Newsletters That Teach.

Hydrostatics IV - Faults!

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Posted in Hydraulic

This edition of NEWSLETTERS THAT TEACH is the final edition of the hydrostatic drive series.

Barring a massive external leak which should be quite noticeable, there's just not that many substantial flow paths for fluid in a hydrostatic drive. If the prime mover is turning the pump, and that pump can be brought on-stroke (displacing fluid) then the fluid just moves around a loop and the driven motor should be turning. If the motor won't turn then I'm going to guess that you can't actually bring the pump on-stroke or that you've got some unusual heating and strange noises to deal with. The most important thing to know about your own hydrostatic drive is what your normal charge pressure is supposed to be and how to measure it when on-stroke and when centered.

I've broken the major malfunctions into a couple of categories below. I'm not addressing any particular model of hydrostatic pump here. When you get down to the model level, there can be some unique issues to add to the list. Let us know if you have issues with a particular pump model. We may have some tools and services that can help.

Loop Flow Issues

Problem: The driven hydraulic motor won't go at all.

Question: Can you build pressure?

When you move the displacement control away from neutral (in one direction, then the other), does the pressure increase to the working level on the pump port that is the current flow outlet?

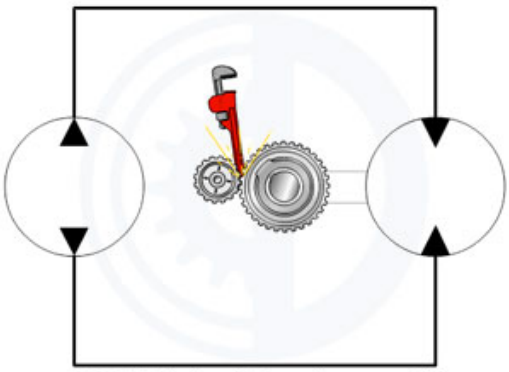
Yes

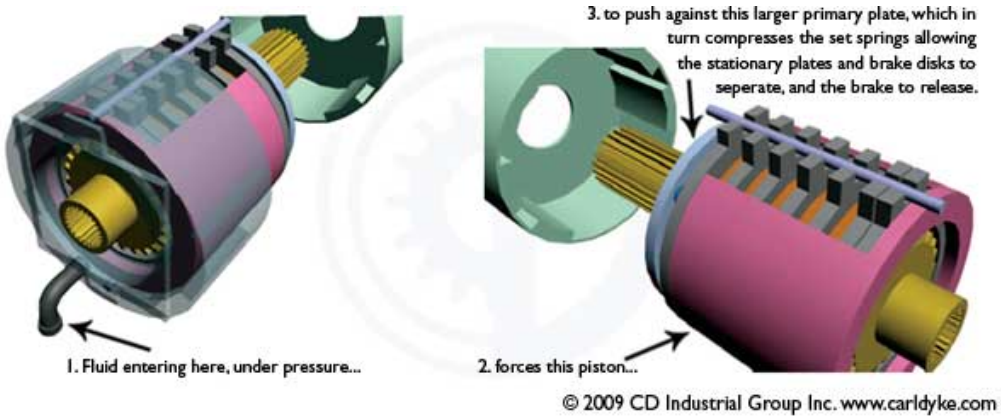
If yes, this means that your pump is attempting to come on stroke (for pressure compensated models) or that your pump is on-stroke (displacing fluid) and that cross-port relief valves have opened (for non-pressure compensated pumps

Pressure Compensated Pump:

So if you cannot achieve motor motion in either direction, then look for mechanical binding at the motor and it the machinery it drives. If your is motor is coupled to a shaft brake that is released by hydraulic pressure, make sure that the brake release pressure is present at the brake. A brake that won't release is one big time mechanical binding issue, and it would account for your ability to build loop pressure while achieving no motor motion.

See the cutaway of a typical motor brake below.



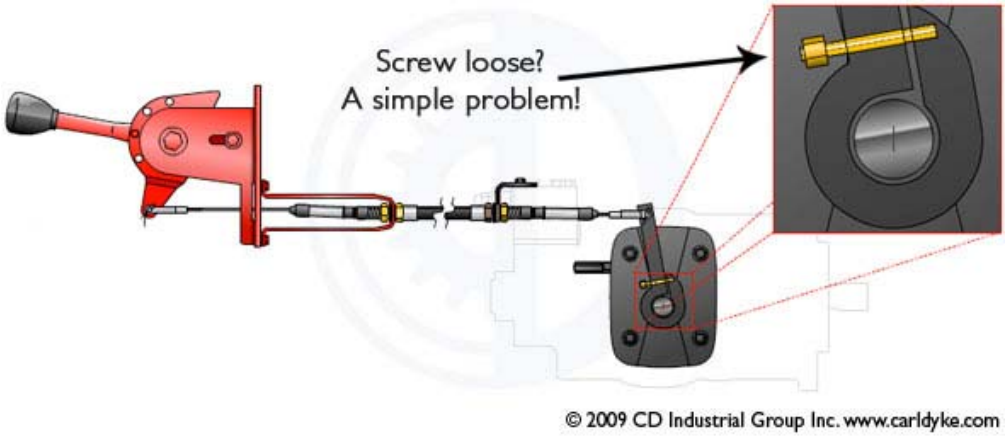


Non-compensated Pump:

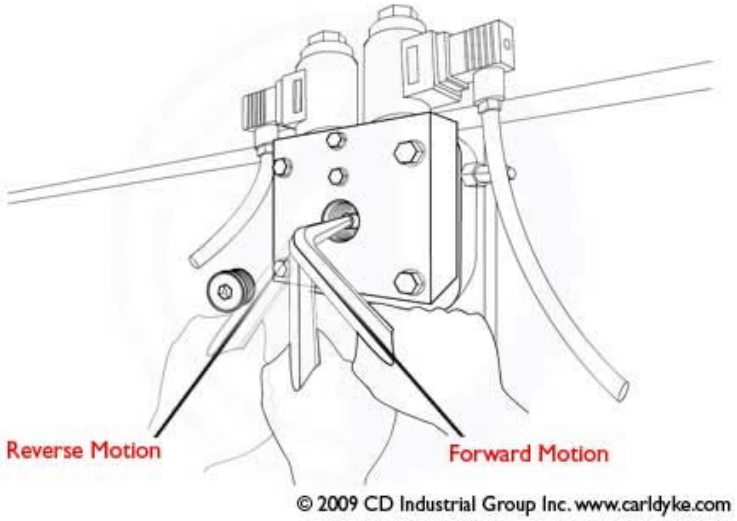
If your hydrostatic pump is not pressure compensated as is the case on small skid steer loaders and similar machines, then full pressure with no motor rotation when you move the displacement control away from neutral, most likely means that your cross-port relief valves are open. The cross-port reliefs when open will make a unique sound. Get used to listening for it. You'll be dealing with some serious heat build up as well. Again you'll have to look for a mechanical binding problem at the motor and the machinery it turns.

No

If you can't build pressure beyond the charge value (always confirm charge pressure first) on either of the main pump ports when the displacement control is moved away from neutral, then start with the easiest items. Can you confirm that the displacement control is actual working? If you've got direct mechanical linkage between the control and the pump, you should be able to see if the linkage is slipping or disconnected. If the control is electrical or electronic, you will have some electrical tests to make.

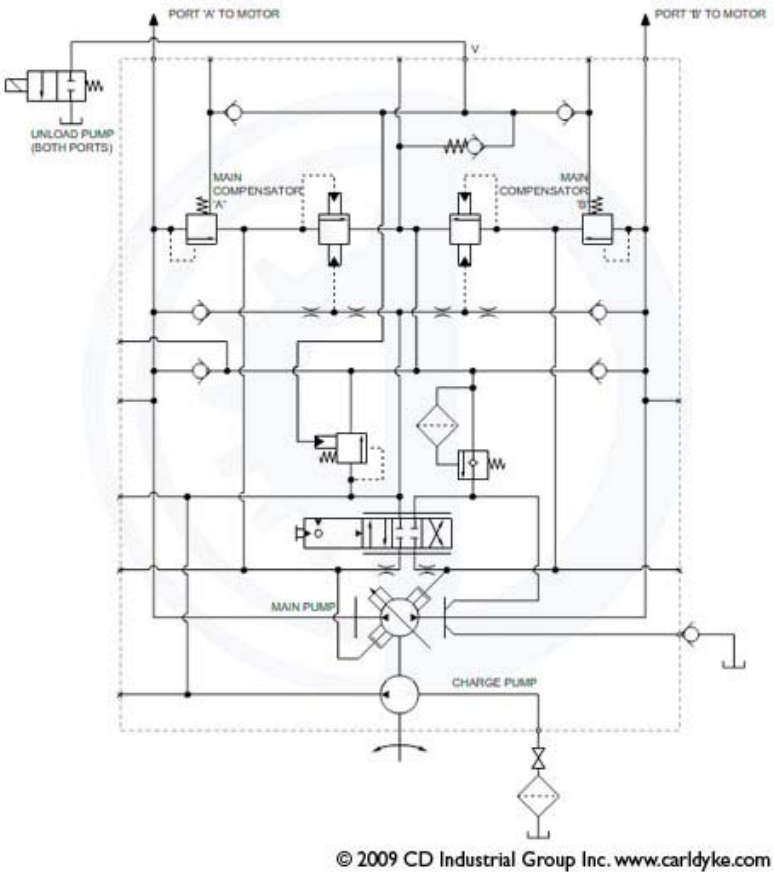


Question: Is there a manual pump displacement control right at the pump housing that you can turn to override the console control that lets you test the pump's ability to come on stroke?



Question: Is there an unloading function on your system?

Some hydrostatic pumps have a vent port that is connected to tank via a solenoid valve. If this valve is left open (stuck open) the displacement control may appear to be working on the outside of the pump but not allowed to work on the inside where the swash plate/cradle needs to be swiveled.



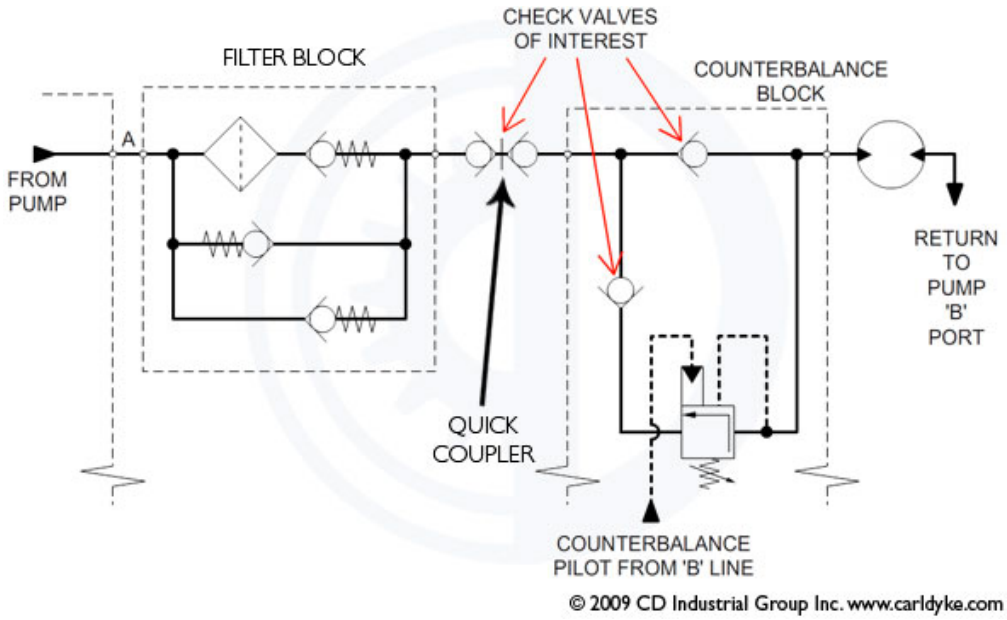
Problem: The driven hydraulic motor will go, but in one direction only.

Obviously you should check the displacement controls, especially if it is an electrical circuit. Whatever device (joystick, potentiometer, PLC output card) may only be sending the

electrical signal for one direction of displacement and not the other. Have a look the plumbing and the hydraulic schematic carefully.

Question: Is there a critical check valve on each side of the loop? Perhaps one that may be stuck closed?

Look carefully as it may be contained within a counterbalance valve. It may also be completely disguised as a quick coupler (learned this one from my friend Dale, a skilled mechanic and hydraulics troubleshooter at an oilfield services shop). These couplers sometimes fail to retain the internal spring in the correct position. You end up with a coupler that allows flow in one direction only.



If you are still examining the schematic, look again for those unloading vent ports on the pump. A pump like the Denison Gold Cup series (oops, there's a specific model) has separate vent ports for the two main outlet ports (port "A" and port "B"). If one is these vents is dumping to tank through a solenoid valve or a dialed out pressure relief valve, then obviously your hydrostatic drive will not displace fluid in one of the two directions.

Problem: This one is a bit tricky. What makes it tricky is finding the source of the problem. I've bumped into this one as a system design/engineering problem, an operator fault and as a degradation issue.

Degradation: As a degradation issue, the matter is often tied to wear at the motor that is allowing excessive cross-port leakage. The uneven motor motion that results from this is usually something that is detected when the motor is heavily loaded or when being operated at very slow speeds. There are a couple of graphs that show a leaky motor's performance versus one with very little leakage in this article (http://www.hydraulicspneumatics.com/200/GlobalSearch/Article/False/45410/) by Jack Johnson of Idas Engineering (http://crms3878.etelosserve.com/www.idaseng.com), a hydraulics engineer who I have truly come to respect. The article covers the science behind the issue quite well and is worth a read if you are up to speed on mechanical issues such as static friction and hydraulic capacitance.

Operator Fault: Some simple to solve causes for uneven motion are found at the operator's controls. If your hydrostatic loop includes displacement control, variable pressure control, and motor displacement control as is found on many oilfield service rigs, then you've got a dynamic system to say the least. Think about what happens when the pump is on-stroke but the the motor has been left in a low displacement setting (good for attaining higher motor shaft speeds, not much torque). If the system comes under sudden load from difficult work, the system pressure will quickly spike to the setting on the pump's compensator. The compensator will begin to destroke the pump and the motor may stall or almost stall. If the force applied by the motor allows the machine to break through and begin to handle the difficult work, the pump will come back on stroke and accelerate the motor again.

You may achieve much smoother motion if you operate the pump with higher displacement and then operate the motor at high displacement allowing for greater mechanical force (torque) at lower hydraulic pressure that is less likely to spike up to the compensator setting as loading at the motor varies through its normal ranges. Feel free to write to me if you'd like more information on the displacement vs. pressure relationship I'm talking about. There are some hydraulic fundamentals at work here.

Safety Note: For the sake of safety, do not adjust any settings on the pump that are designed to limit the absolute maximum system pressure. Know your pump and know your system well and respect the safe parameters that the machine designers and engineers have built in.

Engineering and Design Issue: From the engineering and design viewpoint uneven motion may be the result of changes to the nature of the work you do with the machine. It may have been designed to work optimally for certain types of jobs, speeds or duty cycles but not others. Get your supplier or engineering department involved with this type of problem solving early on. There may be a need to dampen the response of the servo valve (often a matter of installing a particular size of internal orifice in the pump) that brings the pump on-stroke to slow down the rate of motor acceleration. There may also be a need to reduce the dampening.

Problem: Motor Creeping (Can't find neutral or null)

If your hydraulic motor cannot be brought to a complete halt you have some a few fine control issues to examine.

The servo valve on the pump that sets the desired displacement can usually be chosen and configured for a marginal deadband or none at all. Without getting into the fine points of valve design suffice it to say that no deadband means that you have chosen a servo valve that has almost no neutral position to begin with. But lets begin with the simple stuff.

Question: Is the control linkage or electronics that connect operator controls to the pump working correctly? Check to see if there a null adjustment on the servo valve at the pump. Of course if you have to make a substantial adjustment, ask yourself what else has changed or could have happened that this adjusment is now required.

Question: Are there counterbalance valves in the main loop lines that feed the motor? If so, then has someone adjusted those valves to a lower setting?

Extreme Caution: Adjusting counterbalance valves without very certain knowledge of what you are doing could be deadly. Counterbalance valves are often supporting a vertical load that could drop if the setting is inadvertantly reduced.

Question: Is there a spring applied motor shaft brake that is supposed to set when the pump displacement is at or near neutral?

Perhaps the brake won't apply if the charge pressure has been set higher than normal.

Problem: Heat and Noise.

Heat unusually high? Check these:

- Check the air cooler (plugged fins, internal passages plugged with contaminants, or the bypass check valve jammed open)
- Tank level too low (can't cool fluid if there isn't enough of it in the tank)
- Pump case drain line is partially blocked (ooh that's a bad one)
- System operating too long at high cross-port pressure relief setting (assumes that you pump is not of the pressure compensated type, or the system settings are poorly adjusted)
- Excessive internal leakage (at the motor, or at other points in the system. Fluid gets hot any time you shoot it through a small opening at high velocity)

Noise

- Air in the system (you've probably got some uneven motion too)
- Tank level too low (aeration bad!!)
- Blockage on charge pump suction line (cavitation! Solve it right away!)
- Insufficient charge pressure (main pump and loop starving/cavitating. Check your pump manual for procedures to verify and adjust the charge pressure)

Wrapping Up

As I mentioned earlier, these are some of the big issues. Its not an exhaustive list and it doesn't take the many variations of circuit design into account. Ultimately tough problems require you to get to know your complete system and its optimum settings. You must also know each component in the system.

We have built quite a few interactive animated schematics for hydrostatic drives. Some of the generic ones are featured in our open registration courses and in our on-line materials at LunchBoxSessions.com. The client specific simulations we build are designed to help maintenance and operations teams learn all of the system functions and be ready for efficiency and effective troubleshooting when needed. Let us know if we can help you with your system training needs.