Brendan Casey's

Hydraulics Pro Club Newsletter

May 2009

I got a reminder notice in the mail last week from a company whose business is the proactive maintenance of domestic hot water heaters. Now, you might be thinking: "How could anyone make a business out of that?" Well, the hot water heater in my house, like thousands of others, is a storage type – basically a tank of water heated by gas. But the steel tank has a sacrificial anode installed to protect it from corrosion and therefore extend its life.

I had the anode replaced three years ago. And the letter is to remind me it is now due for inspection. But from past experience, I know the anode will be spent. The cost of a new anode is $150. What to do?

If you're responsible for keeping hydraulic equipment running, this is the sort of decision you have to make on a regular basis: do I spend a modest amount of money now to avoid an expensive disaster down the track?

In the case of my hot water heater, $150 is not a life-changing amount of money. Still, it would be very easy to sit on my hands and do nothing. After all, replacing the anode will do nothing to enhance its performance; I won't get a better shower in the morning.

But that's why it's called *proactive* maintenance. Proactive maintenance requires accurate thinking, followed by appropriate action – or in some cases, *intentional* inaction.

Since ignoring the reminder notice is neither of the above, some accurate analysis is required. My brother-in-law is a plumber, and he reckons if the anode is replaced every 3-4 years, the water heater should last at least 12. But it could rust out in as little as 6 without anode replacement. A new unit is around $1200 excluding installation. And Murphy's Law suggests it will rust out during the Christmas holidays when my Mother-in-law wants to wash her hair. Plus, if I *can* get hold of a plumber he'll want a king's ransom just to show up.

Without factoring in the consequences of my Mother-in-law having to choose between a cold shower or a bad hair day, the numbers are not hard to crunch: without any anode replacements, assuming a service life of 6 years, then after 12 years I will have replaced two water heaters at a cost of $2400 (2 x $1200). If I replace the anode at years 3, 6 and 9 – and the complete unit at 12 years, the total cost over 12 years is $1650 ($1200 + 3 x $150). So I am in front by $750 ($2400 – $1650) worth having.

But the return on investment (ROI) is even more impressive: I have invested $450 to save $750, and ROI of 167% (750/450 x 100). I won't get that sort of return by leaving the money in the bank.

But what if my water heater doesn't make it to the 12 year mark? Say it rusts out in 8 years. Well, based on a 6 year life without anode replacement, and a unit replacement value of $1200, each year of service life extension is worth $200 ($1200/6 = $200).

So say I replaced the anode twice at years 3 and 6 for a total cost of $300 (2 x $150) but only got 8 years out of the unit. Those 2 years of life extension are worth $400. In this case I am only $100 in front after deducting the cost of two anode replacements ($400 - $300 = $100). But even in this worst case scenario I am still better off.

So based on this analysis I feel confident that getting the anode replaced now (year 6) is a sensible proactive maintenance decision.

"That's great Brendan, but what's it got to do with me?" I can hear some of you thinking. Well, if you are a hydraulic equipment owner, or work for one, consider this *your* reminder notice. What proactive maintenance decisions are you putting off or procrastinating about?

Of course, as the above example illustrates, to make informed decisions in these matters you need accurate information about your hydraulic equipment. And that's another reason you've got me, showing up in your mailbox each month.

With that thought in mind, one of our members, who works for a large hydraulic equipment manufacturer, posed this question, which affects every hydraulic equipment owner.

"We would like to know the contamination issues to consider when we buy crimped hoses from a vendor. We want to ensure the hoses we buy will not add contamination to the system. This is a big issue for us because each of our machines uses as many as 400 hoses."

It's a pretty good question. Hydraulic hose fabrication is a big business with a lot of competition and more than a few cowboys running around.

The hose fabrication process – or more specifically - the hose cutting process introduces contamination, in the form of metal particles from the hose's wire reinforcement and the cutting blade itself, and polymer dust from the hose's out cover and inner tube.

The amount of contamination which enters the hose during cutting can be reduced by employing techniques such as using a wet cutting blade instead of a dry one, blowing clean air through the hose as it is being cut and/or using a vacuum extraction device. The latter two aren't very practical when cutting long lengths of hose from a roll or in a mobile hose-van situation.

Therefore the main focus must be on effectively removing this cutting residue – and any other contamination that might be present in the hose - prior to installation. The most efficient and therefore most popular way of doing this is by blowing a foam cleaning projectile through the hose. If you are not familiar with this equipment, do a search on google for "hose projectile".

The manufacturers of these cleaning systems claim that hose cleanliness levels as good as ISO 4406 13/10 are achievable. But like most everything else, the results achieved depend on a number of variables, which include using a projectile of the correct diameter for the hose being cleaned, whether the projectile is used dry or wetted with solvent, and the number of shots fired. Generally, the higher the number of shots, the cleaner the hose assembly. Oh, and if it is a new hose assembly that's being cleaned, the projectile cleaning should be done BEFORE the ends are crimped on.

Almost all hydraulic hose fabricators these days have and use hose cleaning projectiles. But how meticulous they are when doing it is another matter entirely. This means if you want to ensure you take delivery of hose assemblies to a certain standard of cleanliness, it's something you must specify and insist upon – as this little story from another of our members illustrates:

*"I was changing some hoses on a Komatsu 300 HD for a customer and he noticed me washing out a hose before I put it on, so he asked: "They clean them when they make them don't they?" I said yup but I like to check. I took the caps off a new hose and washed it with solvent and emptied the contents into some paper towel as he watched. His response was holy sh*t!"*

And it's not just the standard of the cleaning which must be insisted upon. A few years back I was at a customer's premises when their hose supplier arrived to deliver a big bunch of hose assemblies. When the pallet came off the truck it was obvious to anyone with eyes that none of the hoses were capped to prevent contaminant ingression. And the customer accepted them. Nuts. As soon as I saw what was going on, I advised this customer to require all hoses be delivered with caps installed and not to accept them otherwise. This sort of penny foolishness should not be tolerated from any hose fabricator.

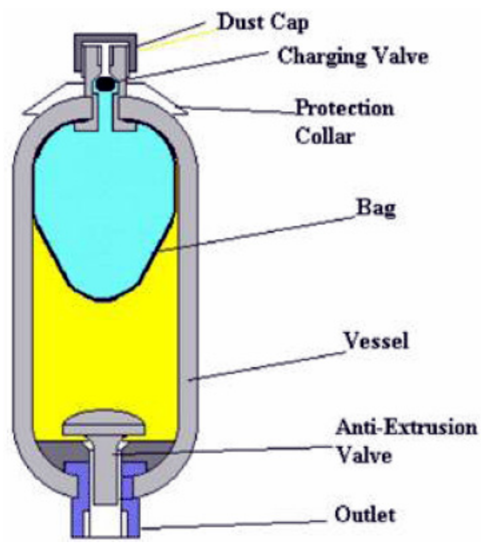
On this month's CD I've included a Gates document on hose assembly cleanliness which expands on many of the above points. It also includes an explanation of the standards an OEM customer like the one who posed this question might use to specify a required level of cleanliness for hose assemblies delivered by its vendors.

But whether you buy one hose at time or hundreds – or fabricate them yourself, this seven page document is definitely worth reading - and printing for your reference library.

Component Basics: accumulators. The three types of accumulators you'll encounter on hydraulic systems are bladder, piston and diaphragm.

The most popular type, bladder accumulators, feature fast response (less than 25 milliseconds), a maximum compression ratio of around 4:1 and a maximum, hysteresis-free flow rate of 15 liters (4 gallons) per second. Although "high-flow" versions up to 38 liters (10 gallons) per second are available.

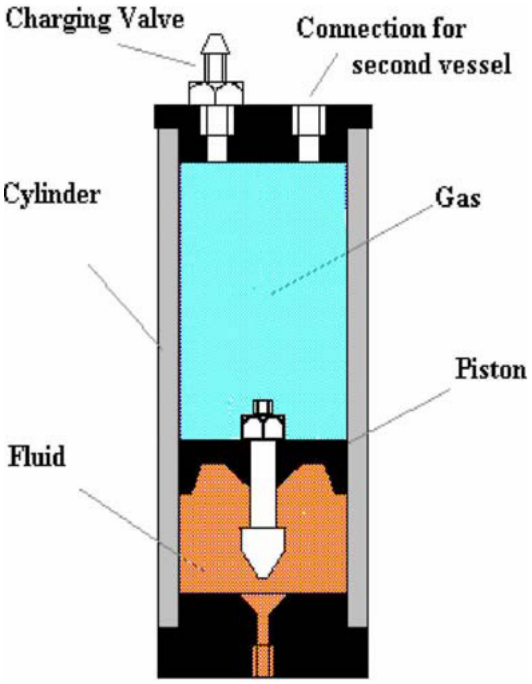
Bladder accumulators also have good dirt tolerance (largely unaffected by particle contamination of the hydraulic fluid).



Bladder Accumulator

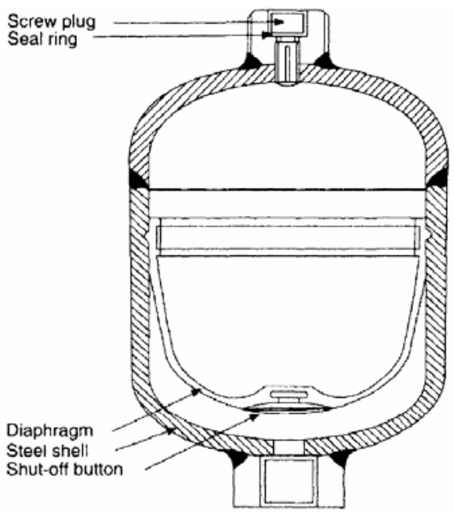
Piston accumulators on the other hand, can handle much higher compression ratios (up to

10:1) and flow rates as high as 215 liters or 57 gallons per second. Unlike bladder accumulators, which should always be mounted vertically to prevent fluid getting between the bladder and the sidewall of the vessel, piston accumulators can be mounted in any position.



Piston Accumulator

But piston accumulators also require a higher level of fluid cleanliness than bladder units, have slower response times (greater than 25 milliseconds), especially at lower pressures and exhibit hysteresis. This is explained by the static friction of seal which has to be overcome, and the necessary acceleration and deceleration of the piston.



Diaphragm Accumulator

Diaphragm accumulators come in limited volumes, have most of the advantages of bladder-type units but can handle compression ratios of up to 8:1. But their performance can sometimes be affected by gas permeation across the diaphragm.

While accumulators present a number of advantages in hydraulic system design, they do require ongoing maintenance. For example, maintaining gas pre-charge, bladder/piston seal replacement, and inspection, testing and certification as required by law – remember they are pressure vessels.

When replacing a bladder, always ensure the inside of the vessel shell is lubricated with clean hydraulic oil to help protect the bladder from damage during initially pre-charge.

When charging the gas end of a bladder accumulator the nitrogen gas should always be admitted very SLOWLY. If the high pressure nitrogen is allowed to expand rapidly as it enters the bladder, it can chill the bladder's polymer material to the point where immediate brittle failure occurs.
Rapid pre-charging can also force the bladder underneath the poppet at the oil-end causing it to be cut.

If precharge pressure is too high or minimum system pressure is reduced without a corresponding reduction in precharge pressure, the operation of the accumulator will be affected and damage may also result.

Excessive precharge of a piston accumulator can cause the piston to bottom out at the end of its stroke, resulting in damage to the piston and its seal. The good news is, if this happens an audible warning will result. You'll hear it!

Similarly, excessive precharge of a bladder accumulator can drive the bladder into the poppet assembly during discharge, causing damage to the poppet assembly and/or the bladder. Excessive precharge is a common cause of bladder failure.

Low or no precharge can also have drastic consequences for bladder accumulators. It can result in the bladder being crushed into the top of the shell by system pressure. The can cause the bladder to extrude into or be punctured by the gas valve. In this scenario, only one such cycle is required to destroy the bladder.

And as you may have gathered from the preceding few paragraphs, another advantage of piston accumulators, is they are more tolerant of improper precharging.

One of our members posed this question about the difference between load-sensing circuits used on some hydraulic excavators:

"I read one of your articles where you explain that load-induced pressure downstream of the control valve (orifice) is sensed and pump flow adjusted to maintain a constant pressure drop and therefore flow across the control valve, ensuring the actuator speed does not change with change in load.

Is a constant pressure drop maintained across the control valve in an open-center, load sensing system fitted with variable displacement axial piston pump – for example, Komatsu excavator?"

The short answer to this question is no. But before I explain why, some definitions:

The type of load-sensing control referred to in the first part of this question and which is covered in detail in both *Industrial Hydraulic Control* and *Advanced Hydraulic Control* is closed-center load sensing (CLS) - see diagram inside back page .

The load-sensing system referred to in the second part of this question and which is used on older Komatsu and some other makes of hydraulic excavators (see diagram on back page) is open-center load sensing (OLS).

Plug the enclosed CD into you disc drive and sit back, relax and watch while I explain the key differences between the two systems on this month's video.

Final thoughts this month… I just finished a conference call with a client for whom I am working to solve a series of piston pump failures. There were three of them on the call: maintenance manager, reliability engineer and equipment manager.

Because the pump failures appear to be the result of lubrication failure, the conversation turned very quickly to their oil analysis program. Turns out they *are* doing oil analysis, but doing it very badly. In fact, I would go as far as to say they're flushing the money their spending on oil analysis down the toilet.

Like a lot of hydraulic equipment owners - and they didn't say this but, they're taking oil samples and sending them to a lab just to get particle counts. What's wrong with that you might ask? Well, if that's all they want, given this company's size, they'd be better off investing in a portable particle counter.

And it would save them the embarrassment of being asked a load of questions by someone like me which they can't answer. For example, water weakens lubricating film strength, but they couldn't tell me the level of water contamination in the oil – not accurately anyway. And given the hydraulic system has large single-rod (unequal displacement) cylinders and works in a high-humidity environment - but doesn't have a desiccant tank breather, this would have been very interesting to know.

Then they wanna know when to change the hydraulic oil. So I explain there are only two conditions which necessitate an oil change: base oil degradation and additive depletion. Set up properly, their oil analysis reports will provide data on both of these conditions. But it's not, so they aren't. Again, we're considering lubrication-related failures, so it would be nice to know whether the oil's anti-wear additives are depleted or the base oil is past its use-by date.

Anyway, I shouldn't grumble. It creates work for me – and all the hydraulic repairers out there. But I've resolved since YOU are a Hydraulics Pro Club member, you need to be smarter than the average bear when it comes to oil analysis.

Which is why in future issue of this newsletter you'll find practical articles about the finer points of hydraulic oil analysis. Study them closely and you'll add another string to your bow.

I would appreciate your feedback on this issue. Please send it to me by email bcasey@hydraulicsupermarket.com or fax +1 440-919-6050 (US) or +61 8 9388 9895 (Australia). And don't forget, as a Hydraulics Pro Club member, you are welcome to submit your hydraulic questions and/or problems to be considered for detailed discussion and analysis in this newsletter.

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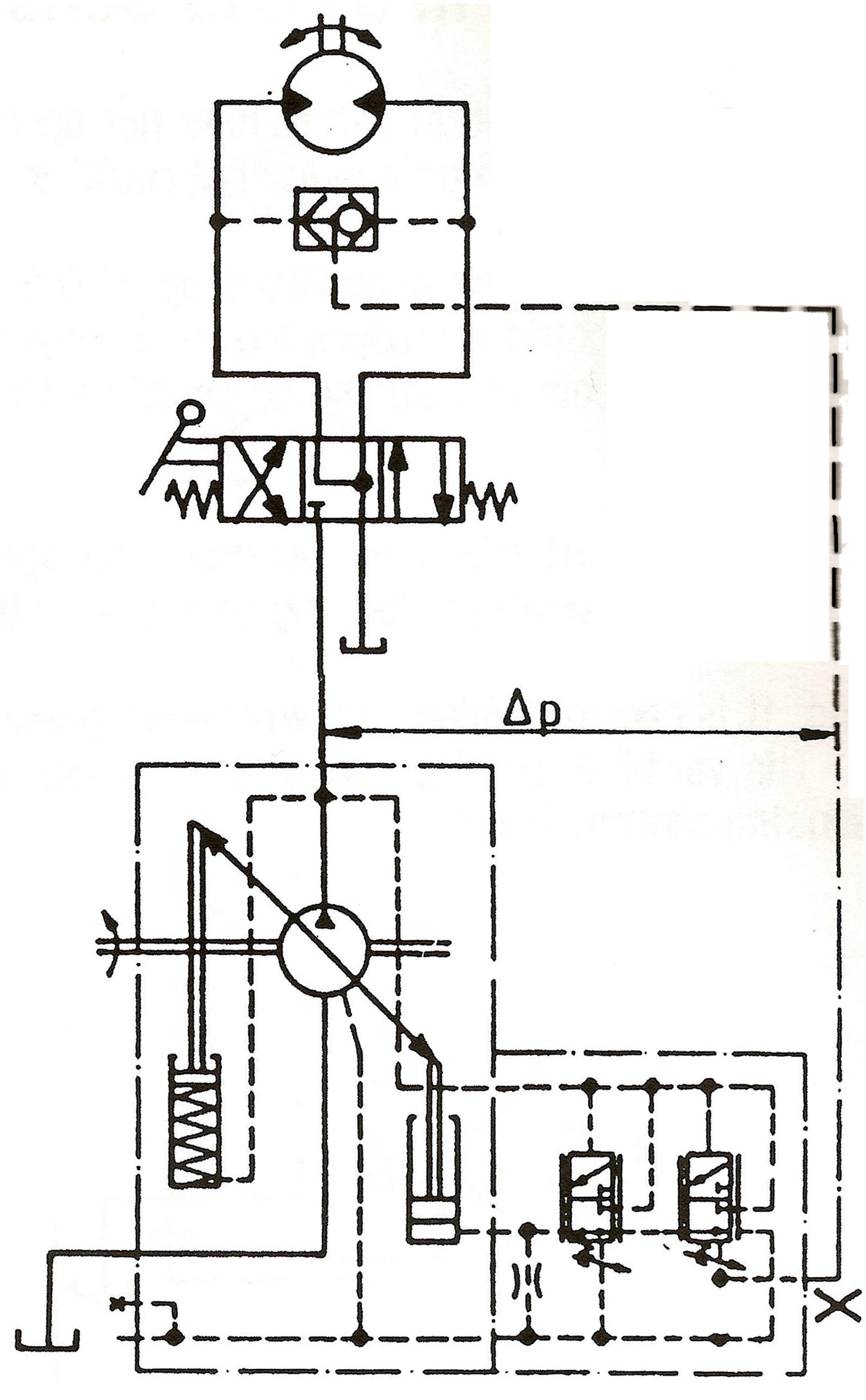
Closed Center Load Sensing (Bosch Rexroth)



Open Center Load Sensing (Komatsu)