INTRODUCTION

The Penn Valley Double Disc Pump™ utilizes a unique principle of operation whereby the discs perform the duties of pumping and valving, providing a double acting, non-clogging, pumping action. Through an arrangement of connecting rods and a camshaft, a reciprocating action of the discs is created, forming a large cavity between discs. This cavity is filled and exhausted in a continuous flow. The large, valve-like discs mean that large solids and rags can be handled without loss of the pumping action. The valve-like discs have large seating areas that provide for low internal velocities, extending the pump wear life on abrasive sludge's and slurries. The fluid chamber is sealed with flexible trunnions that eliminate packing, mechanical seals, and requires no flushing water or other forms of lubrication. The large diameter discs are proven to handle large solids, rags, plastics, etc. that would cause other pumps to fail.

Here's how it works:

Suction Cycle (fig. 1)
The suction disc (right) is lifted from its seat creating a vacuum. The cavity between the discs is filled during the reciprocating motion of the suction disc. The discharge disc (left) is seated, creating a seal in the flow path during the suction cycle. A clack valve prevents return flow.

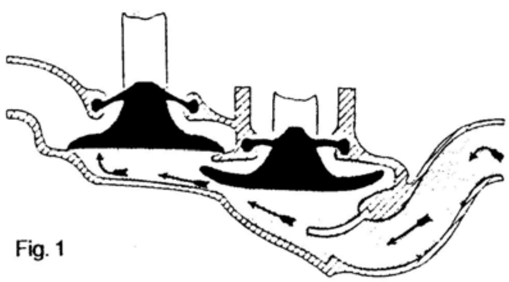

Fig. 1

Discharge Cycle (fig. 2)
The reciprocating action then causes the suction disc (right) to seat and create a seal in the flow path and a downward motion of the discharge disc (left) forces the discharge.

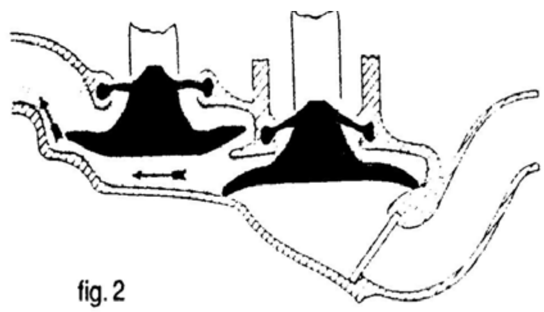

fig. 2

FEATURES

- Double Disc Pumps use a flexing membrane, which achieves the sealing of the fluid chamber. There are no rotating shafts so packing and mechanical seals are eliminated. No seal water required.
- Maintain-in-Place design allows pump to be serviced without disturbing piping
- All Double Disc Pumps can operate dry without fluid chamber damage.
- There are no close-clearances, rotating parts in the fluid chamber to wear on abrasive applications.
- There are no check valves in the suction or discharge that will plug. Double Disc pumps will pass hand towel sized rags.
- There are no reciprocating pistons requiring packing or that will wear on abrasive slurries.
- Double Disc Pumps can operate in either direction of shaft rotation without affecting the pump efficiency.

PIPING and SUPPORTS

***IMPORTANT:* When connecting piping to the pump, the connection should be made with the pipe in a free supported state and without the need to apply vertical or side pressure to obtain alignment of the piping with the pump flanges.**

All piping should be independently supported near the pump so that pipe strain will not be transmitted to the pump. The use of pipe hangers or pipe saddles that just support, rather than rigidly attach and brace the piping are not adequate enough to prevent pipe movement.

Sufficient, rigid, piping support and bracing must be supplied to prevent the suction and discharge piping from moving during the suction and discharge cycle. Adequate support and bracing close the pump is the best method to prevent pipe movement. See Figure 3 and Figure 4 illustrations below for recommendations.

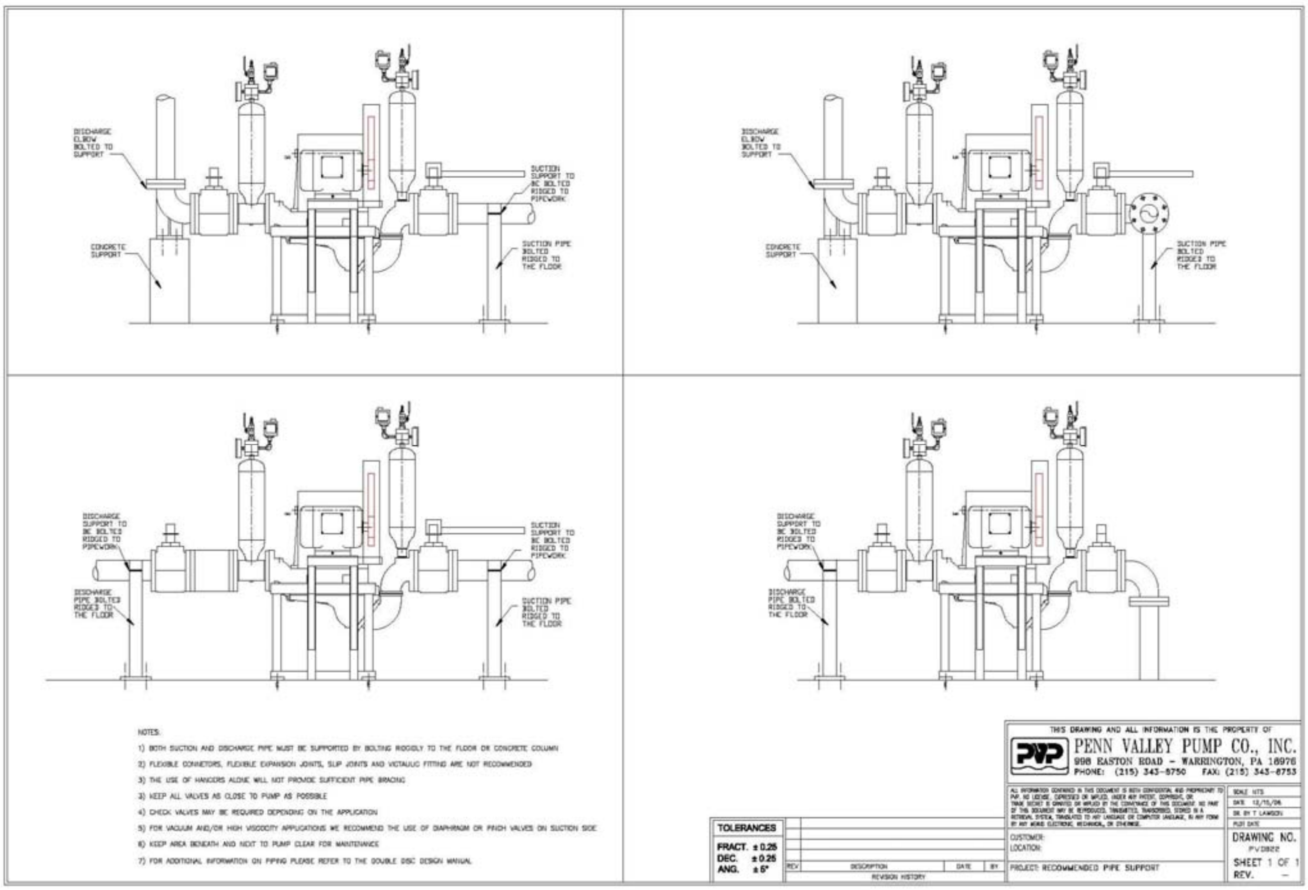

Fig. 3

We do **NOT** recommend the use of flexible connections/expansion joints on the suction and discharge ports of the pump. Our long-term experience has found these items do not reduce vibration, but rather can enhance vibration allowing improperly supported piping to move substantially when used with reciprocating positive displacement pumps. To maximize the pumps "Maintain-in-Place" the suction swan neck should be attached rigidly to the suction piping.

The use of slip joints and mechanical pipe joining systems (i.e. Victaulic style) is also highly discouraged. These mechanical systems do not provide the same rigid connections as traditional flanged piping systems. These mechanical systems can be difficult to properly brace leading to pipe vibration issues. If mechanical piping joining systems will be used, the engineer, contractor or owner must ensure the manufacturer's installation method for *rigid pipe cutting* and coupling connections is strictly adhered to.

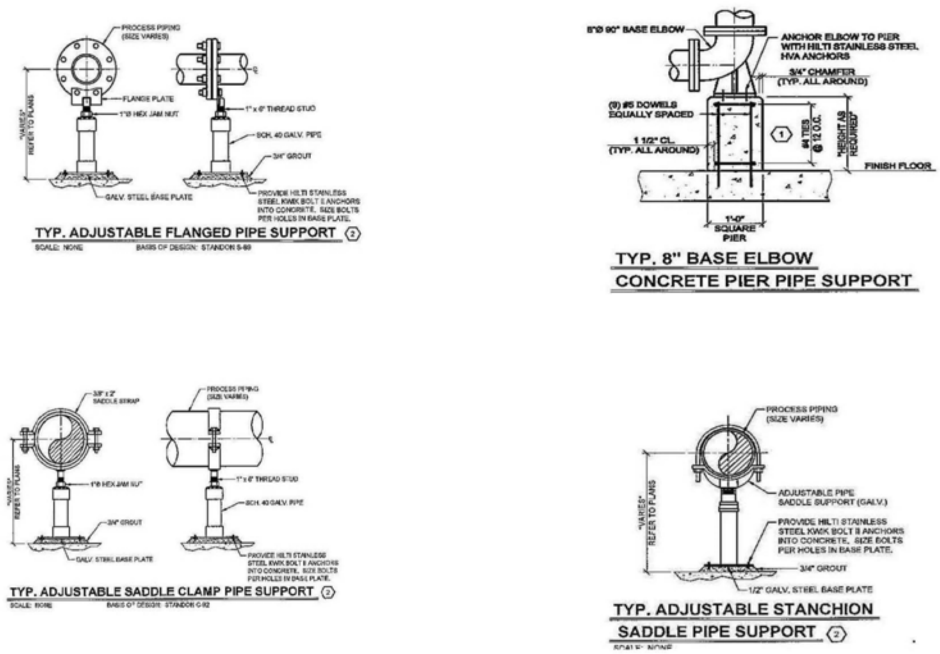

Fig. 4

Pressure gauges should be installed on the suction and discharge piping and located as close to the ports as practical. The operator can only determine any unstable pump operation by observing these gauges. Any change in the system operating characteristics will be indicated in the gauge readings.

Install isolation valves in the suction and discharge piping as close to the pump as practical. The valves will allow for the removal of the pump or permit maintenance on the pump without draining the system.

SUCTION PIPING

***CAUTION:* Do not operate Double Disc Pumps against a closed suction line for extended periods of time. Excessive vacuum build-up can cause disc and/or trunnion failure.**

It is imperative that a properly sized suction piping system be used in accordance with the suction conditions. The importance of proper suction system design cannot be over emphasized. The majority of pump operating problems and pump failures are created by improper suction line conditions.

A Net Positive Suction Head Calculation (NPSH) that includes the Acceleration Head (h_a) component must be calculated for applications with long suction lines to determine if there is adequate suction pressure available based on a given line size and length.

A reciprocating pump, by creating a vacuum at the suction port utilizes atmospheric pressure (14.7 psi at sea level) to draw the liquid into the pump much like a person drinking through a straw. A static suction head will assist this action whereas pipe friction losses, suction pipe length and pressure drop through equipment reduces the overall pressure available. The following design considerations are offered to prevent pump starvation defined as cavitation.

Good system design dictates that the lowest possible suction lift be designed into the piping system. Double Disc Pumps are capable of operating under a 28-foot suction lift when fully primed, will re-prime at 18-feet and will dry prime on systems having a 7-foot lift. When using the standard disc construction, a maximum of 20 -feet suction lift is recommended for continuous operation. If higher suction lifts are necessary, a special disc construction may be required.

The pump should be located as close to the source as possible, with the suction piping as short and as direct as practical. It is imperative that the suction line hydraulics be carefully considered when locating the pump. The suction pipe size is determined by the percent solids, length of run, flow in gallons per minute, taking into consideration the number of elbows and other obstructions in the suction piping. A rule of thumb is that the suction pipe size should never be smaller than the suction port on the pump being installed. On a horizontal run, the suction piping should have a gradual rise, up to the suction port of the pump. This is to prevent air entrapment, causing improper pump operation.

On high suction lifts, long suction lines or on applications handling high percent solids, the suction piping may need to be one or two sizes larger to reduce friction losses and allow the pump to fill. These applications may require the pump to operate under a vacuum condition. When operating under a vacuum condition the integrity of the suction line is critical to pump efficiency and performance. The piping must be air tight to the amount of vacuum that must be generated to allow flow. All valves and fittings must be tight to prevent any air leaks. The use of diaphragm valves or pinch valves is highly recommended when the suction line will be routinely operated under high vacuum conditions. Most plug valves and knife gate valves are not suitable for high vacuum conditions.

The use of a vacuum switch is recommended for the suction side. This device will prevent the pump from operating under a plugged line or closed valve for an extended period of time which can lead to disc or trunnion failure. The Double Disc Pump is capable of generating a vacuum of up to 25” Hg. For materials with entrained debris and a tendency to plug this vacuum generation capability may lead to a more solid plugging potential. We recommend a switch setting of 10”Hg prevent the plugging potential.

DISCHARGE PIPING

***CAUTION:* Do not operate Double Disc Pumps against a closed discharge line. Excessive pressure build-up will cause disc and/or trunnion failure.**

Double Disc Pumps must not be operated against a closed valve in the discharge piping or damage can occur. This type of operation will lead to disc inversion and breakage of the discs. To avoid this, it is imperative that a pressure limit be switch installed as close to the discharge port as practical. The switch setting should be set at 10 psi above operating pressure. When the pressure exceeds the pressure setting, the limit switch will turn the pump drive off.

The use of back flow, swing (flap) check valves is normally only recommended when there are multiple pumps connected to a common discharge line or the pump will be installed on a common discharge line with other pumps. The "flutter" of the valve can cause premature wear and failure. If a back flow valve is required for the application we recommend an elastomer sleeve model, such as those manufactured by Red Valve or an unweighted, non-spring, flapper-style swing check such as those manufactured by Val-matic, Tru-Tech Industries, or equal.

PULSATION DAMPENERS

Pulsation dampeners are designed to control rapid velocity changes that may cause potentially dangerous pressure excursions. This is accomplished by using a vessel charged with inert gas (air) and connected to the pipeline carrying the liquid. This vessel has the capability to convert the kinetic energy of the moving liquid into stored potential energy when a liquid over-pressure occurs. When a pump stops, the vessel air expands and 'pumps' needed liquid into the line to prevent the formation of vacuum or column separation. With a pulsation dampener installed in the pipeline, flow from the pump is received within the pulsation dampener compressing the stored gas on top of the liquid. Pump energy thus stored is released in a controlled fashion to establish steady state flow.

The use of a pulsation dampener, mounted in the discharge piping system is the most effective solution. The pulsation dampener must be sealed from atmospheric pressure, as even a minute leak will soon deplete the air in the top of the chamber. The liquid being pumped may gradually absorb the air in the chamber, causing the chamber to become ineffective until the chamber is purged of liquid and the air is replenished. This is easily accomplished by introducing compressed air on top of the pulsation dampener through the valve provided. This forces the liquid back into the piping system, thereby re-establishing the air cushion in the chamber.

After making certain that the discharge piping is securely supported and the pump is securely bolted to a rigid foundation, the following solution for reducing this phenomenon is recommended.

Pulsation dampeners installed in the suction piping can improve the NPSH conditions of the application and reduce the acceleration head. The following are examples of conditions where suction side pulsation dampeners would be required:

1. Static lift requirement. (i.e. fluid source below pump suction inlet)
2. Suction line diameter smaller than pump inlet.
3. Suction line longer than 50 ft.

Vibration and/or noise can occur on the discharge side due to the valving action of the discs. Discharge chambers are not required on every installation. The system hydraulics must be reviewed to determine the requirements of the pumping system. The following are examples of conditions where pulsation dampeners would be required.

1. Discharge pipe in excess of 100 feet - Discharge Chamber required.
2. Static discharge head in excess of 10 feet - Discharge Chambers required.
3. Multiple pumps discharging into a common line - Discharge Chamber required.

The discharge pulsation dampener must be purged after the piping system is filled with liquid. The pressure in the pulsation dampener then equalizes to the discharge head conditions. If this is not done, the discharge head will cause the liquid to rise in the chamber, thereby reducing the effectiveness of the pulsation dampener.

DRIVES

Each Double Disc Pump is provided completely assembled on a mounting base with an electric motor and v-belt and pulley drive system. The pumps are relatively slow speed pumps and require a speed reduction from the standard 1200 and 1800-rpm motor speeds. This reduction is achieved by sizing the sheave and pulley ratio to achieve the required pump speed and horsepower per belt rating for the motor requirement. A gear reducer between the motor and pump may also be used. The reducer is then used in conjunction with the belt and pulley arrangement.

INSTALLATION

Foundation & Base

Each Double Disc Pump is provided completely assembled on a tubular SS304 mounting base. Each based is completely seam welded and gusseted to handle the torque and load requirements. The frame must be mounted to a solid foundation for proper pump operation. The foundation must be rigid enough to prevent vibration and misalignment during operation. The pump base must be anchored to the floor with appropriate anchor bolts and leveled by shimming at the anchor bolt locations.

The frames are elevated for each model to allow adequate room beneath the pump for maintenance access. Pump disassembly is commenced from the bottom with the “Maintain-in-Place” hinged housing design allowing the housings to be lowered into the area beneath the frame. This area should remain clear of any conduit, piping or other obstruction that would limit access to underside of pump for maintenance.

Outdoor Installation

The standard Double Disc Pump configuration can be mounted outdoors. When installing outdoors in cold weather climates the pump and piping must be protected from freezing temperatures. If the liquid in the pump chamber is allowed to freeze, the resultant expansion will crack the pump housings and cause damage to the pump and piping system.

CONTROLS

The Double Disc Pump can be operated by a motor starter for constant speed applications or a variable frequency drive (VFD) for variable speed applications. If using a motor starter we recommend a soft-start feature to allow the pump speed to ramp up to maximum operating speed to minimize start-up pressure spikes. This feature is especially important on long suction and/or discharge lines.

If using a VFD (recommended option) the unit must be of *constant torque* design sized for the horsepower of the pump. In a few rare cases the reciprocating action of the Double Disc Pump can cause a regeneration occurrence in the drive that will affect the DC Bus voltage. In most cases this regeneration can be remedied through programming in the drive by adjustments to the deceleration rate. In extremely rare instances a dynamic braking resistor may be required to effectively handle the regeneration.

Our long term experience has shown that lower end VFD models perform better than the higher end more sophisticated drives, i.e. Allen Bradley PowerFlex 40 instead of a PowerFlex 70 or 700 series. We have also found the US Drives Phoenix DX drive series to perform well as they are specifically designed to handle regenerative loads without the use of dynamic braking resistors.

For set-up of the VFD we typically recommend a minimum acceleration rate of 30 seconds for speed ramp up to fill speed to minimize start-up pressure spikes. The deceleration rate should be set as close to zero as possible.