White Paper: Solving Long Unloading Time Issues

Background

While pumps are able to pump product at an engineered maximum GPM rate, sometimes pumps do not achieve that rate when installed and operated in the field. There are several factors that can lead to longer than expected transloading times. Longer transloading times cost the customer a significant amount of money and, in most cases, can be prevented or corrected. This white paper discusses how to prevent poor pump performance for new installations and how to correct slow transloading problems for existing installations.

Is it the Pump or the System?

The pump is only part of a relatively complex system made up of several components that interact with each other. For the purposes of this discussion we are assuming that the pump is either new or in good working order.

In the case of Safety Pumping Systems, SPS systems encapsulate pumps from leading pump manufacturers. When the SPS system valve is in neutral or in any position other than full unload position or full load position, it is controlling the flow of product. When the SPS system valve is in the full load or full unload position, it has no effect on product flow. It becomes nothing more than an open pipe. Product will flow at the maximum capacity of the pump unless there are other issues present in the overall system.

The overall pump system consists of the following components: the truck's engine, the truck's transmission, the power take off (PTO) unit and, in the case of hydraulically driven pumps, the hydraulic pump and the hydraulic motor. Even the product hoses and fittings are part of this overall transloading system.

Specifying each component correctly

It is better for all concerned to properly specify each component of the transloading system prior to procurement and installation. This process starts with the type of pump is being installed in the system. Gear pumps typically run at their optimum output at 900 rpm and vane pumps' optimum rate is typically 640 rpm. These speeds refer to the pump shaft rotation speed measured in rpm. Check the pump manufacturer's documentation for their recommended optimal rpm speed.

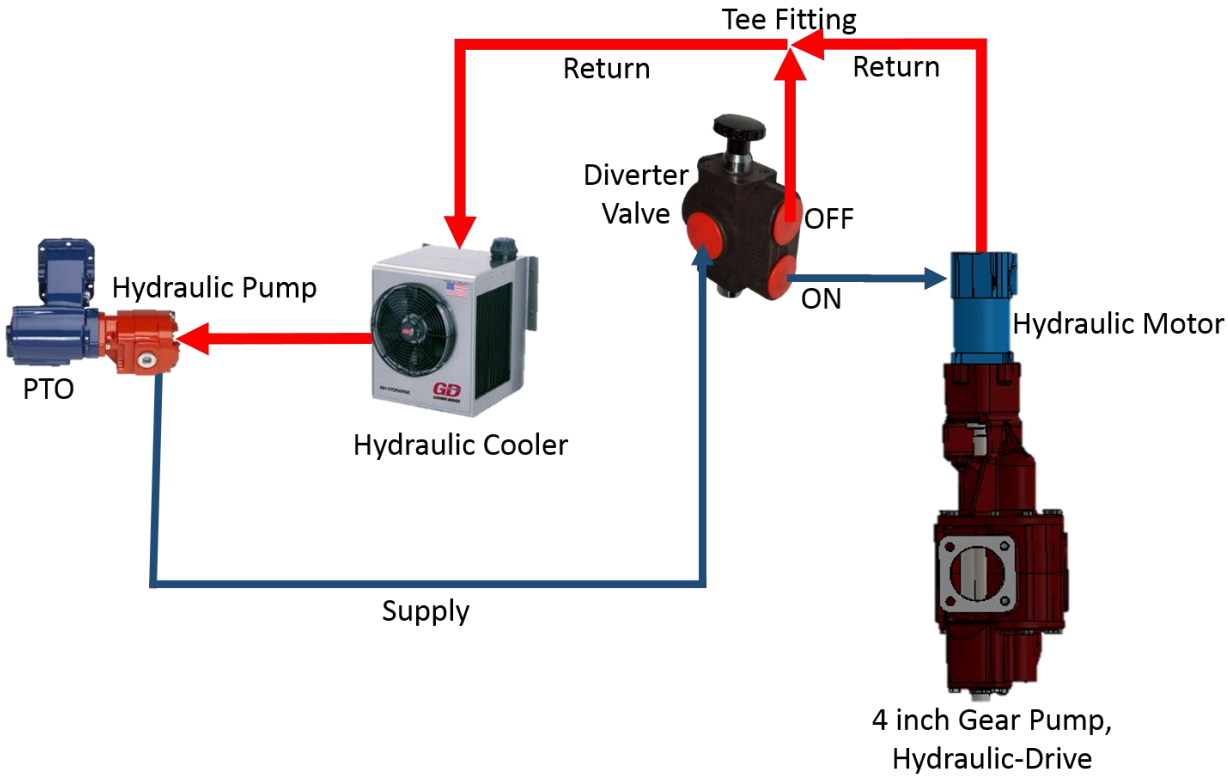
One of the biggest misconceptions regarding pump rotation speed is that faster rotation leads to higher GPM throughput. This is only true up to the pump's optimal rpm. Speeding a pump beyond that level not only degrades GPM throughput due to cavitation, but is also dangerous to the equipment and the drivers.

Selecting the correct components

Once the optimum pump shaft rotation speed in rpm is determined, the next step is to note the truck transmission manufacturer and model number. Using this information in conjunction with the PTO manufacturer's technical data, determine the correct PTO gear ratio, generally stated as a percentage, which will deliver the target pump shaft rotation while the engine is operating at 900 rpm. If the system is already installed and the PTO ratio is not correct, in most cases the PTO gearing can be changed by a PTO service vendor.

For truck-mounted, shaft-driven pump systems that is all that is needed to ensure that the pump is being driven at the optimum rpm when the truck engine is operating at 900 rpm. The 900 rpm engine speed can be set at the truck dealership so that it is preset, while disabling the cruise control, idle bump and gas pedal, preventing pump over speeding.

Hydraulic systems have additional components that must also be specified correctly to achieve the desired result, see image below.



Based upon the truck transmission manufacturer and model number the PTO is selected, refer to the PTO manufacturer' technical information to select the correct PTO gear ratio that will drive the PTO shaft at 900 rpm when the truck engine is operating at 900 rpm. Then select a hydraulic pump (attaches to the PTO) and a hydraulic motor (attaches to the pump) that have a 1 to 1 ratio. If the system is already installed and not operating at the correct rpm, this

could be because the trailer is connected to a different tractor than it was specified for. In these cases either the PTO gearing can be changed by a PTO service vendor or the hydraulic motor ratio can be changed by a hydraulic service vendor to achieve the desired pump shaft rpm.

In all pump system installations it is highly recommended to use a digital tachometer to verify the actual rpm at the pump shaft, see image showing an example digital tachometer. Putting a pump system into the field that is either over speeding the pump or driving the pump too slowly will create problems in the future that are far more expensive to correct once the unit is in the field.

Setting the Pump's Relief Valve

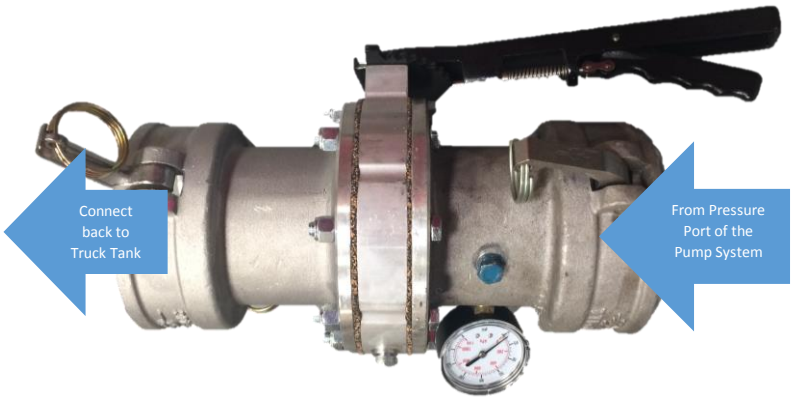
For the purposes of this white paper we are assuming that the pump is equipped with a relief valve and that it is installed correctly. It is highly recommended that all pump systems have pump relief valve protection in both directions of flow. Pump relief valves are mechanical, full by-pass valves and provide immediate relief in over pressure situations. Putting a reversible system in the field with relief valve protection in only one direction of flow is an accident waiting to happen. With an SPS system there is relief valve protection in both directions of flow because the pump rotates in one direction while the flow is controlled by the 4-way valve.

If the pump's relief valve is set too low, some product will bypass through the relief valve and decrease the pump's delivered GPM performance. If the pump's relief valve is set to high, it will not provide the intended safety of relieving pressure if needed before a hose or fitting fails and causes a spill or injury.

As a general rule, vane pumps transloading refined petroleum products are set to 40 psi (Blackmer actually runs the pumps at the factory and sets the relief valve prior to shipment). Gear pumps transloading most crude oils are set in the 70 psi range. Roper does not set the relief valve at the factory. It must be set by the tank shop or system installer.

If the pump rotation speed has been determined to be in the 900 rpm range using a digital tachometer and transloading times are still longer than expected (4 inch gear systems should run at 400 GPM while 3 inch vane systems should run at 240 GPM) then one of the leading causes is that the relief valve is set at too low a pressure.

To set the pump's relief valve the system must be configured into a closed loop using delivery hoses to connect the inlet port to the tank and connect the outlet port of the pump to the same tank. Fluid must be present in the tank. There must be a wet-dry valve on the pressure port of the pump. A fitting with a pressure gauge that measures between 20 psi and 100 psi must be installed in-line on the pressure port of the pump between the pump and the wet-dry valve. With an SPS system the top port is attached to the payload tank and the bottom port, typically connected to the customer tank, is the pressure port where the pressure gauge and wet-dry valve are attached, see image on left.



Caution must be used to utilize hoses and fittings that are in good shape with pressure ratings well in excess of the pressure that you are setting the relief valve. Refer to your pump's documentation regarding how to increase and decrease the relief valve pressure setting.

Engage the PTO with the wet-dry valve in the open positon. The fluid will circulate within the closed loop and no pressure should be measured. In the case of an SPS system the valve handle should be in neutral when the PTO is engaged. Move the valve handle to the 100% unload position.

Start to close the wet-dry valve. Pressure will immediately begin to build and will register on the pressure gauge. Listen for the pump relief valve to engage at the desired pressure level. If it does not, lower the relief valve setting until it does. If you can hear the relief valve opening when the pressure is below the desired level then raise the relief valve setting until it engages at the desired level. Once you have set the relief valve, make sure that this setting is locked in place. Refer to your pump's documentation to do so.

What if the problem still isn't solved?

If the pump rotation rpm is confirmed at the optimum speed and the relief valve is confirmed at the desired psi setting and transloading speeds remain below the pump's engineered GPM performance then there are other factors that could be causing the degraded performance. Some of the potential causes are discussed below:

1. Hoses are too small for the pump application. 4 inch pumps require 4 inch hoses to deliver their full 400 GPM. If at any point between the pump and the payload tank or between the pump and the delivery tank a hose or a fitting is choked down below 4 inches (typically to 3 inches)

then the system will only deliver ~300 GPM of performance. Likewise for 3 inch pumps, all hoses and fittings involved should be at least 3 inches.

2. The pump is wearing out and is no longer capable of delivering maximum performance. Gear pumps start to wear from their first minute of operation. Worn bushings, rotors, gears, etc. cause them to never be as efficient as they were when they were new. Likewise vane pump vanes and seals wear out and need to be replaced from time-to-time in order to ensure maximum GPM performance.

3. The product being pumped it very viscous and cannot be pumped at the pump's maximum GPM throughput. Different materials affect how efficient the pump can be. Certain liquid product can cause cavitation, leaving the pump starved for product and introducing air into the system. In some instances, such as high wax content crude oil, heating the product can improve pump performance. Generally the pump's stated maximum GPM performance assumes optimum product viscosity, such as diesel.

Conclusion

There are a lot of details that must be addressed in order to properly specify, procure and install a pump system that is both safe to operate and will deliver the maximum GPM throughput that the pump is capable of. The SPS system is nothing more than an open pipe when its valve handle is in maximum load or maximum unload position. Issues that are causing poor system GPM performance lie with other components, all of which need to be specified, installed and adjusted properly in order to avoid either slow transloading times, or worse, an incident that puts oil on the ground or causes an injury. All of the components and factors discussed in this white paper must be considered by shops and installers when putting together pump systems in order to provide the best performing and safest systems possible.