**Pumps: The Heart of HVAC**

*Proper maintenance remains essential for efficient pump operation, but new technologies offer managers greater opportunities to control costs*

**By James Piper**   [HVAC](https://www.facilitiesnet.com/hvac)

The centrifugal pump has long been the workhorse of HVAC systems, supporting the operation of chillers, boilers, cooling towers, domestic water systems, and hydronic distribution systems. And while practically every other component in an HVAC system has been greatly modified to meet ever changing requirements for efficiency and reliability, centrifugal pumps have not changed very much.

That does not mean today’s centrifugal pumps are the same as those of 20 years ago. Manufacturers have made significant improvements in impeller designs, construction materials, bearing and seal designs, and couplings. But these changes have been more evolutionary than revolutionary.

As a result, many managers simply overlook the pump as an opportunity to improve the performance and reliability of HVAC systems. Building designers replicate designs used in the past in new building designs or renovation plans. System operating practices simply follow past tried and true practices. And when pumps fail, technicians replace them with new ones with the same characteristics.

The situation is changing today. Many advances that have affected other areas of building HVAC operation are being applied to pumps and their operation. As a result, engineering and maintenance managers can achieve levels of operating efficiency that were unheard of as recently as 10 years ago. And while improved operating efficiency is a primary benefits of today’s pump installations, it is not the only one. System performance has improved. Reliability has increased. Maintenance requirements have been reduced.

**Improving Pump Efficiency**

The overall efficiency of any pump used in a building HVAC system is determined by a number of factors, including:

* the efficiency of the pump and motor
* the efficiency of the pump control
* how well technicians maintain the pump and its related components.

New pump designs and high-efficiency drive motors can improve operating efficiency. For example, by replacing a pump motor with a high-efficiency model, managers can achieve a reduction in energy requirements of 1-5 percent. Similarly, installing a high-efficiency pump can reduce energy requirements 1-3 percent. While these efficiency improvement numbers are relatively small, the typical annual hours of operation for many pump applications can make the resulting savings very significant.

While using higher-efficiency pumps and motors will improve operating efficiency somewhat, the greatest improvements in efficiency come from new designs of pump controls. Traditional pump installations use constant-speed pumps. Technicians use building, balancing, throttle or bypass valves to reduce flow when demand is low or to balance the flow to different areas of the building.

These valves restrict the flow of water through the end device, but the pump still uses the same amount of energy to operate. Also, technicians tend to set these valves and forget them. Conditions and loads change in a building, but the valve setting remains the same.

An alternative to throttling flow that improves both performance and energy efficiency is the use of variable-frequency drive (VFD). VFDs have slowly gained acceptance in use with building HVAC pumps because of their ability to effectively control the operation of a pump over a wide range of flow requirements, while also significantly reducing the energy requirements for the pumping system.

For example, as control valves cut back on the flow of water through terminal heating or cooling devices, the control system senses the reduced flow requirement and directs the VFD to reduce the pump speed to match the conditions found. Since the vast majority of systems operate at loads below peak capacity 95 percent of the time or more, VFDs can greatly reduce pumping energy requirements. In a typical HVAC application, pump energy savings typically are 20-50 percent annually.

**Enter the Intelligent Controller**

While VFDs can greatly improve the energy efficiency and control effectiveness of pumping systems, manufacturers have developed a new generation of controls that goes even further. This new generation of pump controls — intelligent pump controllers — offers improvements in pump reliability while further improving system performance.

Intelligent controls can better adjust to system load changes, better control pump operations, and provide control over a wider range of load conditions, and produce smoother pump startups.
Intelligent controllers also use VFDs to regulate pump speed, but they do so not as a standalone device, but as another element in the overall building automation system. By connecting the pump and its controller to a digital field bus, data from the pump and its sensors can integrate into the system. Software monitors the operating conditions and identifies conditions that are outside normal operations and those that could damage the pump.

For example, if the flow to a pump is restricted, the flow rate through the pump decreases. A conventional VFD control systems then signals the pump to increase its speed, possibly resulting in cavitation, a condition that can rapidly damage pump components. In contrast, an intelligent pump controller detects cavitation condition, notifies the operator of the situation, and — if programmed to do so — reduces the flow rate sufficiently to prevent cavitation without shutting down the system.

Cavitation is just one condition that intelligent controllers can detect. Operators can program the software to detect abnormalities, from sticking control valves to system leaks. Technicians can use the system to identify recurring or intermittent problems that otherwise might go undetected.

**Don’t Overlook Maintenance**

No matter how advanced the control system or how good the design, pump systems will operate effectively and efficiently only if managers schedule maintenance properly. Too often, though, they ignore maintenance until something goes wrong.

The resulting costs from pump repairs and disruption to building operations typically exceed the cost of ongoing pump maintenance by a factor of 10 or more. Maintenance activities and the frequency with which they must be performed vary with the capacity of the pump and the nature of the load that it is serving.

One of the most important maintenance tasks is to pay attention to a pump’s operation. Does it look and sound normal, or has it developed unusual sounds or vibrations? Louder-than-normal or unusual sounds can indicate a range of problems, from misalignment and bad bearings to cavitation.

A small leak rate at pump seals is normal, but a sudden flooding of the area near pump shafts indicates that a seal has failed and needs replacing. Excessive heat can indicate a failing bearing or a motor that might need replacing. By checking the pump regularly, maintenance technicians can identify pump problems early, reducing repair costs and disruptions to operations. Although it might be too late to prevent having to overhaul or replace the pump, at least the maintenance department, rather than the pump itself, will be able to pick the time when the pump is out of service.

Beyond periodic checks on pump operations, maintenance personnel should follow the manufacturer’s recommended schedule of maintenance activities. But these are the minimum maintenance requirements. Pumps serving critical applications in a building will require additional maintenance activities if they are to enhance system reliability.

A successful pump installation requires that managers change their ways of thinking about pumps. Sticking with old design and operating practices will prevent the system from operating as efficiently and reliably as it could, and waiting to adopt new technologies that are available means missed opportunities to ensure smooth building operation and enhanced energy efficiency.

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| **Finding Failure**Even with proper maintenance, pumps fail. When they do, instead of simply replacing or rebuilding the existing pump, maintenance and engineering managers should take the time to determine the cause of the failure.Pump failures fall into four general categories:* a defective pump
* a poor application design
* improper maintenance
* poor operating practices.

Unless managers and technicians determine the cause of the failure, it will be impossible to ensure that the failure will not be repeated with the new pump.For example, if a pump fails because of contamination in the circulating fluid, replacing the pump without taking steps to remove the contaminants will only result in the premature failure of the replacement pump. Similarly, if a pump fails due to stress induced by thermal expansion and contraction in the piping system, the replacement pump also will fail unless technicians properly install expansion joints at the pump connections.*— James Piper* |

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