Strategies to Optimizing Pump Efficiency and LCC Performance

Presented by: Joe Ruggiero
Title: Strategic Account Manager
Company: ITT IBG Goulds Pumps
Pumping Systems Are Energy Intensive

<table>
<thead>
<tr>
<th>Industry Type</th>
<th>Pump Energy (% of Total Motor Energy Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>59%</td>
</tr>
<tr>
<td>Forest Products</td>
<td>31%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>26%</td>
</tr>
<tr>
<td>Food Processing</td>
<td>19%</td>
</tr>
<tr>
<td>Primary Metals</td>
<td>9%</td>
</tr>
</tbody>
</table>

A 150 hp pump uses about $40,000 in electricity annually

MECS 1994, Bureau of Economic Analysis 1997
Census of Manufacturers, 1993
Evaluation of 1690 pumps at 20 process plants:

- Average pumping efficiency is below 40%
- Over 10% of pumps run below 10% efficiency
- Major factors affecting pump efficiency:
  - throttled valves
  - pump over-sizing
- Seal leakage causes highest downtime and cost
Excessive Valve Throttling is Expensive

- Higher energy consumption
- Lower process reliability
- Poor process control
  - increased variability
  - manual operation

Control engineers need to incorporate the pumping system as part of the automation architecture.
Some Fundamentals

Fixed vs. Variable Speed Pumping
Hydraulic System

Static Head

Friction Head
Basic Pump Curves

Pump Curve:
- Motor Speed
- Impeller Diam.

System Curve:
- Static Head
- Friction Head

The operating point is at the intersection of the pump and system curves.

H = Head
Q = Flow
= operating point
• Valve throttling results in excess power consumption
• Excess energy noted in blue area.
• Bypass lines consume excess power consumption.
• Excess energy noted in blue area.
Thrust Brg. Horz.
Overall Vibration Vs. Flow
Fixed Speed with Control Valve vs Variable Speed

Flow (GPM)

Vibration (IPS)

Test 11 Variable Speed Test 17.5" Dia
Test 1 1785 Rpm 17.5" Dia

BEP = 1500 GPM

Stock Pump

- Fixed Speed
- Variable Speed
Reliability Issues Relative to BEP
Pump Performance Curve

Variable Speed: *Maximizes HQ Flexibility*

N = Speed
• Variable speed control meets the exact flow and head requirements
• No excess energy is consumed!
Effect of pump speed changes on a system with low static head.
Effect of pump speed changes on a system with high static head.
Energy savings are possible because of affinity laws.

Speed reduction provides significant energy savings at partial load.

The reduction of the speed provides:

- Flow reduction according to the linear function
- Head reduction according to a square function
- Power reduction according to a cubic function!

$P = \text{Power}$
Variable Speed Control

Opportunities and Benefits
U.S. Motor Systems
Market Opportunity Assessment

“Motor systems equipped with VSD’s account for only 4% of motor energy usage, compared to the potential for application on 18 - 25% of the total energy used…”

Source: DOE-Office of Industrial Technology
Pumping System Elements

Traditional Pumping System
(Fixed speed pump, control valve, transmitter)

Variable Speed Drive Pumping System

Control loops are tightly associated with pumping systems

“Impacted by process changes”

“Adapts to process changes”
Pressure Control

Diagram showing a pressure control device connected to a shower bank with three stations labeled 1, 2, and 3.
Pressure Control

![Graph showing pressure control with TDH (feet) on the y-axis and capacity (gpm) on the x-axis. The graph includes curves and points labeled 1, 2, and 3.]
Flow Control
Flow Control

![Flow Control Graph](image-url)
Optimizing Pump Performance
A Systems Approach
The Systems Approach

- Focusing on individual components often overlooks potential design and operating cost-savings.
- Future component failures are frequently caused by initial system design.
- Use a LCC approach in designing systems and evaluating equipment options.
Prescreening Methodology

First: Can it be turned off?

**Primary screening**

1) Size and time AND 2) Load type

**Secondary screening**

- Symptom-based
- Analysis-based

**Focus here**

**Back burner stuff:**

- Small Loads:
  - Low Run Hours,
  - Non-centrifugal loads

- Properly Matched Pump:
  - System Need = Supply

Source: DOE - OIT
Pump Symptoms that Indicate Potential Opportunity

• Throttled valve-controlled systems

• Bypass (recirculation) line normally open

• Multiple parallel pump system with same number of pumps always operating

• Constant pump operation in a batch process or frequent cycle operation in a continuous process

• Presence of cavitation noise (at pump or elsewhere in the system)
## Energy Savings Methods

<table>
<thead>
<tr>
<th>Action</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replace throttling valves with speed controls</td>
<td>10 - 60%</td>
</tr>
<tr>
<td>Reduce speed for fixed load</td>
<td>5 - 40%</td>
</tr>
<tr>
<td>Install parallel system for highly variable loads</td>
<td>10 - 30%</td>
</tr>
<tr>
<td>Equalize flow over product cycle using surge vessels</td>
<td>10 - 20%</td>
</tr>
<tr>
<td>Replace motor with more efficient model</td>
<td>1 - 3%</td>
</tr>
<tr>
<td>Replace pump with more efficient model</td>
<td>1 - 2%</td>
</tr>
</tbody>
</table>

Source: DOE - Office of Industrial Technology
Throttled Valve
with
Bypass (recirculation line)
normally open
PM Saveall Supply Pump

SAVEALL VAT

#35 SAVEALL SUPPLY CHEST PUMP

SAVEALL SUPPLY CHEST
72-40900-12
17′ W×26′ L×5′ H×14′ - 6′ H

SAVEALL SUPPLY CHEST PUMP
72-40910-20
# Paper Machine Saveall Supply

## 35PM Save-all Supply Pump

<table>
<thead>
<tr>
<th></th>
<th>21-Sep</th>
<th>22-Sep</th>
<th>23-Sep</th>
<th>24-Sep</th>
<th>27-Sep</th>
<th>28-Sep</th>
<th>29-Sep</th>
<th>30-Sep</th>
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</thead>
<tbody>
<tr>
<td><strong>Design 10,331 GPM@ 99.1' TDH</strong></td>
<td>10,331</td>
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<td>10,331</td>
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<tr>
<td><strong>Installed Motor 350HP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Grade Basic Weight lb</strong></td>
<td>51</td>
<td>OUTAGE</td>
<td>50</td>
<td>51</td>
<td>51</td>
<td>60</td>
<td>46</td>
<td>50</td>
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<tr>
<td><strong>Speed ft/min</strong></td>
<td>3130</td>
<td>OUTAGE</td>
<td>2975</td>
<td>3035</td>
<td>3153</td>
<td>3200</td>
<td>3410</td>
<td>3200</td>
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<tr>
<td><strong>Pump Discharge Pressure in Ft</strong></td>
<td>81</td>
<td>OUTAGE</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>76</td>
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<tr>
<td><strong>Suction Pressure in Ft</strong></td>
<td>8</td>
<td>OUTAGE</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<tr>
<td><strong>Motor Load in amps</strong></td>
<td>60</td>
<td>OUTAGE</td>
<td>58</td>
<td>58</td>
<td>60</td>
<td>60</td>
<td>60</td>
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</tr>
<tr>
<td><strong>Tank level control valve position (LV 159)</strong></td>
<td>31%</td>
<td>OUTAGE</td>
<td>37%</td>
<td>41%</td>
<td>35%</td>
<td>35%</td>
<td>41%</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Other Control Valve (HV433A)</strong></td>
<td>87%</td>
<td>OUTAGE</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
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<tr>
<td><strong>Static Head in Ft</strong></td>
<td>20</td>
<td>OUTAGE</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<tr>
<td><strong>GPM</strong></td>
<td>10400</td>
<td>OUTAGE</td>
<td>10600</td>
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<td>10600</td>
<td>10800</td>
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</tr>
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</table>

*Eliminate By-pass line & Valves, Cavitation and High Maintenance*
Greenfield Project Benefits

- Potential to downsize pumps, motors and pipes (smaller footprint)
- Eliminate valves, starters, pneumatic lines, and related wiring
- Reduce medium voltage power requirements in MCC
Pump Optimization Benefits Summary

- Reduce Energy and Maintenance Cost
- Improve Pump and Process Reliability
- Increase Process Uptime and Throughput
- Improve Process Control & Quality
  - less variability
  - higher % of loops in automatic
- Reduce Fugitive Emissions
High Reliability Impact VFD Applications

- Mill Water Supply
  - Pressure control
- Seal Water Supply
  - Pressure control
  - Reduce process downtime
- Stock Blending
  - Consistency control
  - Improve product quality
- WW Dilution
  - Consistency control
- Machine Chest
  - Basis Weight MD control
  - Improve PM performance
- Broke Chest
  - Reduce Energy & Maintenance
- Repulper Chest
  - Reduce Energy & Maintenance

“There are many high impact applications that improve bottom line performance”
Strategies to Optimizing Pump Efficiency and LCC Performance

Thank You!