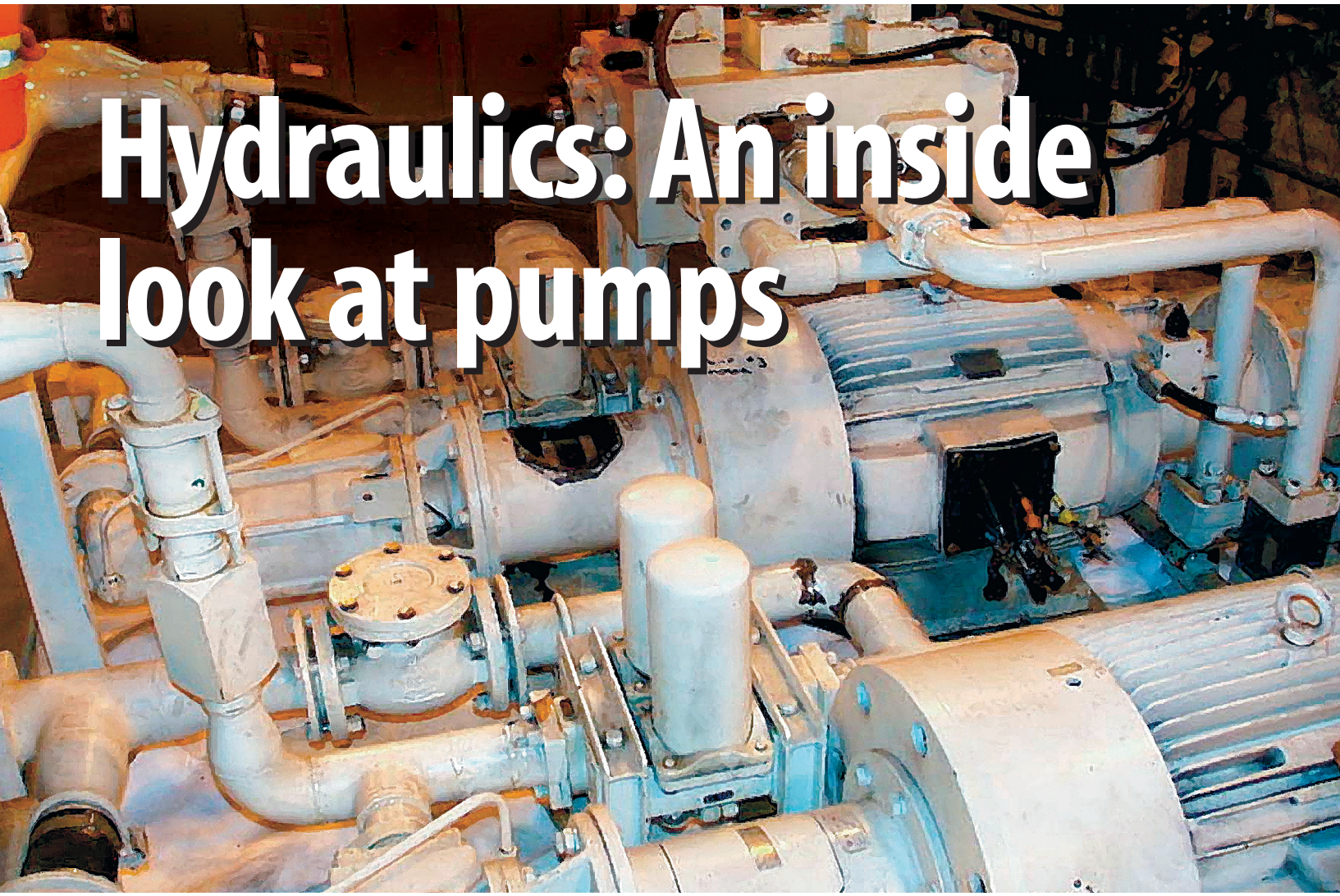
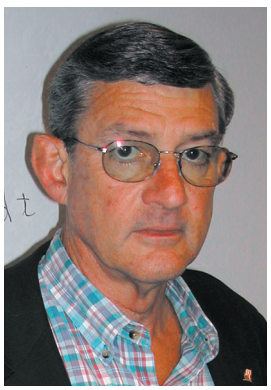


Hydraulics: An inside look at pumps

These hard-working mechanisms are at the heart of any hydraulic system



by Dr. Robert M. Gresham
Contributing Editor

In previous articles, we have discussed at some length fluid flow and fundamental hydraulic principles. With this as background, let's peel back another layer of the onion and look more closely at hydraulic systems. At the heart of the system is the hydraulic pump.

Hydraulic Pumps provide one and only one function: to provide flow of the hydraulic fluid. This is a question on the CLS® exam! Many people think the pump provides pressure—wrong! Pressure comes from resistance to flow due to a variety of causes: restrictions in the lines, viscosity, load on the actuator, etc.

The pump converts mechanical energy from the electric motor or a gas or diesel engine used to drive the pump to create fluid energy. The pump is of the type called a positive displacement pump. This means that the pump is designed with special seals and close tolerances such that one revolution of the pump delivers a measured amount of fluid with little possibility for leakage under normal pressures.

Thus, as pressure in the system increases primarily due to the load on the actuator, the motor or engine must work harder (draw

more amperage or use more fuel) to deliver the necessary flow. Indeed, the pump system will deliver this flow to the point of its own destruction (stalled motor or engine, blown seals, hoses, etc.). For this reason, the system is always protected with a pressure relief valve. Thus, the pump provides fluid flow.

Brad Poeth of Eaton Corp. is one of the instructors for STLE's Hydraulic Systems Education course. Brad is an expert on pumps and has a wealth of practical experience in design and operation of hydraulic pumping systems and troubleshooting. If you really need an expert on pumps, contact Brad at **bradppoeth@eaton.com**, (952) 294-2017.

Hydraulic pumps are of several basic types: gear, vane and piston pumps.

Gear pumps are generally the least expensive, least sensitive to fluid type, most tolerant of contamination and least efficient of pump designs.

Gear pumps are generally the least expensive, least sensitive to fluid type, most tolerant of contamination and least efficient of pump designs. System pressures are typically 1,500 to 5,000 psi. Gear pumps are most often used on mobile equipment where these characteristics make the most sense given the level of maintenance, contamination and needed performance.

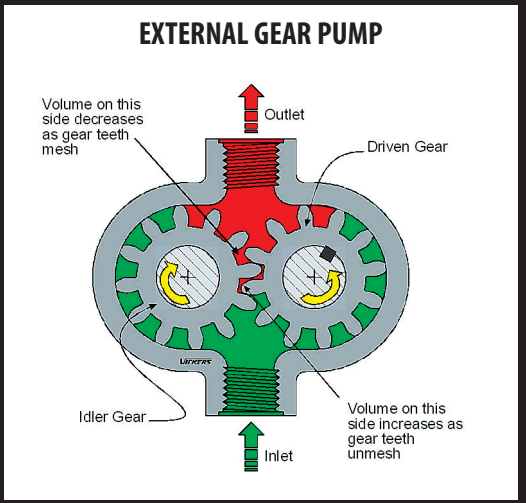
The gears rotate in opposite directions, one driven by the motor and the other as an idler. The fluid enters the inlet chamber and is carried between the gear teeth and the housing around the outside of the gears. Fluid cannot go through the center as there is insufficient clearance. Then the two streams recombine and push out the pressure side of the pump.

Gear pumps can operate in both directions, which may be of some use in certain system designs. Further, because the bearings generally see pressure from one direction, the pressure side, the pump is said to be unbalanced. Thus, gear pumps tend to wear disproportionately on one side. Gear pumps can be of the more common external (Figure 1), internal or gerotor design.

Vane pumps are higher-performing pumps and are widely used, but they require a fluid with excellent antiwear properties. Vane pumps have a number of surfaces that are subject to wear. Wear areas include the vane tip, rotor to side plate and the vane slot in the rotor.

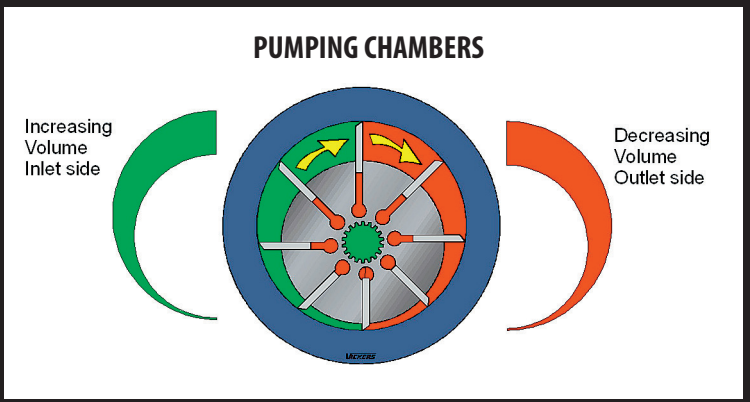
One advantage of vane pumps is the vane tip remains in contact with the cam surface as it wears, as long as the wear is uniform. This increases efficiency. Additionally, vane pumps, when designed with two inlets and two outlets located on opposite sides, are balanced and, thus, there is uniform and lowered stress on the bearings. By mechanically varying the shape of the chamber, vane pumps can be made as variable displacement pumps increasing their

Figure 1.



Because the bearings generally see pressure from one direction, gear pumps tend to wear disproportionately on one side.

Figure 2.



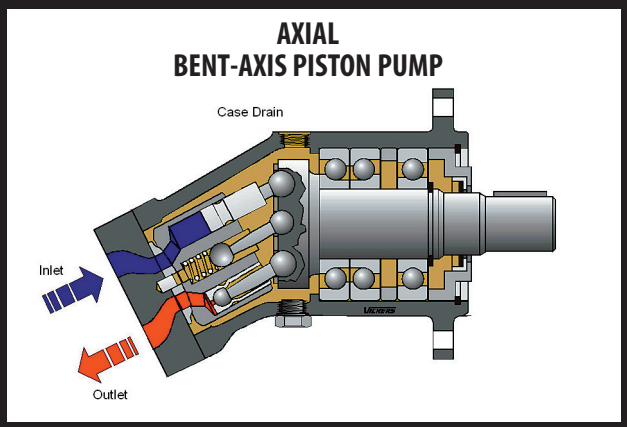
By mechanically varying the volume of the inlet and outlet, the pump can be made into a variable displacement pump.

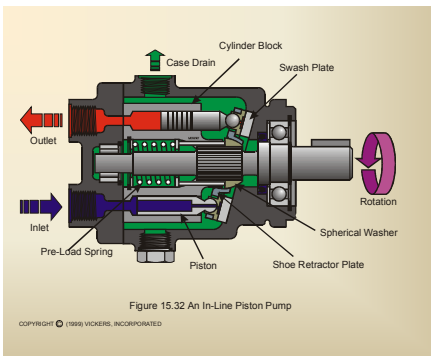
Hydraulic Pumps provide one and only one function: to provide flow of the hydraulic fluid.

efficiency—and initial cost (Figure 2).

Vane pumps are less tolerant of contamination than gear pumps as particulate contamination tends to cause uneven wear of the vanes. Vane pumps can operate in the range of 1,000 to 3,000 psi system pressures.

Figure 3.





Piston pumps are of either a radial or axial design, where the pistons radiate from the axis of a circular cylinder block like wheel spokes, or where the pistons and cylinders are parallel to each other and the axis of rotation .

Piston pumps are the Cadillacs of hydraulic pumps. They are the most efficient, most expensive and highest performing. The pumps are capable of operating up to pressures of 10,000 psi in radial piston pumps.

Piston pumps are of either a radial or axial design, where the pistons radiate from the axis of a circular cylinder block like wheel spokes, or where the pistons and cylinders are parallel to each other and the axis of rotation (Figure 3). Piston pumps are made with very fine tolerances and, therefore, are very sensitive to abrasive wear from particulate contamination.

Piston pumps can be made of fixed or variable displacement designs. Variable displacement designs allow for compensation for system pressure changes and, therefore, are the most efficient on the order of 92%-97%. Pump efficiency is a subject for yet another article, but in the interim give Brad a call if you have further questions.

Regardless of the type of pump used in our system, newly assembled hydraulic systems must be thoroughly cleaned and flushed before startup. All sources of contamination must be aggressively minimized. And new or top-up fluid must be filtered as it is added, as a properly operating well-filtered hydraulic system will likely be cleaner than the new fluid. In addition to cleanliness, type of fluid, temperature range/viscosity of fluid, fluid condition (oxidation, water contamination, etc.), system loading (pressure), aeration and cavitation can all affect pump and pump life.

In future articles we will take a closer look at other system components and best practices, but for now: What does a hydraulic pump provide?

(If you don't know, go back to Paragraph Two, reread the first sentence, write it down, then rewrite it 500 times.) **<<**

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Photo Illustrations provided by Brad Poeth — Eaton Corp.