressure Head
- Total Head
- Flowrate
Typical Centrifugal Pump Curve

System Head Curve

- Static head
- Pressure Head
- Total Head
- Flowrate
Typical Centrifugal Pump Curve
Pump Head-Capacity Curve

- Pump operating point
Typical Centrifugal Pump Curve

Efficiency Curve

- Best Efficiency Point (BEP)
Defined Terms

- **BEP** – best efficiency point
  - The point on the pump curve where efficiency is greatest.

- **POR** – preferred operating range
  - The range where the pump will satisfactorily operate without vibrations above standards or damage.
  - Varies depending on pump size, typically between 70% to 115% of the flow rate at BEP.

- **AOR** – allowable operating range
  - The range where the pump will operate satisfactorily but will experience some cavitation, vibration above standards and shorter service life. The pump manufacturer will determine this range.
  - Generally in the flow rate range is 60%-120% of the flowrate at BEP.

- **Obtain these values from pump manufacturer for specific pumps being considered**
Pump Operating Ranges

- Best Efficiency Point (BEP)
- Preferred Operating Range
- Acceptable Operating Range
Operating Outside the Acceptable Range

**LEFT OF BEP:**
- High shaft deflection
- Vibration
- Temperature Build-up
- Excess recirculation
- Very inefficient
Operating Outside the Acceptable Range

LEFT OF BEP:
- High shaft deflection
- Vibration
- Temperature Build-up
- Excess recirculation
- Very inefficient

RIGHT OF BEP:
- Cavitation
- High flow – high velocity – high wear
- Motor overload
Damage Caused by Cavitation / Vibration
Typical Centrifugal Pump Curve

Variable Speed Pumping

- Flow function of speed
- Head function of square of the speed
Typical Centrifugal Pump Curve

Variable Speed Pumping

- Check operating condition at min. speed also
Typical Variable Speed Pump Curve

- System curve
- Acceptable operating range
- Variable speed pumping curves
- Efficiency curves
Certified Pump Testing

- Pump speed (rpm)
- Discharge pressure (psi/ft)
- Flowrate (gpm)
- Power (HP)
- Correct to gage elevation
Case Study No. 1
Filter Backwash Pump Testing

Design Criteria

- Designed to pump 5,000 – 8,000 gpm
- [6 – 10 gpm/SF filter backwash rate]
- Pump suction El. is 2’ higher than discharge El.
- Variable speed
Filter Backwash Pump Testing

Backwash piping configuration
Filter Backwash Pump Testing
Backwash piping configuration
Filter Backwash Pump Testing

Submittal Curve
Filter Backwash Pump Testing

Initial Test Results:
- 7,550 gpm max (vs. 8,000 gpm required)
- Pump head?
- Pump speed?

Initial Manufacturer Diagnosis:
- Air trapped in piping increasing head
- Piping change during construction added head
Filter Backwash Pump Testing

Field Testing

- Pressure gage
- Manometer
- Tachometer
- Ladder
## Filter Backwash Pump Testing

### Initial Test Results

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Flowrate (gpm)</th>
<th>Pressure Gage (PSI)</th>
<th>Manometer (in H₂O)</th>
<th>Depth to Water (inches)</th>
<th>Vel Head (feet)</th>
<th>Corrected Gage Pressure (feet)</th>
<th>Corrected Head (feet)</th>
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<td>3270</td>
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</tbody>
</table>

1. All measurements use TOC (El. 544.50) as zero basis, (WSE approx 537.58)
2. Gage height was 64" above TOC (El. 549.83)
3. When both gage pressure and manometer height is available, manometer reading is used as assumed to be more accurate
Filter Backwash
Pump Testing

Pump Test No. 1

Certified Curve
Manometer
Pressure Gage

Flowrate (gpm)

Total Dynamic Head (ft)
Filter Backwash Pump Testing
Pump Test No. 2

Certified Curve
Retest Results

[Graph showing total dynamic head in ft against flowrate in gpm]
Filter Backwash Pump Testing

Backwash Piping Configuration
Filter Backwash Pump Testing

Pump Test No. 3

Results

- Corrected pump operation
- Overclocked pump to achieve required flow in last filter
Case Study No. 2
Chemical Recirculation Pump

Design Criteria

- Mag drive centrifugal hypochlorite pump
- 50 gpm @ 14 ft TDH
- 3-inch suction line, 3-inch discharge
Case Study No. 2
Chemical Recirculation Pump

**Damaged Components**
- Broken sleeve bearing
- Damaged thrust washer
- Outer magnet assembly after exposed to fluid
Chemical Recirculation Pump Testing
System Curve Review
Chemical Recirculation Pump Testing

System Curve Review

![System Curve Graph](image-url)
### Chemical Recirculation Pump Testing

#### Results

- 3-inch discharge pipe supposed to be 2-inch
- Pump runout / cavitation
- Pump failure after 2 months operation
- Throttle pump back on curve
Case Study No. 3
High Service Pump performance

**Background / Review**

- Four 1,000 HP pumps (identical)
- One pump with lower output
  - 6,900 gpm (each of 3 pumps)
  - 6,100 gpm (1 pump)
Case Study No. 3
High Service Pump performance

- Pressure Gage
- Control Valve
Case Study No. 3
High Service Pump performance

Results

- 800 gpm more
- 25 psi less pressure
- Assume 2,000 hrs/yr
- Saves ~ $36,000/yr in electrical cost
Pump Testing

Results and Conclusions

- Factory testing to confirm pump meets design intent
- Start-up testing to establish proper operation in system
- Routine testing/checking to track operational performance
Questions?

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