THE HIGGINSON CIRCUIT

JULY 2016

It's Not Worth Crying Over Spilled Milk

Written by: Josh Cosford

You can cry over spilled milk if you wish, and while you'recrying, you will probably wonder how I'm going to use this to segue into this article. I was attempting to think of the number one most cliché expressionever to exist, and "it's not worth crying over spilled milk" definitely ranksup there, although I could have gone with "the pen is mightier than the sword"or "laughter is the best medicine" (I'll remember that next time myone-year-old is freaking out with an ear infection and then throw on a DaneCook DVD to see if it helps).

The theme here is clichés. You might assume the world offluid power is immune from clichés, since hydraulic and pneumatic technologiesare engineering centred fields with a foothold in reality, but that's far fromthe case. There are two clichés I'd like to discuss, both nasty little thingswhich have staying power like The Rolling Stones.

Please stand up if you have heard either "Flow Makes it Go,"or "Pressure is Resistance to Flow." Please sit down if you disagree with thesestatements. I can't see any of you, but I know there are still too many of youstanding.

My goal is not to make you feel terrible for believingeither of these terms. I was taught both of these when I first learnedhydraulics, and although my spider senses tingled at the idea that pressurecame from the restriction, I have no choice but to believe what I was taught.The same thing applies to you or anyone else taught the same thing without everbeing told differently. I'm here to teach you differently.

I won't discuss the process in which the sun's energy makesit into a hydraulic system, because it's just a massive chain of energy beingconverted to one form or another, but let's agree that a hydraulic pump getsits energy from the gas engine or electric motor turning it. Furthermore, let'sagree that pump then turns the mechanical energy of the prime mover intohydraulic energy used by our hydraulic system. It is very important tounderstand ALL the useful energy in our hydraulic system enters via the pump.

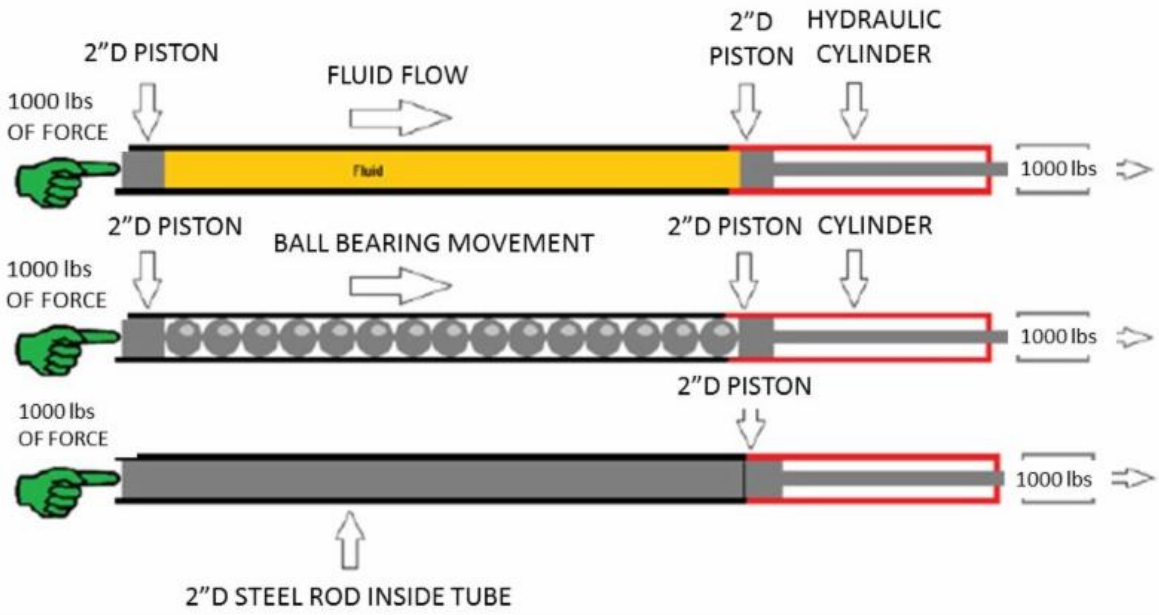
Let's get back to the clichés, and I'll start with "Pressureis Resistance to Flow." This is obviously untrue, or I would not be writing anarticle about it. Saying that pressure comes from the resistance is anadmission of magic capable of defying the natural laws of the universe. Take ahydraulic cylinder as an example; a load on the cylinder creates a resistanceto flow. This resistive load then creates pressure in our hydraulic system, andthe load rises.

Essentially, the load on the cylinder is creating its own energy to lift itself … levitating if you will. Clearly this is impossible, because if not, why do we even need a pump?

"We need a pump to create flow, and only flow," the old school theory claims. This

term makes a little more sense than the first, but still has Sir Isaac Newton turning in his grave. The “Flow Makes it Go” catch phrase incorrectly tells us we only use volume and flow rates to calculate cylinder velocities and cycle times. The unfortunate part of this circumstance is that the calculations are completely accurate when you try to describe the steady state motion of a cylinder, the same way engine RPM and gearing allow you to calculate vehicle speed. Problems arise when you throw *any* other variable in the mix, such as acceleration, vector relative to gravity (angle), friction etc. All of these factors and more are taken into account when you do proper calculations for cylinder motion control.

There is only one thing in the universe that makes things go, and that thing is *force;* Force Makes it Go. Before I continue, please study the attached diagram. The green finger belongs to The Hulk, but this one I like to call The Credible Hulk. Starting from bottom, what we have is The Credible Hulk’s finger pushing on a 2” diameter solid steel rod, which slides in a 2” inside diameter tube. This tube, like in all three examples, is butt welded to the cap end of a hydraulic cylinder sharing the same 2” diameter ID.



Essentially, the load on the cylinder is creating its own energy to lift itself … levitating if you will. Clearly this is impossible, because if not, why do we even need a pump?

“We need a pump to create flow, and only flow,” the old school theory claims. This term makes a little more sense than the first, but still has Sir Isaac Newton turning in his grave. The “Flow Makes it Go” catch phrase incorrectly tells us we only use volume and flow rates to calculate cylinder velocities and cycle times. The unfortunate part of this circumstance is that the calculations are completely accurate when you try to describe the steady state motion of a cylinder, the same way engine RPM and gearing allow you to calculate vehicle speed. Problems arise when you throw *any* other variable in the mix, such as acceleration, vector relative to gravity (angle), friction etc. All of these factors and more are taken into account when you do proper calculations for cylinder motion control.

There is only one thing in the universe that makes things go, and that thing is *force;* Force Makes it Go. Before I continue, please study the attached diagram. The finger belongs to The Hulk, but this one I like to call The Credible Hulk. Starting from bottom, what we have is The Credible Hulk’s finger pushing on a 2” diameter solid steel rod, which slides in a 2” inside diameter tube. This tube, like in all three examples, is butt welded to the cap end of a hydraulic cylinder sharing the same 2” diameter ID.

When The Credible Hulk pushes on the steel rod with at least 1000 pounds of force (or slightly more), it pushes on the piston of the hydraulic cylinder and our 1000 lb load moves. It is clear in this example that force transmitted via Hulk’s finger, through

the rod, to the piston, through the piston rod and then to the load. The force *starts* with the finger, not at the load.

In the second example, I've placed a piston just inside first portion of the tube, and the rest of the steel rod is replaced by 2" diameter ball bearings. When The Credible Hulk pushes on the piston, it in turn pushes on the first ball bearing, and the ball bearings push down the line with the same effect as the steel rod. Once again, the force *starts* with the finger, not at the load.

In the top example, the ball bearings have been replaced with hydraulic fluid. Once again, The Credible Hulk pushes on the piston, and the piston this time pushes on the fluid. The fluid then pushes its way to the right and pushes on the piston of the cylinder. What makes this example different than the bottom example? As far as I'm concerned; nothing. The fact that the molecules of the oil are free to move amongst themselves within the tube, and the molecules of the steel rod are fixed in place has nothing to do with anything.

The top example, as far as physics is concerned, uses a rod made of fluid, able to transmit force in the same way the bottom two examples do. It is the force created by the Hulk that ultimately moves our 1000 lb load. If we put a handle on the piston, added a reservoir and a couple check valves, we could turn the top example into a pump. Calling it a pump does not disqualify force from being the reason work can be achieved in a hydraulic system; force still makes it go. The Hulk's finger on the piston is just as much a pump as any other hydraulic pump.

The pressure in a hydraulic system is always highest at the pump, and there is no way around this. Energy can move only from an area of higher energy to an area of lower energy. If at any time pressure was higher anywhere else in the system, the fluid would move backwards to the pump. The fact that restriction and resistance RESULTS in pressure does not mean those restrictions and resistances CREATED the pressure.

The pressure at a restriction results from Newton's Third Law, stating every action has an equal and opposite re-action. The restriction is pushing back against the force created by the pump, and pressure (which is force over a defined area) rises proportionately to the force put in by the pump. Pressure will rise until the force at the restriction is high enough to move it (or flow through it), or until the pump stalls, goes on stand-by or blows up.

Pressure and flow are two factors of hydraulic energy. Pressure, even fractions of a PSI, is required at the gear/vane/piston of a pump to create flow, regardless what is downstream of the pump. But if force (pressure) makes it go, why do we need flow? Flow is the rate in which we can create pressure in a hydraulic system. If you pump fluid into a cylinder with a load, you create a differential of force between the cap side of the piston and the rod side of the piston. When you stop pumping (and there is no leakage) the pressure component exists, but with no flow, you can no longer create the force differential to maintain movement. Fluid is merely trapped, and as per Pascal's law, is equal in all areas.

I've coined and recently used the term, "Flow is the Rate in Which You Can Create Pressure" and I feel it so strongly describes flow's contribution to hydrostatics, I'd like to expand on it further to create a statement to replace the previous (incorrect) catch phrases. I'm naming the new expression "Cosford's Law" and the new expression is: "Pressure Makes it Go, and Flow is the Rate in Which You Can Create Pressure." Narcissistic, sure, but something needs to replace the previous anachronistic fallacies. Feel free to shorten if to, "Flow Makes the Pressure Go" if it sounds catchier to you.

Now if you don't mind, I'm going to ready responses to the hate mail that will flood my inbox shortly. Until next time!

Contact us today to speak with one of our professionals!

Higginson Equipment Inc.
Burlington, ON
Phone: 905-335-2211
info@higginson.ca

Don't miss out on our newsletter, The Higginson Circuit!
Sign up below!

JOIN OUR MAILING LIST

VISIT OUR WEBSITE

WEBSITE THE COMPANY PRODUCTS CONTACT US