



Pump *Clinic* ...Issue 34

10 Misconceptions on Rotary PD Pumps

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*(Authors John Petersen, Technical Customer Service
and CH Tan, Regional Director for Asia Pacific Region)*



Ten Misconceptions on Rotary PD Pumps

John Petersen and C.H. Tan, Viking Pump, Inc.

Rotary positive displacement (PD) pumps are not well understood by many specifying engineers and users and are sometimes misapplied, incorrectly specified or simply not used where they could or should be. This article explores the areas of commonality between centrifugal and PD pumps and ten common PD pump misconceptions and the reality behind each.

There is considerable resident knowledge about centrifugal pumps, which comprise the majority of all pump installations. However, rotary positive displacement (PD) pumps are not well understood by many specifying engineers and users.

Rotary PD pumps account for 15 percent of all installations, with sales divided into many different pumping technologies. As a result, PD pumps are sometimes misapplied, incorrectly specified or simply not used where they could or should be. Though PD pumps move liquids through many different approaches, much commonality is shared in design and operation.

Centrifugal pumps move liquid in a much different fashion than do PD pumps, and their resulting performance differs as well. Centrifugal, or kinetic, pumps impart rotational energy to the liquid and convert it to potential energy (pressure) through the design of the volute. PD pumps, on the other hand, move liquids by transferring confined amounts of liquid (defined by pumping element geometry) from the inlet to the outlet of the pump.

The key here is that centrifugal pumps generate pressure and flow results, while PD pumps generate flow and pressure results. In other words, a PD pump generates just enough pressure to overcome system resistance created by the flow of liquid through it. Because of this, flow output from a centrifugal pump varies with differential pressure, whereas flow from a PD pump is essentially constant with varying differential pressure.

All of the many different types of PD pumps use geometry of the parts to expand and contract volumes of liquid. Volume expansion draws liquid into the pump and volume contraction moves liquid out of the pump. Though a number of geometries are involved, most rotary PD pumps share common design and operating characteristics:

- All try to displace the same amount of liquid with each rotation of the shaft.
- Flow is directly proportional to speed.
- All can pull liquid from below the pump or self prime.
- Most have close fitting internal parts.
- Most have one pumping element driving another (gears, rotor/vanes, etc.).
- All have a small amount of liquid that goes from discharge back to suction. This is called *slip*, and it varies with liquid viscosity and differential pressure.
- All require some form of overpressure protection.

Conventional wisdom says that a PD pump must be used over a centrifugal pump when one or more of the following application conditions exist:

- Liquid viscosity is too high (generally anything over 150-cps requires a PD pump).
- Constant flow is needed over varying differential pressure.
- Suction lift or self priming ability is needed.

Although these criteria are all sound, PD pumps may still not be used, or there may be rationale to use a PD pump when none of these conditions exist. At this juncture, many of the common misconceptions on PD pumps come into play. Let's explore ten of them.

1. PD Pumps Are Not Well Suited for Thin Liquids

Ask almost any pump user what type of pumps to use for a thin liquid application and the response is generally a centrifugal pump. This is often the right answer, but sometimes not. Some believe that PD pumps cannot be used on thin liquids at all due to their design characteristics. For example, how can a gear pump be used on a thin non-lubricating



liquid when one gear drives the other?

The fact is most PD pumps – including gear pumps – *can* be used on thin liquids. Water is the most common thin liquid, and the internal gear pump was actually invented to handle it. Liquefied petroleum gas, refrigerants, solvents, fuel oils, gasoline and even liquid carbon dioxide are some of the other thin liquids handled very successfully with PD pumps. Selecting proper pump materials is important when moving a thin liquid, and most manufacturers offer many choices to handle the low lubricity and viscosity typically associated with thin liquids.

2. PD Pumps Do Not Need Overpressure Protection

A centrifugal pump that is dead headed, either accidentally or on purpose, can develop a predictable maximum shut off pressure. It will be above the normal operating pressure, but generally not much more.

A PD pump that is dead headed tries to displace the same amount of liquid for each revolution of the shaft. Because of this, pressure continues to increase until something breaks in the system, the pump is damaged or the driver runs out of power. None of these are safe or desirable conditions. To prevent this, having some form of overpressure protection either on the pump or in the system is important.

Many manufacturers offer pump mounted relief valves, but other ways can accomplish the same purpose. System relief valves, rupture disks, torque limiting couplings and motor power load monitors can all be used to limit maximum attainable pressure in the pump or system. Though a system is designed to be continually open, inadvertent valve closing, plugged filters or other system upsets may cause enough blockage to significantly increase pressure. Overpressure protection is a must with all PD pumps – and this is often overlooked.

3. PD Pumps Damage Shear Sensitive Liquids

This may well be the most common misconception on PD pumps, particularly with gear type pumps. With close fitting internal parts, the liquid is often thought to be simply sheared or damaged by close running components. While it is true that some of the liquid is sheared within the close internal running clearances, only a small amount of liquid is actually being sheared within the pump. The vast majority of liquid going through the pump comes through in “chunks” and is not sheared at all.

Numerous applications and actual testing have busted this myth. Most notable is wastewater polymers, where excessive shearing changes the viscosity. Gear pumps are frequently used to transfer these polymers at actual manufacturing facilities and do no damage to the liquid. Many installations of gear pumps at wastewater treatment facilities operate without affecting liquid properties.

Field testing of other sensitive liquids proves these pumps

can be used very successfully. One particular customer would not allow use of gear type PD pumps because of perceived liquid damage. Actual testing showed this perception to be wrong. Most important, PD pump manufacturers typically reduce speed and slightly increase internal clearances to minimize the effects of shear. The takeaway is PD pumps can handle shear sensitive liquids without damage if properly applied.

4. PD Pumps Are Not Suitable for Abrasives or Solids

True, some PD pump principles do not handle solids, but most can handle some form of abrasives. Lobe pumps and progressing cavity pumps do a good job on solids and can handle abrasives too. Gear pumps handle abrasives quite well, with a few material changes to retard wear, but they will not tolerate solids.

A large majority of shingle manufacturing relies on gear pumps to handle a mixture of asphalt and up to 60 percent to 70 percent finely ground stone. This mixture is quite abrasive, but reasonable life can be attained by reducing pump speed and using hard parts in key wear areas.

Abrasive wear is caused by forces acting on the relative motion surfaces within the pump in the presence of an abrasive media. Pressure and speed of the pump create these forces, so minimizing them can extend pump life. Reducing pump speed is the logical way to do this. Most manufacturers recommend this in varying degrees, depending upon the abrasive nature of the product being pumped. Pressure is a function of the system, so proper design helps extend pump life by reducing the load the pump is required to handle.

5. PD Pumps Cannot Handle Non-Lubricating Liquids

Non-lubricating liquids range from thin to thick viscosity. Many thin liquids have poor lubricating properties, but so do some thick liquids. For example, number 6 fuel oil (sometimes used for heating or diesel fuel) can be as thick as 15,000-cps, but it is not very lubricating.

Manufacturers tend to limit the load from pumping element contact in PD pumps by limiting maximum pressure with non-lubricating liquids. Doing this minimizes pumping element wear on most non-lubricating liquid applications.

The critical area in PD pumps is pumping element support, which can be either a journal bearing operating in the liquid pumped or an external antifriction bearing. PD pump manufacturers have a wide array of journal bearing and shaft materials to handle low lubrication situations. The key is choosing the right materials for the particular liquid characteristics to get the best pump life.

External antifriction bearing support takes away the material problem, but in most designs this moves the support farther away from internal pump loads, resulting in higher bearing loads that may also limit maximum pressure on a particular design.

6. PD Pumps Do Not Run Fast

Browsing product information for a number of different pump designs and manufacturers reveals this is not true. Granted, PD pumps must run more slowly as viscosity increases and also when flow is above 200-gpm, but direct motor speed operation is not uncommon.

Many smaller displacement pumps run at direct motor speeds of 1800-rpm, with some even going to 3600-rpm. Motor speed PD pumps provide an economical solution to liquid transfer for any number of applications where liquid properties like viscosity, abrasiveness and shear sensitivity are not a problem.

7. PD Pumps Are Expensive to Own

The initial cost of most PD pumps is more than centrifugal pumps, but one must consider the total cost of ownership. Using a simplistic approach to cost of ownership, the main contributors are first cost, repair costs and energy to operate.

Assuming an average pump life of seven years, a couple of repairs during its life span and rather modest pressure requirement energy to operate the pump equals one half of the total cost of ownership. First cost is the lowest, with repair parts coming in second. Figure 1 shows the detail. PD pumps can be quite efficient. A small increase here can save considerable money over the life of the pump.

8. PD Pump Repairs Are Expensive

Repair parts costs vary between manufacturers. Since these costs differ, understanding them before the pump purchase is always a good idea. Misconception 7 above assumed an average pump life of seven years with two lower level repairs and a major overhaul (replacing all critical wear parts) during the life of the pump. Cost for the parts required for a major overhaul is only two-thirds the price of a new pump. PD pumps are usually easy to work on too, so labor costs are not high.

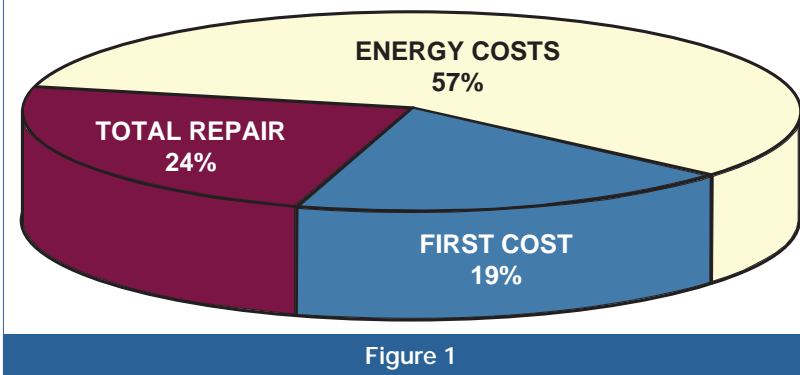
9. PD Pumps Have Pulsing Flow

This is true for reciprocating PD pumps, but not for most rotary PD pumps. This may seem counterintuitive since these pumps move liquid by delivering confined volumes of liquid from the suction to the discharge port. Although it would seem that confined volumes or buckets of liquid would result in flow pulsations, they actually don't.

In theory, gear, vane, some lobe pumps and all types of screw pumps deliver a continuum of liquid resulting in very little, if any, flow pulsations. There may be slight differences in slip within the pump, depending on rotational position of the pumping elements that result in minimal pressure pulsa-

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tions, but theoretical output remains constant. Traditional lobe pumps with three lobed rotors do have theoretical flow pulsation, but again this is minimal.

10. PD Pumps Cannot Run Dry

PD pumps *self prime*, meaning they are capable of pulling a liquid from a level below the pump into the pump port. This means the pump must run without liquid for the time it takes to get liquid up the elevation. In other situations, PD pumps are asked to empty tanks, which many times results in periods of running with little, if any, liquid inside the pump.

Most PD pumps can run dry for short periods of time without damage. In many cases there is a small amount of liquid in the pump, which keeps the parts wetted to the point damage does not occur. Obviously, extended periods of run dry are not recommended and some designs are more tolerant than others. In any case, run dry situations are more common than anyone likes to admit and PD pumps can usually handle them.

Summary

Rotary PD pumps are (for the most part) simple devices, but more complex in application. Understanding the basic operating characteristics of PD pumps and system requirements is a great place to start in correctly applying a pump.

Recognizing these common misconceptions opens up a whole new application area for these pumps to improve performance, extend service life or operate more efficiently. Consider all the alternatives to a pumping problem before making a decision – you'll be surprised by how many choices you have.

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John Petersen is vice president, technical customer service and CH Tan is regional director for the Asia Pacific Region of Viking Pump, Inc., a unit of IDEX Corporation, 406 State Street, P.O. Box 8, Cedar Falls, IA 50613-0008, 319-266-1741, Fax: 319-273-8157, www.vikingpump.com.