



GUIDELINES FOR PUMP SYSTEM DESIGNERS

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Synopsis

The following is a list of potential problems areas or simply just good design practice that the author has applied and encountered over the years. They deal mainly with piping issues that affect pump performance.

1. Gate valves at the pump suction and discharge should be used as these offer no resistance to flow and can provide a tight shut-off. Butterfly valves are often used but they do provide some resistance and their presence in the flow stream can potentially be a source of hang-ups which would be critical at the suction. They do close faster than gate valves but are not as leak proof.
2. Always use an eccentric reducer at the pump suction when a pipe size transition is required. Put the flat on top when the fluid is coming from below or straight (see Figure 1) and the flat on the bottom when the fluid is coming from the top. This will avoid an air pocket at the pump suction and allow air to be evacuated.

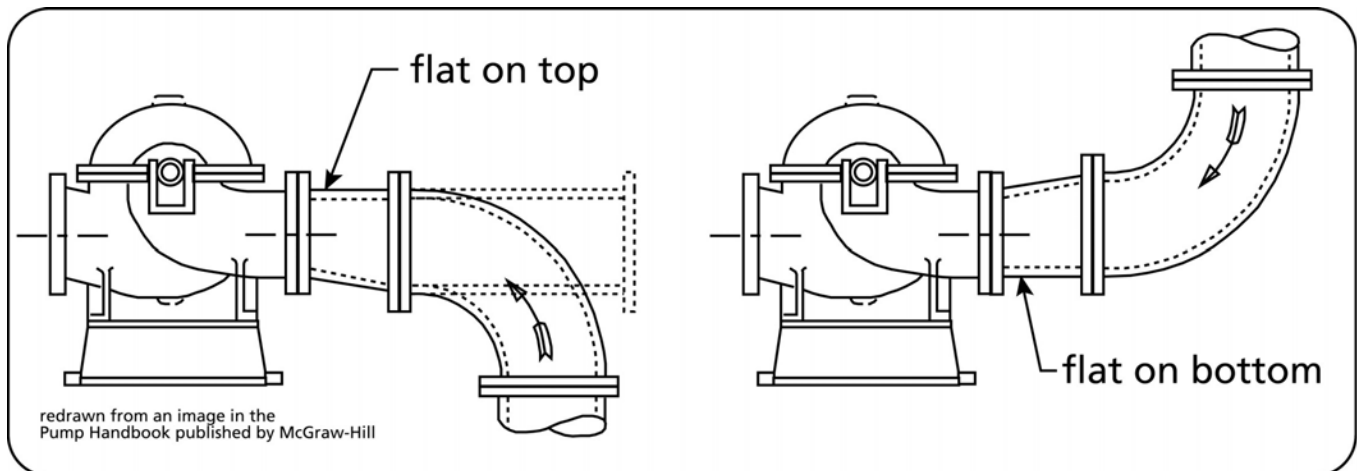


Figure 1 Eccentric reducers at the pump suction (source: the Pump handbook published by McGraw-Hill)

3. Keep the suction line straight and short as much as possible. The primary goal of this guideline is to avoid plugging or obstructing the pump suction, this can also be done by ensuring that there is sufficient pressure and velocity at the pump suction. There are many suction lines that are quite long, in some cases hundreds of feet long such as happens sometimes with pumps that are installed in series. The key is stable flow at the pump suction with sufficient pressure.
4. For new systems, ensure that there is always a half inch threaded tap available near the pump suction and discharge for the future installation of pressure gauges. This will provide the owner with the ability to trouble-shoot the pump in the future.
5. For new systems that do not have a flow meter, install flanges that are designed for an orifice plate in a straight part of the pipe (see Figure 2) and do not install the orifice plate. In the future, whoever trouble-shoots the pump will have a way to measure flow without the owner having to incur major downtime or expense. Note: orifice plates are not suitable for slurries.

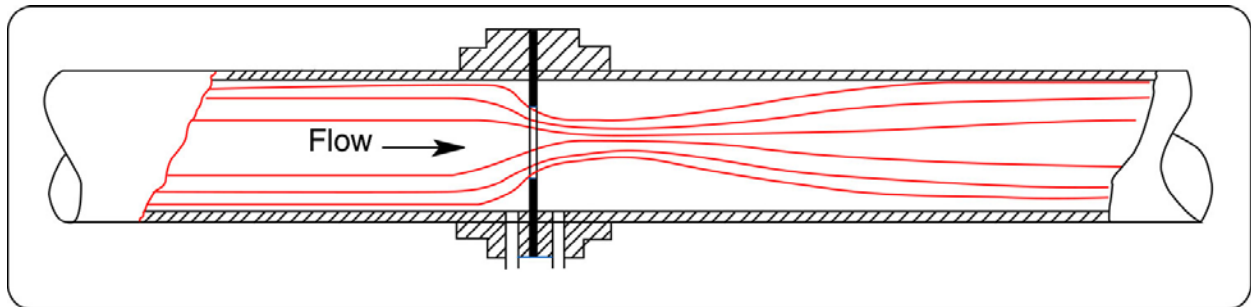


Figure 2 Orifice plate (source: www.orificeplates.com)

6. Insure that the pump inlet pipe is sufficiently submerged to avoid vortex formation which entrains air into the pump suction (see Figure 3).

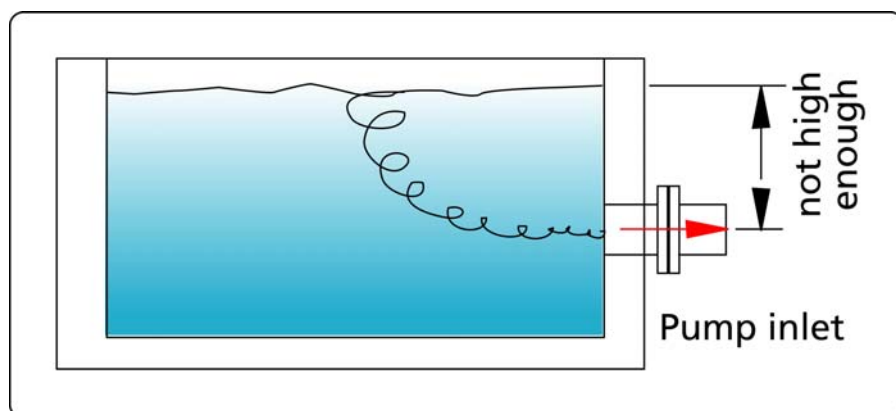


Figure 3 Insufficient submergence height leads to vortex formation.

7. Avoid pockets or high point where air can accumulate in the discharge piping. An ideal pipe run is one where the piping gradually slopes up from the pump to the outlet. This will ensure that any air in the discharge side of the pump can be evacuated to the outlet.
8. Be aware of potential water hammer problems. This is particularly serious for large piping systems such as are installed in municipal water supply distribution systems. These systems are characterized by long gradually upward sloping and then downward sloping pipes. Solutions to this can involve special pressure/vacuum reducing valves at the high and low points or additional tanks which provide a buffer for pressure surges (see <http://www.ventomat.com/default.asp>).
9. Make use of check valves to isolate pumps installed in parallel. If the pump discharge is submerged, always install a check valve at the pump outlet to avoid siphoning when the pump is shut-off, otherwise backwards flow will cause reverse rotation of the impeller.
10. Position control valves closer to the pump discharge outlet than the system outlet. This will ensure positive pressure at the valve inlet and therefore reduce the risk of cavitation.
11. Avoid the use of filters at the pump inlet if at all possible. Their maintenance will often be neglected and the pump will suffer from poor performance and perhaps cavitation.
12. Calculate the level of pressure of the high point in your system (see Figure 4). The pressure may be low enough for the fluid to vaporize and create a vapor pocket which will be detrimental to the performance of the system. The pressure at this point can be increased by installing a valve at some point past the high point and by closing this valve you can adjust the pressure at the high point. Of course, you will need to take that into account in the total head calculations of the pump.

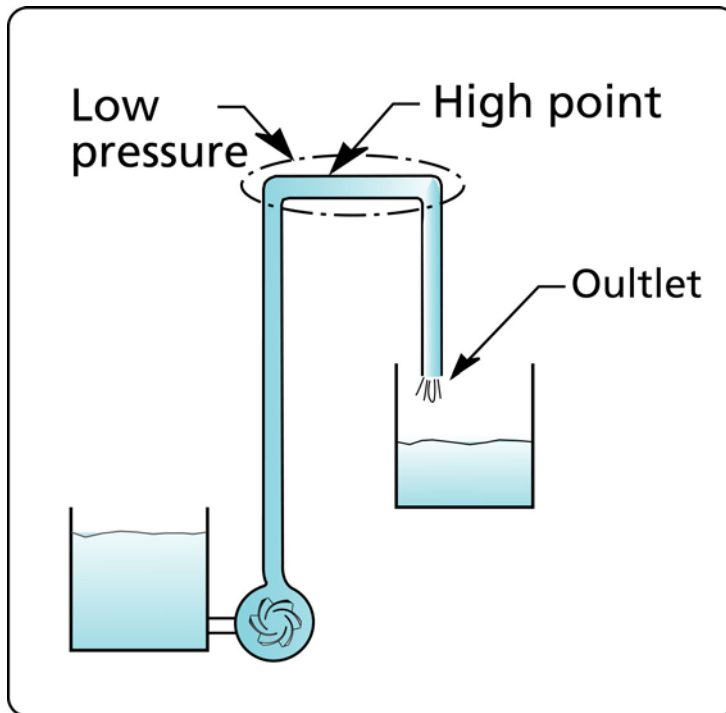


Figure 4 Location of low pressure at a high point in the system.

13. For series pump installations make sure that the pressure rating of the pumps is adequate. This is particularly critical in the case where the system could become plugged due to an obstruction. All the pumps will reach their shut-off head and the pressure produced will be cumulative (see Figure 5). The same applies for the pressure rating of the pipes and flanges.

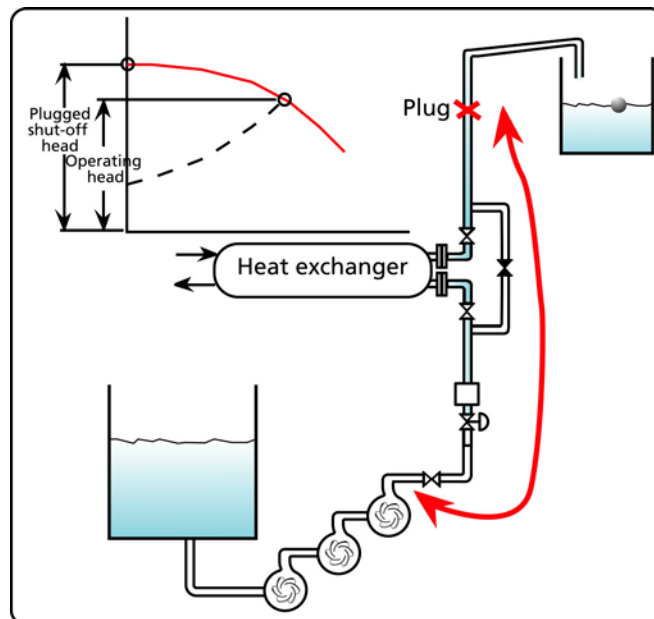


Figure 5 Danger of increased pressure due to a plug in a series pump system.

14. Use a 90° or 45° elbow at the pump's inlet pipe end (see Figure 6). This will allow almost complete drainage of the tank and is especially useful in the case of fluids that can not be readily dumped to the sewers. It also provides additional submergence reducing the risk of vortex formation.

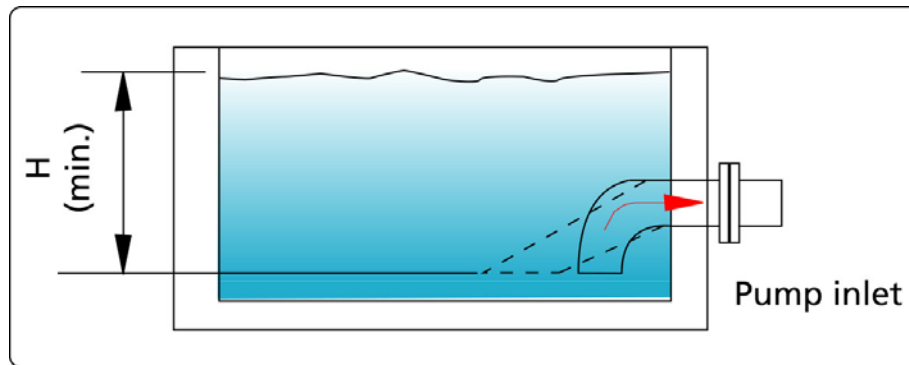


Figure 6 Using an elbow at the pump inlet pipe end.

15. For pumps 500 gals/min or larger use semi-automatic manual valves at the discharge that are controlled to open gradually when starting the pump. This will avoid water hammer during the initial start and damage to the piping system.