Selection, Application and Commissioning of HVAC pumps

- Traditional and Modern Pump Types
- Pump Components and Materials
- Installation and Operation
- Commissioning
3 Basic pump configurations

Horizontal split case
End suction
Vertical in-line
Ease of installation:
Base mounted split case pump

Typical cost required

- Inertia base spring mounts: $5,740
- Flex connectors: $500
- Grout and alignment: $2,100

Extra cost to install: $8,340
Ease of installation:
Vertical In-Line pump

Typical cost required

<table>
<thead>
<tr>
<th>Item</th>
<th>8” Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Inertia Base</td>
<td>0</td>
</tr>
<tr>
<td>No Spring Mounts</td>
<td>0</td>
</tr>
<tr>
<td>(Base snubbers only for seismic applications)</td>
<td></td>
</tr>
<tr>
<td>No flex connectors</td>
<td>0</td>
</tr>
<tr>
<td>No grout or alignment</td>
<td>0</td>
</tr>
</tbody>
</table>

Extra cost to install 0
Consider six major criteria

<table>
<thead>
<tr>
<th>Vertical</th>
<th></th>
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<tbody>
<tr>
<td>A. Floor space</td>
<td>✔</td>
</tr>
<tr>
<td>B. Ease of installation</td>
<td>✔</td>
</tr>
<tr>
<td>C. Maintainability</td>
<td>✔</td>
</tr>
<tr>
<td>D. Reliability</td>
<td>✔</td>
</tr>
<tr>
<td>E. Energy costs</td>
<td>✔</td>
</tr>
<tr>
<td>F. Sustainability</td>
<td>✔</td>
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Values escalate exponentially with integrated controls
Installation Cost / Complexity / Risk / Energy Savings

Up to 80% energy savings

VS.

Sensor Acquisition and Installation
VFD Mounting and Wiring
Harmonic and RFI Filtering
Thermistors and Space Heaters
Energy and Flow Metering
Grounding Rings
Modern Technology – Intelligent Pumps

- Unit including pump/ motor and continuous control can include
  - Components matched and tuned together
    - More efficient than pump, drive and control meeting on site
  - Sensorless control built in
  - Flow, head and energy consumption read out for optimization
  - Exchange information with BMS / internet
  - 25% of cases motor / control one size smaller than traditional (i.e. 25hp (18.5kw) vs 30hp (22kw))
    - Saves cost and energy
  - Harmonic and RFI mitigation
  - Soft start
  - Designed and selected for part load operation
  - Minimize energy use over load profile
  - Self diagnostics
  - Performance management

All major commercial building pump vendors have versions of this today.

They are available from 1 (.75kw) to 1250hp (950kw).
Design Envelope Installed Cost Savings

Traditional
Space: 100%
Installed cost: 100%
Risk: 100%
Energy: 100%

Dual casing Design Envelope
Space: 26%
Installed cost: 39%
Risk: 50%
Energy: 43%
Cost / Carbon Footprint – Sizing for 100% standby vs 2 x 50% in Parallel

One pump provides 75% of flow and 95% of heat transfer
Exceeding ASHRAE 90.1 (70% energy savings at 50% flow)

Traditional, Wall Mount VFD

- Design point: 72%
- Average load: 68%

Design Envelope Pump

- Design point: 68%
- Average load: 74%

**Benefit** - can save **7%** in pump cost and **14%** in energy costs
**Major Components**

1. Motor (ODP / TEFC)
2. Bracket / Pedestal
3. Motor Shaft
4. Split Spacer Coupling (flexible on Horizontal)
5. Pump Shaft
6. Mechanical seal
7. Seal flush connection
8. Impeller - Dynamically balanced
9. Casing
10. Pump inlet
11. Reinforcing rib
Casing & Mechanical Components

- **Materials**
  - Casings are typically cast iron (Gray or Ductile) for HVAC. Bronze and stainless steel are also used; though not as often
  - Grey iron standard, Ductile high pressure, bronze / SS for potable water

- **Impellers**
  - Typical is bronze
  - Due to reduction in cost moving to stainless Steel.

- **Mechanical Seals**
  - Prevent leakage of fluids around rotating shaft ingestion
  - Most common is silicone Carbide on Carbon, Silicone Carbide on Silicon Carbide for Gycol.

- **Ball bearings**
  - Support rotating shafts
  - Vertical – motor only
  - Horizontal – motor plus pump
Why have Throttling ability in Variable Flow System?

Triple duty valves
- 90° elbow when needed
- Isolates pump
- Check feature
- Throttle AVAILABLE if system is outside pump operation
  - Reducing speed will not achieve this
  - Use on all pumps

A = Design Point
B = Actual Site Duty Point
C = Reduced Speed without throttling
D = Reduced Speed with Throttling
Traditional variable flow systems with dP zone sensor

Typical dP zone sensor locations

- Most Remote Load
- Other Remote Load
- Mechanical Room
Sensor location in the mechanical room

Minimum Head equates to sensor setting across the pump in traditional systems.
Sensor location at remote load

Minimum Head equates to sensor setting at remote load piping leg in traditional system

A  Design Point
B  Minimum Head
Sensorless Control

Algorithm embedded in controller that equals / exceeds performance of sensor

Sensorless control can also provide a constant flow
Commissioning Basics

- Verify Power is available to the pump/Drive.
- Check the pump installation for proper mounting per I&O manual.
- Confirm if the start command is to be hardwired from the BAS, or communication protocol if applicable.
- Confirm there is water on the system and the flush line has been purged.
- Bleed the pump seal flush line to verify no air is locked inside.
- Verify alignment for base mounted pumps
- Check piping system valves can be opened to simulate a maximum load condition.
Wire and Program the Drive on Wall

- Identify the control method of the pump. BAS protocol (If supported by the drive), Sensor feedback (either DP or PT), External Signal (0-10V/ 4-20ma), Potentiometer, Speed override, etc.
- Verify installation of the VFD to the pump motor, considering length of wiring within specs to avoid harmonics losses.
- Check correct starting and speed reference signals.
- Program the drive with motor parameters and limits
  - HP
  - RPM
  - FLA and Service Factor
  - Efficiency
  - Power Factor
Wire and Program the Drive on Wall

- Program the Drive with the maximum speed of the application.
- Scale external signals accordingly to match the speed maximum speed of the application.
- Start the pump and test the control method for proper performance. At this point it might be required to have a balancer on site, or external sensors to determine DP across the pump, required flow, etc.
- Confirm the Pump can reach to design conditions, or can satisfy the system at max load.
Commissioning Intelligent Pumps

- Identify the application of the pump and, if necessary select the pre-configured program. Pumps are typically shipped properly pre-configured.
- With all valves open, manually ramp the pump to design speed. This will help identify if the actual system conditions match the pump design. A Sensorless readout should be given at this point. No need for external sensors to identify or measure the flow & head.
- If the sensorless readout match the design values, the commissioning should be done at this point! By simply placing the package in AUTO mode, it should find its way to setpoint.
- If system resistance does not match the design, the already pre-configured pump curve set points of the package may be adjusted to maximize efficiency. For smaller installation the preset controls may be left. This is usually done by changing the Design Pressure at Design Speed, and the minimum pressure at no flow. (so basically 3 settings). (Auto balancing can be a feature in an intelligent pump)
- Once the new curve has been adjusted (if required) place the package in AUTO mode and it should find its way to set point.
Links

- Design Envelope Pump I&O link:

- Design Envelope Commissioning Procedure Link:
Pump Performance Management

- On board wireless connectivity for all DE new generation pumps (Q4 2017)
  - Direct connect to pumps on site – ease of data access for user
- Secure cloud computing via the Internet
- Flow, head, power, speed, run time, manual override status, vibration detection, and diagnostics for warnings and alerts
- Alerts and warnings via SMS or E-Mail (user preference)
- Data storage on the cloud for - 5 years of data at 5 minute intervals
- Trending with multiple pumps and data combinations
- Central performance management center
- Downloadable quarterly performance reports
- Firmware updates

- Maintains Commissioned Performance
  - Armstrong performance manages over 100 plants
    - 50% of them have found the pumps in hand for extended period
    - Most have major problems with flow metering over time