INDUSTRIAL PUMP BASICS

What is a pump?
A pump is a machine that increases the pressure of a flowing liquid.

Pump construction and terminology: impeller (a.k.a. rotor or wheel), housing (casing), shaft, bearings, other mechanical parts as illustrated below.
Pump assembly operation: on/off, throttle, speed control drive (direct, VFD, belt & pulley, magnetic).

A typical pump assembly:

Pumps are part of some industrial process systems. What is a system? A system includes pumps and the associated equipment that all work together to do something useful such as deliver water for a cooling system, circulate refrigerant in a refrigeration system or pump sewage in a treatment system.

A sample industrial system that includes pumps:

FCV = flow control valve
What can be done to reduce the kWhs consumed by pumps?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Range of kWh savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve pump or pump assembly</td>
<td>5-50%</td>
</tr>
<tr>
<td>Better control (eliminate throttle losses, reduce speed, use it when</td>
<td></td>
</tr>
<tr>
<td>you need it)</td>
<td></td>
</tr>
<tr>
<td>Upgrade or replace with a more efficient pump</td>
<td>10-30%</td>
</tr>
<tr>
<td>Replace V-belt with an energy-efficient “sync” belt</td>
<td>3-5%</td>
</tr>
<tr>
<td>More efficient motor (not usually your best bet)</td>
<td>2-5%</td>
</tr>
<tr>
<td>Improve system</td>
<td>5-50%</td>
</tr>
<tr>
<td>Modify the process to reduce flow or pressure required</td>
<td></td>
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</table>

What does Power Smart need to know to help our customers?

<table>
<thead>
<tr>
<th>Information to ask</th>
<th>Possible or sample answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of pump and what it does?</td>
<td>Pumps water, part of refrigeration, ...</td>
</tr>
<tr>
<td>For each pump: rated motor horsepower (hp)</td>
<td>50 hp</td>
</tr>
<tr>
<td>For each pump: hours of operation per year</td>
<td>6 days / week @ 16 hours / day = 96 hours/week (~ 5000 hr/yr)</td>
</tr>
<tr>
<td>For each pump: how is it controlled?</td>
<td>On/off (automatic? manual?), variable speed, throttle valve (automatic? manual?)</td>
</tr>
<tr>
<td>Any problems with this pump?</td>
<td>High maintenance, fails frequently, difficult to control, not enough capacity, vibrates</td>
</tr>
<tr>
<td></td>
<td>a lot, overheats</td>
</tr>
<tr>
<td>“Look beyond the energy savings”</td>
<td>Are there plans to expand production? Reduce production? Save maintenance costs?</td>
</tr>
</tbody>
</table>
Sample calculation of pump savings in kWh/year and $/year

**Information you are given (e.g., from questions you asked on the phone):**
1. “Nameplate” information on the motor: 25 hp, 460 volt, 26 amps.
   1.1. Note: information on nameplate is always the nominal, full load rating. Actual motor amps are usually less than nameplate, but sometimes a bit higher. Nameplate power may be horsepower (hp), or could be in kilowatts (kW).
   1.2. To convert hp to kW, multiply hp by 0.746:
   \[ 25 \text{ hp} \times 0.746 \text{ kW/hp} = 18.7 \text{ kW} \]
2. 19 amps measured by the customer’s electrician.
3. The pump operates 52 weeks/yr, 6 days/wk, 16 hrs/day (5000 hours per year).
4. Average electricity cost is 5.5 cents/kWh ($0.055/kWh).
5. Pump is controlled with a throttle valve.

**Information you assume:**
1. Based on table on page 3, make a “guesstimate” that 25% can be saved by speed control.
2. Assume motor “power factor” is 0.9.
Calculation:

(a) kWh/yr consumption:

kWh/yr this pump consumes ("baseline")

\[ kW = \text{volts} \times \text{amps} \times \sqrt{3} \times (\text{power factor}) / 1000 \]

\[ = 460 \times 19 \times 1.73 \times 0.9 / 1000 = 13.6\ kW \]

kWh/yr = 13.6 kW \times 5000\ hours/yr = 68,000 kWh/yr

(b) potential kWh/yr savings:

About how many kWh/yr can be saved each year?

kWh/yr savings = 0.25 \times 68,100\ kWh/yr = 17,000\ kWh/yr

(c) $/yr savings:

How much money can be saved each year?

17,000\ kWh/yr \times $0.055/\text{kWh} = $940/yr

Additional Resources

1. Improving Pumping System Performance - A Sourcebook for Industry (2\textsuperscript{nd} edition)
   http://www1.eere.energy.gov/industry/bestpractices/motors.html
   http://www1.eere.energy.gov/industry/bestpractices/motors.html
   http://www.cee1.org/files/ASMEEnergyAssessmentforPumpingSystemsGuidancev0.2.pdf
4. www.pumpsystemsmatter.org
5. www.pumps.org
6. www.pumplearning.org

\[1\text{ This is a useful formula to keep handy. It is good for 3-phase power systems, typical of industrial plants. Note that in our homes we have 1-phase power, and the formula is the same except take out the } \sqrt{3}.\]