PITFALLS OF PUMP PIPING

by ***Ross Mackay***

There are three major problems associated with poor pump piping.

1. There is a scarcity of accessible information available on the topic.
2. No one pays any attention to it when installing a pump.
3. It can remain undetected and cause repetitive pump failures for many years.

As a consequence of 1 and 2 above, most pumps are piped up incorrectly. In fact when we look at the way many pumps have been installed, it resembles a "plumbers nightmare." Many pumps appear as if they've been squeezed into a corner out of the way, and the pipes threaded in and out, without any consideration for fluid flow patterns.

There will be many who read this column and realize, to their horror, that some of the most problematic pumps in their plant don't follow any of the basic rules of pump piping. Why?

Let's Get Practical! If you were installing a new pump in a new system, where would you go for information on how the pump piping should be arranged?

Most of us would refer to the pump's Installation, Operation and Maintenance (IOM) Manual. Unfortunately, that won't provide a lot of information, as most of the pump companies used to subscribe to an attitude of limiting their responsibility within the confines of the suction and discharge nozzles of the pump.

Although this attitude is fast disappearing, the change has not yet reached most of the IOM Manuals. As a consequence, accurate and complete information is still severely limited, and a high proportion of the pumps in most industries are installed with inappropriate piping arrangements that result in premature failure.

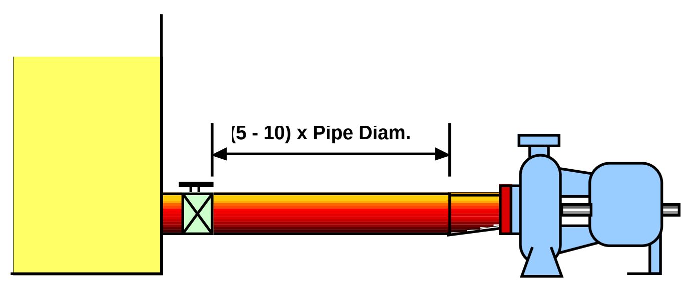
The major problem with this condition is that it positions the root cause of the pump failure outside the physical confines of the pump itself, thus making it difficult to source for the unwary and inexperienced.

The "pitfalls of pump piping" easily can be avoided by following a few straightforward rules.

Rule No. 1

Provide the suction side with a straight run of pipe, in a length equivalent to 5 to 10 times the diameter of that pipe, between the suction reducer and the first obstruction in the line (Fig. 1).

This will ensure the delivery of a uniform flow of liquid to the eye of the impeller, which is essential for an optimum suction condition. (The experienced engineer will note that this contradicts the information given in most IOM Manuals, where it states that the suction piping should be "as short as possible.")



Rule No. 2

The pipe diameter on both the inlet and the outlet sides of the pump should be at least one size larger than the nozzle itself.

On the horizontal inlet side, an eccentric reducer is required to reduce the size of the pipe from the suction line to the inlet nozzle. By positioning the reducer with the flat side on top as shown in Fig. 1, it eliminates the potential problem of an air pocket in a high point in the suction line. A concentric increaser can be used on the vertical discharge.

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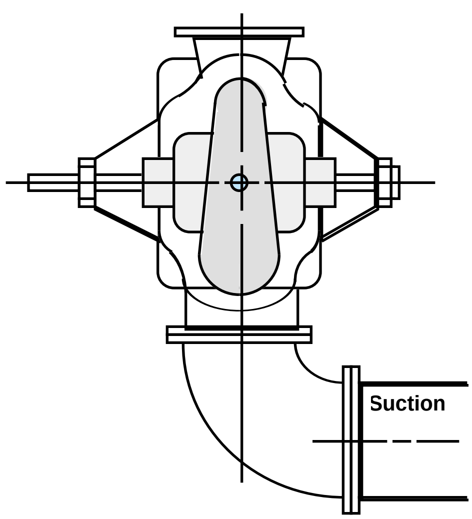
Rule No. 3

Eliminate elbows mounted on, or close to, the inlet nozzle of the pump.

Much discussion has taken place over the acceptable configuration of an elbow on the suction flange of a pump. Let's simplify it. There isn't one!

There is always an uneven flow in an elbow, and when one is installed on the suction of any pump, it introduces that uneven flow into the eye of the impeller. This can create turbulence and air entrainment, which can result in impeller damage and vibration.

The problem is even greater when the elbow is installed in a horizontal plane on the inlet of a horizontal double suction pump as shown in Fig. 2. This configuration introduces uneven flows into the opposing eyes of the impeller, and essentially destroys the hydraulic balance of the rotating element.



Under these conditions, the overloaded bearing will fail prematurely and regularly if the pump is packed. If the pump is fitted with mechanical seals, the seal will usually fail instead of the bearing--but just as regularly and often more frequently.

When it is absolutely essential to position an elbow on the inlet of a double suction pump, it must be located at right angles to the shaft.

The only thing worse than one elbow on the suction of a pump is two elbows on the suction of a pump--particularly if they are positioned close together, in planes at right angles to each other. This creates a spinning effect in the liquid that is carried into the impeller and causes turbulence, inefficiency and vibration.

Rule No. 4

Eliminate the potential for vortices or air entrainment in the suction source.

If a pump is taking its suction from a sump or tank, the formation of vortices can draw air into the suction line. This usually can be prevented by providing sufficient submergence of liquid over the suction opening. A bell-mouth design on the opening will reduce the amount of submergence required. This submergence is completely independent of the NPSH required by the pump.

Great care should be taken in the design of a sump to ensure that any liquid emptying into the sump does so in such a manner that air entrained in the inflow does not pass into the suction opening. Any problem of this nature may require a change in the relative positions of the inflow and outlet if the sump is large enough, or the use of baffles.

Rule No. 5

Arrange the piping in such a way that there is no strain imposed on the pump casing.

Piping flanges must be accurately aligned before the bolts are tightened and all piping, valves and associated fittings should be independently supported without any strain being imposed on the pump. Any stresses imposed on the pump casing by the piping reduces the probability of satisfactory reliability and performance.

As there is an exception to almost every rule, the A.P.I. 610 Specification identifies a maximum level of forces and moments that may be imposed on the pump flanges. These must be acceptable to any pump being sold into the petroleum industry, or any related industry, using that specification. As a consequence, all API. pumps are of a much more robust and heavier design than their ANSI size equivalents.

Conclusion

Piping design is one area where the basic principles involved are frequently ignored, resulting in problems such as hydraulic instabilities in the impeller, which translate into additional shaft loading, higher vibration levels and premature failure of the seal or bearings. As there are many other reasons why pumps could vibrate, and why seals and bearings fail, the trouble is rarely traced to incorrect piping.

It has been argued that because many pumps are piped incorrectly, yet are operating quite satisfactorily, piping procedure is not important. That doesn't make a questionable piping practice correct, it merely makes it lucky.

Any piping mistakes that are made on the discharge side of a pump, frequently can be accommodated by increasing the performance of that pump. Problems on the suction side however, can be the source of repetitive failures, which may never be traced back to that area and could continue undetected for many years to come.

So let's not only get practical, let's stay practical! Follow the rules and eliminate the problems!

Ross Mackay specializes in helping companies reduce pump operating and maintenance costs by conducting training courses in person, and through a self-directed video program.

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