6 Basic Rules of Pump Piping Design

Why users need a piping expansion joint.

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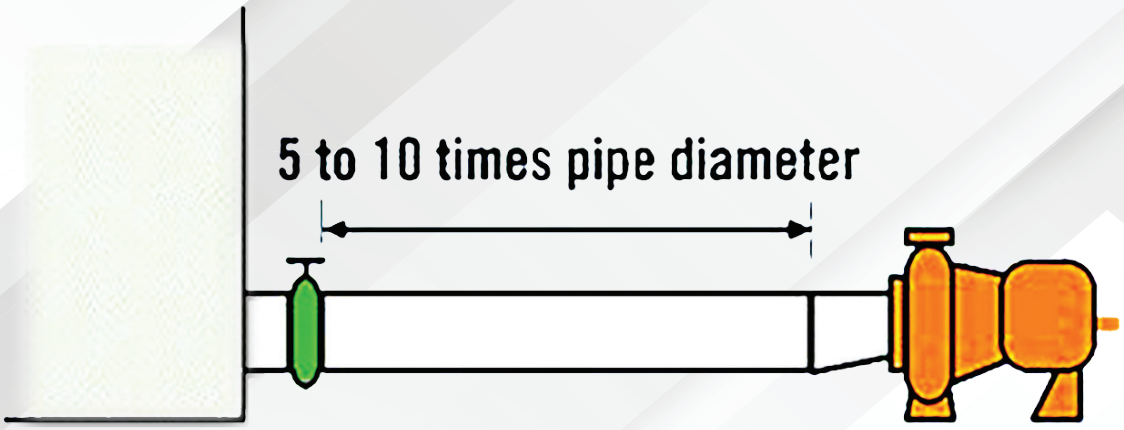

IMAGE 1: The pipe diameter on the suction side should be equal to or one size larger than the pump inlet. (Image courtesy of Crane Engineering)

Installing a new centrifugal pump? After carefully selecting the right size and materials, make sure the new pump is set up for success with proper installation. Setting the base correctly and aligning the pump is crucial. It is also important that piping to the pump is done properly.

Pump piping design is sometimes overlooked when setting up new installations. The focus is more on the equipment than the pipes that supply it. However, when installed with inappropriate piping arrangements, pumps can experience premature and repeated failures during the life of the pump. Maintenance teams will regularly repair the pump, effectively treating the symptom instead of the true problem.

Knowledge and resources are limited on this topic, except what is found in the installation, operation and maintenance (IOM) manual (which is minimal). But by following these six simple rules, users can avoid premature pump failure and related pump piping pitfalls.

1 Keep Suction Piping as Short as Possible

Include a straight-run pipe length equal to five to 10 times the pipe diameter between the pump inlet and any obstruction in the suction line. Obstructions include valves, elbows, "tees," etc.

Keeping the pump suction piping short ensures that the inlet pressure drop is as low as possible. The straight-run pipe gives users a uniform velocity across the pipe diameter at the pump inlet. Both are important to achieving optimal suction.

2 Pipe Diameter on Suction Side Should be Equal or One Size Larger Than Pump Inlet

Pipe sizing is a balancing act between cost and friction loss. Larger pipes cost more, whereas smaller pipes impose greater friction losses on the system. In terms of diameter, discharge pipe diameter should normally match the discharge flange on the pump but can be larger to reduce friction losses and decrease system pressure.

On the suction side, the diameter can be the same size, but often engineers select a size or two bigger, thus requiring an eccentric reducer.

Larger suction piping on the suction side is usually preferred if the liquid viscosity is greater than water. This also helps produce an even flow to the pump and avoid cavitation.

3 Use Eccentric Reducers on the Suction Side

Consider using eccentric reducers on the suction side of the pump when a pipe size transition is required. Install the flat side of the reducer on the top when fluid is coming from below the pump. If the fluid comes from the top, the flat portion of the reducer should be mounted on the bottom of the pipe. The flat portion is designed to discourage an air pocket from forming at the pump suction.

4 Eliminate Elbows Mounted on or Close to the Inlet Nozzle of the Pump

Include five to 10 pipe diameters of straight-run pipe between the pump inlet and elbow. This helps to eliminate the "side loading" of the pump impeller and creates uniform pump axial bearing loading.

5 Eliminate Potential for Air Entrapment in the Suction Piping

Maintain adequate levels in supply tanks to eliminate vortices from forming and air entrapment. Avoid high pockets in suction piping, which can trap air. Keep all pipe and fitting connections tight in suction vacuum conditions to prevent air from getting into the pump.

6 Ensure the Piping Arrangement Does Not Cause Strain on the Pump Casing

Pumps should never support the suction or discharge piping. Any stress on the pump casing by the piping system greatly reduces pump life and performance.

Keep in mind that increasing the performance of the pump will help to make up for piping mistakes made on the discharge side of a pump. Problems on the suction side, however, can be the source of repetitive failures, which could cause problems for years to come if not addressed appropriately. Suction side piping problems cause the majority of pump issues.

Piping design is an area where basic principles are frequently ignored, resulting in increased vibration and premature failure of the seals and bearings. Incorrect piping has long been disregarded as a reason for these failures because of the many other reasons this equipment can fail. Many experienced engineers may argue that pumps with incorrect piping still function and operate as they should. This argument, although valid, does not make questionable piping practices correct.

Why You Need a Piping Expansion Joint

The same pump failed again. A manufacturer experienced repeated failures on the same pump, and even though the pump had been properly repaired, installed and aligned, it still experienced chronic vibration issues.

A closer look determined that the vibrations were not being emitted from the pump, instead it was being affected by vibrations from other equipment as it traveled along the pipes. What can be done to stop rogue vibrations from affecting the pump? A piping expansion joint might help.

What Is a Piping Expansion Joint?

An expansion joint is installed in piping systems for a couple of reasons. They can be used to absorb vibrations and shock and to relieve anchor stress, reduce noise and compensate for misalignment. Certain expansion joints are also designed for thermal expansion in hot applications. Expansion joints allow pipes to move in three different ways: axial compression or extension, lateral offset or angular deflection.

They typically come in three different materials to cover a variety of applications.

Metal: Metal expansion joints are mostly used in applications where thermal expansion is an issue. When the temperature of the pipe increases, the metal expansion joint compresses to compensate for the movement, taking stress off the anchors and the pipe. A metal expansion joint is a prime example of how to handle expanding hot pipes.

Rubber: Rubber can be used for thermal expansion, and it also absorbs vibration and shock waves well. That is why this type of expansion joint is great for minimizing the transmission of noise, vibration from other equipment to protect equipment like pumps. They also work as shock absorbers to minimize trauma caused by water hammer, pressure surges and seismic events.

Braided: Braided stainless hoses with flexible or metal liners are not technically an expansion joint, more of a flexible connector. They work well in high pressure and temperature applications requiring vibration dampening or pipe misalignments. These are often used on pumps and other equipment to help eliminate thrust load on the equipment nozzles due to thermal expansion. Eliminating that load is critical to pump performance. Braids provide lateral and angular movement. They also absorb vibration.

The entire process is intertwined, and each piece affects the next. Having a reliable piping system is key to a process that maximizes uptime. Carefully managing a piping system will keep the pipes in great working condition and also extend the life of the equipment attached to them. ■