Why Pump Style Matters in Modern HVAC System Design

The advantages of base-mounted pumps in commercial installations

BY JAI JAYARAJ
Photos courtesy of Xylem Inc.

When designing an HVAC system for commercial building applications, engineers and contractors need to consider more than just pumping capacity when selecting the type of pump to use. Operating and energy costs, system reliability and longevity, along with the ability to maximize the footprint of the total installation should be evaluated when choosing between vertical inline or base-mounted pumps.

The way for engineers and facility operators to make the best choice of a pumping system that delivers on the building owner’s objectives of keeping costs to a minimum and leasable space to a maximum is to consider the HVAC system as a whole—and how each system component contributes. From that foundation, it is useful to examine the real benefits and a cost analysis of both vertical inline (VIL) and base-mounted pumps.

Footprint considerations
There is a general misconception in the market that the installed footprint of VIL pumps is much smaller than base-mounted pumps. Although this can be true in some smaller horsepower applications, such as boiler pumps (a smaller hydronic system), it doesn’t necessarily apply across the board.

It’s important to think about the footprint of the total installation, instead of solely the pump itself. Using this approach, any space advantages of installing VIL pumps becomes negligible.

Smaller VIL pumps mounted in the piping can create some space savings, but overall, base-mounted pumps are the better choice for applications invol-
drive combinations. The National Electrical Code (NEC) calls for 3-4 feet of clearance in front of the drive. This decisively negates any significant space advantage for VIL pumps in the context of the complete installation.

**Accounting for pump vibrations**
The rotating elements within a pump cause vibration. Both base-mounted and VIL pumps have motors and impellers that rotate, and both pumps are designed and manufactured to the same vibration standard (ANSI/HI 9.6.4). Further, ANSI/HI 1.1-1.5, *Centrifugal Pumps, for Nomenclature, Definitions, Application & Operation*, cites seven possible sources of vibration in pumps:

- Recirculation radial forces at low flows;
- Fluid separation at high flows;
- Cavitation due to NPSH problems;
- Air entrainment or aeration of the liquid;
- Hydraulic resonance in the piping;
- Solids contained in the liquid;
- Wear of rotating components.

A closer review of the ANSI/HI standard shows that base-mounted pumps are able to handle more vibration than VIL pumps (per ANSI 9.6.4-2000). Inline pumps send their vibration into the system piping and ultimately the building structure. Base-mounted pumps, typically attached to the ground, send their vibration into the earth, which can extend its equipment life up to twice that of VIL pumps (per the ASHRAE 2015 Handbook and U.S. Department of Energy).

Vibration challenges must be managed based on the location of installation and horsepower required to fit the application.

Inertia bases are necessary for pumps that are not installed on the ground floor to help absorb vibration. Base-mounted pumps installed on the ground floor only require a housekeeping pad. VIL pumps can be installed without an inertia base where the mass of the pumps, piping and water is relatively small and the...
of factors, including mechanical seal replacement and whether or not a pump has true back pullout capability, enabling the pump to be serviced without disturbing the piping. An example of this is a centrifugal end suction pump, which also doesn’t need the motor to be moved for any maintenance activity. While it is true that mechanical seal replacement in VIL pumps may be considered easy, seal replacement is not total service. Total service also comprises replacement of the throttle bushing, impeller and pump shaft. The motor must be completely removed; requiring ample space and often cumbersome hoisting equipment even with a relatively small pump.

Installation costs
While VIL pumps are typically the more cost-effective choice over base-mounted pumps, the nature of the VIL system dictates that more equipment is often needed to provide the appropriate pump support and vibration mitigation.

An example of this is apparent in the ANSI Effect of Rigidity (Article 1.4.6.1.3.6): “… conventional horizontal split-case pumps (i.e., base mounted) are more rigid than vertically mounted pumps,” which means that they “become part of (the) structure (building).” Conversely, VIL pump installations are inherently flexible and may require additional support, such as isolation pads, flex connectors, heavier pipe flanges and piping to support the weight of the system. This additional equipment offsets the cost of the housekeeping pad for a base-mounted pump, and in some instances exceeds the cost of the housekeeping pad.

For pumps 7.5 hp or less, VIL installations can cost less than base-mounted pumps and in some cases are more practical; however, in midsize and larger pump applications, like large chilled water pumps or condenser water pumps, base-mounted installations are much more cost-effective.

Ease of pump service and maintenance
Ongoing pump maintenance is based on a number
can pose a safety hazard for technicians to work on a large VIL pump between two others that continue to operate at full speed. One pump may need to be shut down, forfeiting redundancy and risking adequate capacity. Alternatively, service access in a base-mount installation is straightforward and safer because of the layout of the system enables easier access.

**Pump life expectancy and reliability**
Base-mounted pumps have greater reliability, extending the product’s life. The mechanical seals in VIL pumps need external flushing tubes that are vulnerable to damage and can plug over time, leading to premature seal failures and lower pump life expectancy. Base-mounted pumps have internal flushing capability that passes up to three times more flow over the seal faces, helping reduce the seal temperature and extend seal life.

In addition, some base-mounted pumps have two sets of bearings, one set for the thrust and radial load and one set for the motor, reducing wear and tear. VIL pumps have only a motor bearing, which must do double duty, reducing life expectancy. The ASHRAE Equipment Life Expectancy Chart bears out the superior longevity of base-mounted pumps.

**Making the selection**
In choosing the best pumps for commercial building HVAC systems, building designers, owners and contractors should explore several key factors that affect performance, reliability and long-term ownership cost. Companies with an extensive background in manufacturing, an expansive representative network and large installed base, are good companies for professionals to consider when making the decision about the most efficient and cost-effective pumping system for their buildings.

<table>
<thead>
<tr>
<th>Pump Type</th>
<th>Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-mounted</td>
<td>20 years</td>
</tr>
<tr>
<td>Pipe-mounted (VIL)</td>
<td>10 years</td>
</tr>
<tr>
<td>Sump and well</td>
<td>10 years</td>
</tr>
<tr>
<td>Condensate</td>
<td>15 years</td>
</tr>
</tbody>
</table>

Table 2
Life expectancy of base-mounted pump vs. pipe-mounted (VIL) pumps (per ASHRAE)

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