CHAPTER FIVE
PIPING DESIGN

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5.1 Introduction

The design of a piping system can have an important effect on the successful operation of a centrifugal pump. Such items as sump design, suction piping design, suction and discharge pipe size, and pipe supports must all be carefully considered.

5.2 Suction & Discharge Piping Design

Selection of the discharge pipe size is primarily a matter of economics. The cost of the various pipe sizes must be compared to the pump size and power cost required to overcome the resulting friction head.

The suction piping size and design is far more important. Many centrifugal pump troubles are caused by poor suction conditions. The function of suction piping is to supply an evenly distributed flow of liquid to the pump suction, with sufficient pressure to the pump to avoid excessive cavitation in the pump impeller.

The Suction pipe should never be smaller than the suction connection of the pump and in most cases should be at least one size larger. Suction pipes should be as short and as straight as possible. Suction pipe velocities should be in the 5 to 8 feet per second range unless suction conditions are unusually good.

Higher velocities will increase the friction loss and can result in troublesome air or vapor separation. This is further complicated when elbows or tees are located adjacent to the pump suction nozzle, in that uneven flow patterns or vapor separation keeps the liquid from evenly filling the impeller. This upsets hydraulic balance leading to vibration, possible cavitation, and excessive shaft deflection. Especially on high and very high suction energy pumps. Shaft breakage or premature bearing failure may result.

On pump installations involving suction lift, air pockets in the suction line can be a source of trouble. The Suction pipe should be exactly horizontal, or with a uniform slope upward from the sump to the pump as shown in Figure 5.1. There should be no high spots where air can collect and cause the pump to lose its prime. Eccentric rather than concentric reducers should always be used, on horizontal installations, with the flat side located on top.

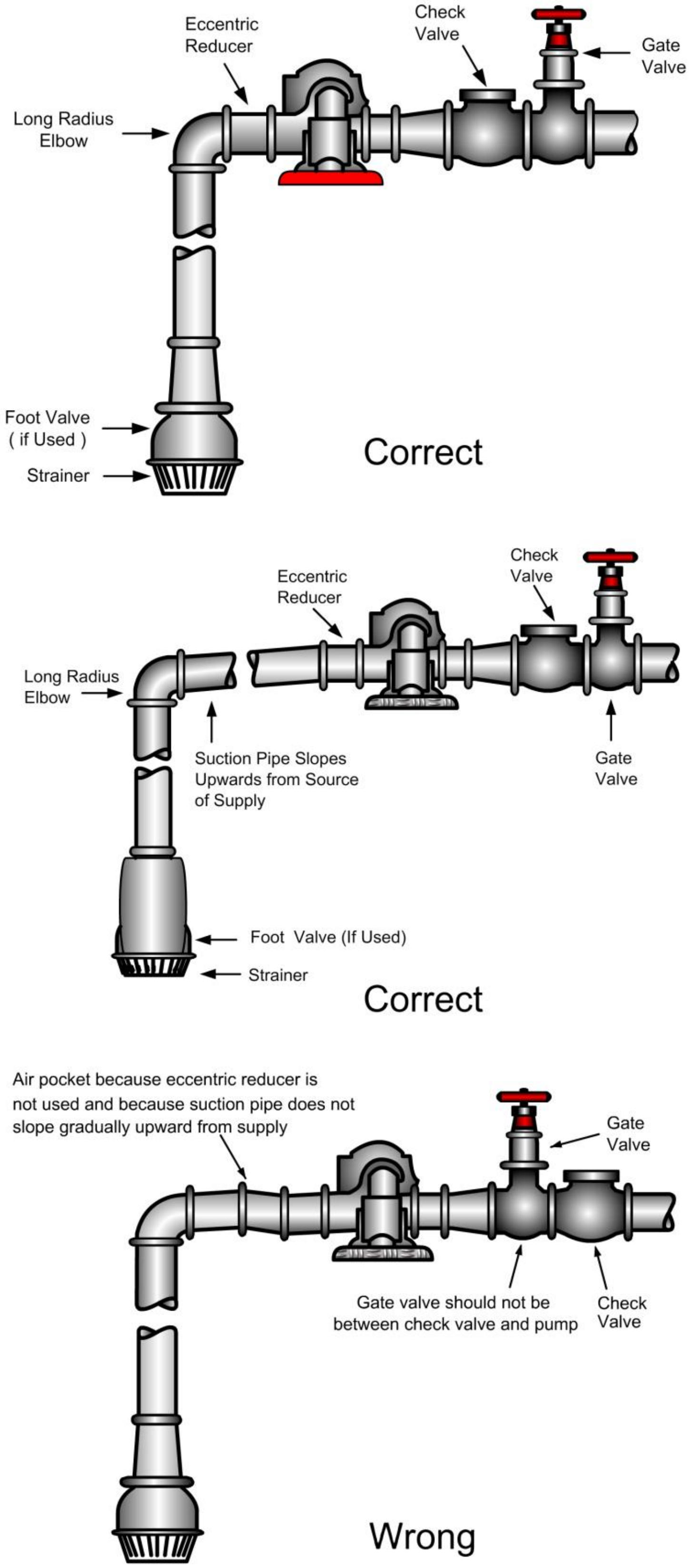

Figure 5.1 – Air pockets in suction piping

If an elbow is required at the suction of a double suction pump, it should be in a vertical position if at all possible. Where it is necessary for some reason to use a horizontal elbow, it should be a long radius elbow and there should be a minimum of three diameters of straight pipe between the elbow and the pump as shown in Figure 5.2 for low suction energy pumps, and five pipe diameters for high suction energy pumps. Figure 5.3 shows the effect of an elbow directly on the suction. The liquid will flow toward the outside of the elbow and result in an uneven flow distribution into the two inlets of the double suction impeller. Noise and excessive axial thrust will result.

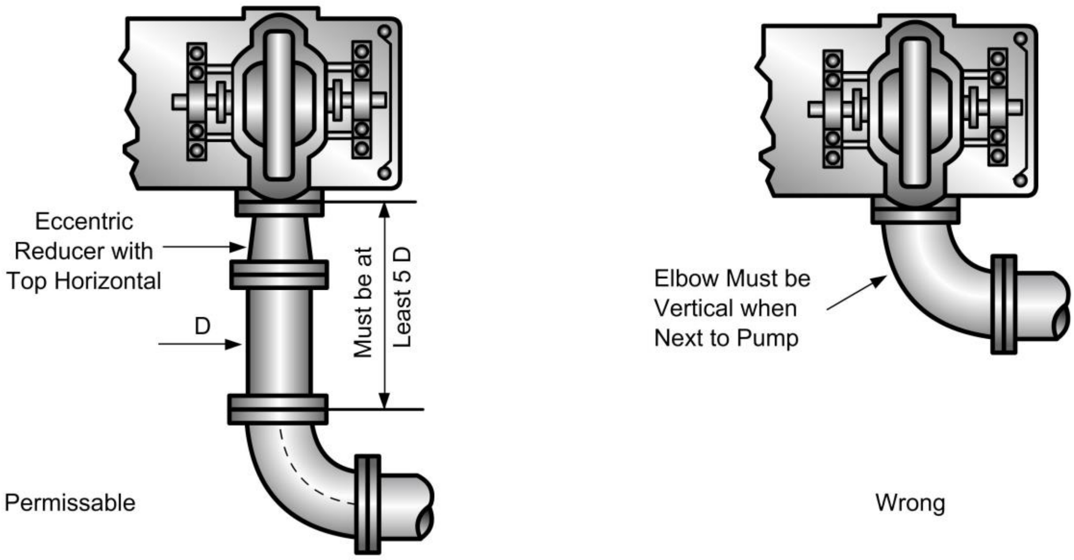

Figure 5.2 – Elbows at pump suction

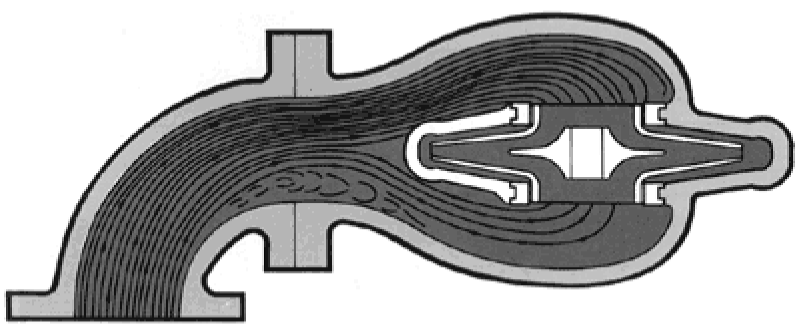

Figure 5.3 – Effect of elbow directly on the suction

5.3 General Considerations

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 the Figure) 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.

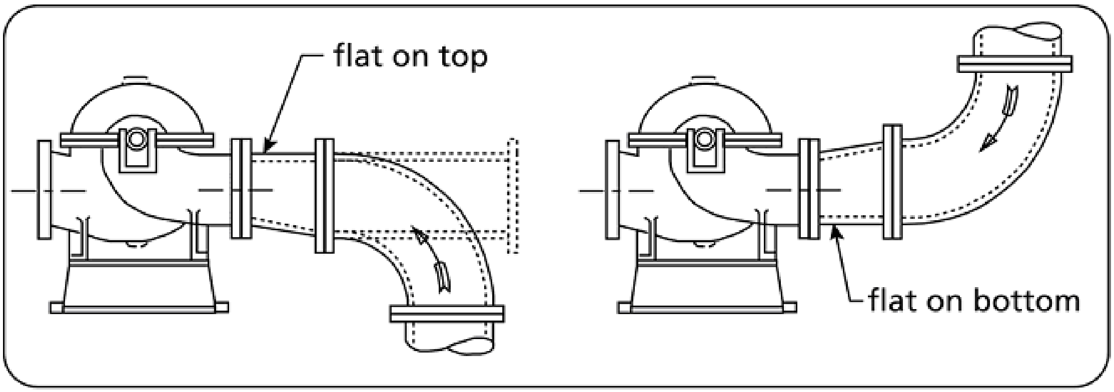

Figure 5.4 – Eccentric reducer at the pump suction

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 may 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 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.

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

5.4 Supply Tank Design

There are several important considerations in the design of a suction supply tank or sump. It is imperative that the amount of turbulence and entrained air be kept to a minimum. Entrained air will cause reduced capacity and efficiency as well as vibration, noise, shaft breakage, loss of prime, and/or accelerated corrosion.

The free discharge of liquid above the surface of the supply tank at or near the pump suction can cause entrained air to enter the pump. All lines should be submerged in the tank, and baffles should be used in extreme cases as shown in Figure 5.4.

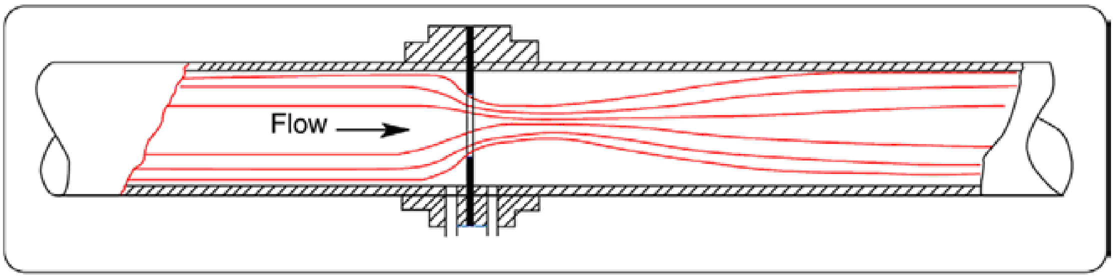

Figure 5.5 – Use of baffles