How the old proverb of “a once of prevention is worth a pound of cure” will add profit to the bottom line.

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Over the course of three decades I have been involved with designing, building, enhancing and maintaining processing systems including hydraulic systems. What has always mystified me is the capital investment made by companies for equipment who then show little concern for maintaining their equipment, thus their investment. I don’t know how this came to be so prevalent, whether it is the idea of “don’t fix it if it aint broke” or just a general lack of knowledge. Whatever the reason, the lack of proper and routine maintenance not only reduces equipment and component lifetimes, but also equipment efficiencies, which ultimately is money lost.

One industry where proper maintenance seems to be a continuing problem is the carwash industry. I have been retained a number of times to investigate incidences of equipment failure and 9 times out of 10 the failure comes down to poor routine maintenance. In the carwash industry the types of problems can roughly be separated into three categories; electrical and electronic problems, water problems, and hydraulic system problems. In the first category, that of electrical and electronic problems, routine maintenance is difficult because of the nature of the equipment. Generally you don’t know you have a problem until something fails. The only thing that I can say is to make sure that when components are repaired or replaced; that like products are used. With electrical and electronics the OEM (Original Equipment Manufacturer) carefully selects the components to perform the function both safely and efficiently. Therefore, replacing like with like is critical to system operation and human safety. When problems begin to emerge it’s important to get on them immediately to avoid a cascading failure effect. However, water systems and hydraulic systems are a completely different story.

Much can be done through routine maintenance to prevent catastrophic failures in both high pressure water wash systems and systems with hydraulics. High pressure water wash systems have four primary weak points.

The four weak points in a high pressure water system are; the water pump, filtration, nozzles and valves.

At the literal heart of the system is the high pressure water pump. In the carwash industry it is normally a triplex type plunger pump. These pumps traditionally have ceramic plungers lubricated by wicking from an internal pump oil reservoir. The pumps are sensitive to raw contaminated water, high temperatures and lack of lubrication. The pump OEMs usually recommended that the pump’s oil levels be checked at least every 90 days and the seals be replaced roughly every 300 to 1500 hours dependent on use. Under normal conditions and routine maintenance the pump will last until the plungers are worn to the point where the pump will no longer create the desired pressure and flow. This is indicated by the fact that the pump begins to have so much internal leakage that it is difficult to raise and maintain system pressure. Something else that happens with worn pumps is that it is possible for the oil to transfer from the oil reservoir to the water system, thus contaminating the water. Therefore when the pump becomes too worn it should be repaired or replaced prior to more serious problems occurring. In general, if the OEM’s maintenance recommendations are followed with good discipline then satisfactory lifetimes should be achieved.

Of the remaining three problem areas, valves and nozzles are fairly maintenance free. The effects of high pressure water passing over the nozzle orifice is highly eroding and if the water isn’t pretreated, thus controlling the water mineral and contamination content, the build up of minerals will also accelerate the wear on the nozzles. Worn nozzles are evident when it becomes impossible to maintain the spray pattern and droplet size. Increasing the system pressure will temporarily counteract the problem but hasten further erosion and ultimate replacement, while adding to increased energy costs. Another problem that occurs with nozzles subjected to contaminated water is the excessive clogging of the nozzle orifice. Maintenance procedures should include routine visual inspection and cleaning of any mineral buildup contaminate blockages.

Although valves have similar problems to nozzles, they have two additional weak points; valve seats and solenoid actuators. The valve seats in water valves are close fit mating surfaces. Normal erosion by the water slowly wears away the valve seat mating surfaces resulting in ever increasing leakage. Also if contaminated water is allowed to flow through the valves for any extended period it will exasperate the erosion. In high pressure water valves the valve seats can be subject to cavitation which will in turn cause damage through pitting, thus leading to unacceptable leakage.

The other significant problem with electrically actuated water valves is the solenoids. Valves are designed and manufactured to endure millions of actuations. In direct acting solenoid valves the spring in the valve stem can weaken over time leading to the inability to either actuate to open or close, depending on whether it is normally open or normally closed. Also, the solenoid coil is prone to failure based on actuation over time and the thermal shock effect. It is always wise to have a few extra coils at the ready for replacement of burned out coils. Good valve

maintenance is usually nothing more than monitoring leakage rates, and when the valve begins to exhibit high rates of leakage it should be rebuilt or replaced.

Of all that can be done to reduce overall cost and eliminate down time; maintaining a good filtration program will bring the greatest return. All water systems have and require good filtration to provide adequate service. The more of the contaminants that can be removed from the water the longer the system will last and the fewer equipment problems will be experienced. This is particularly true to pump, nozzle and valve lifetimes. Most water system filters have a nominal rating of 10µ. In layman's terms this means that about 60% to 75% of all particles larger than 10µ will be retained in the filter media. The finer the filter media rating the more that will be captured, but the more often the filters will have to be changed. Generally the 10µ nominal filters are sufficient for most systems, but they must be changed when full. This is where a few dollars spent will facilitate maintenance and save money in the long run. The cheapest solution is to add a dirt gauge or a dirt switch to the filter. This gives either a visual or audible signal when the filter needs to be changed, thus taking out the guess work. By using dirt indicators, filters will only be changed as needed, saving money by avoiding too frequent of changes and changing often enough to prevent damage to the pumps from clogged filters. Just as you should have spare valve coils, you should also have new filters on hand.

I will not address in this article the maintenance requirements of RO (Reverse Osmosis) and DI (De-ionized) water systems.

Moving on to carwash hydraulic systems, they present a unique set of problems not encountered in the high pressure water wash systems. Generally speaking carwash hydraulic systems are fairly straight forward utilizing a simple open system design. Two types of pumps dominate the market; vane pumps and gear pumps. Most systems are small flows, under 10 gpm and fluid system pressures of < 1500 psi. Unlike water systems where the fluid is naturally low viscosity, erosive, non-laminar, and high vapor point; oils are viscous, non-erosive, low vapor point and laminar. In many ways oils are much more forgiving and tolerate poor attention to maintenance. However, oils have a significant down side; they are flammable, polluting, subject to oxidation, emulsifying, and difficult to clean up when spilled. Even with all of oil's shortcomings all current carwash hydraulic systems are built to use petroleum based mineral oil hydraulic fluids. Maintenance for oil based hydraulic systems is straightforward and simple; keep the fluid clean and repair leaks before they become a problem. A clean hydraulic system can provide average pump lifetimes of between 8,000 to 10,000 hours.

The problem that I have often encountered is improper filter maintenance. The return filter is the primary means for keeping the system clean and well functioning. I had one client who was changing filters about every six months to one year and was having problems with pump and motor failures. He was using a vane pump and they were only lasting less than a year. The orbital motors were developing significant internal and shaft seal leakage resulting in frequent replacement. His system had been operating for a little over four years and he had replaced four pumps and countless motors. During the four years he had not replaced the system oil even once since commissioning the system. As I analyzed the system I took fluid samples and split the filter open. When I received the sample report it indicated that the fluid was completely worn out and was full of oxidants and metal contaminates. Upon opening the filter, it was clogged and in full bypass. In short, he was pumping dirty oil throughout his system. After cleaning the system thoroughly, including steam cleaning of the reservoir; the system was replaced with fresh hydraulic oil. I then put him on a filter maintenance program, changing the return filters once per month and taking fluid samples every six months. I also recommended that whenever system components were replaced that the return filters should be replaced. Based on the system usage we calculated that the fluid needed to be replaced, based on the fluid sample reports, every 3 ½ years. It has been six years since he went on the maintenance program and he has completely eliminated his hydraulic problems, while nearly doubling his production in cars per hour. What had been annual maintenance costs and lost revenues of around $10,500 to $15,500 per annum, due to hydraulic problems, were reduced to an average of < $700 per year. This example illustrates the problems that dirty and worn out oil will cause.

Many carwash owner/operators have taken steps toward eliminating the negative characteristics of mineral based hydraulic fluid by replacing it with water based fluids. This is an excellent solution when the water based fluid is applied properly and maintained.

Of the problems I have encountered with these systems they usually involve maintaining a balanced chemistry of the fluid, high temperature operations, operating in systems with incompatible components such as non-anodized aluminum components (primarily gear pumps, aluminum reservoirs, and reactive elastomers), and the use of improper filters.

A high maintenance item is maintaining the chemical balance of the fluid. Most water based hydraulic fluid used in the carwash industry is a diethylene glycol with 35% to 45% water, along with an additive package. The fluid gets it lubricity from the base pH of 8 to 10.5. Being water based fluid it is susceptible to evaporation. As water evaporates it changes the pH to higher base levels and adversely affects the lubricity between wear surfaces. This increases the wear and can shorten the lifetimes of the system components.

Therefore it is absolutely critical to monitor and maintain proper pH levels. The monitoring is accomplished by commonly utilizing a viscometer, a refractometer, or litmus test. Testing frequency is dependent on ambient operating temperatures. The higher the ambient temperature the more often it needs to be tested. I recommend performing the monitoring at least once per quarter and if operating at high ambient temperatures without a cooling system, as often as bi-monthly or monthly. The fluid supplier can provide direction on how to return the fluid back to proper balance.

Although water based fluids have better heat transfer properties than oil, they also tend to remain too viscous, in comparison to oil, when operated at high temperatures. Water based hydraulic fluids work best below 50° C (122° F) and when operated at or below these temperatures require a less frequent fluid monitoring since the fluid is less likely to evaporate. Some fluid suppliers recommend the installation of system coolers when converting from oil to water based fluids. In general, whether water based or oil, an investment of a few hundred dollars installing a cooling system will pay off with a significant increase in system lifetime. Also maintaining system fluid levels are critical in holding down heat.

Most carwash hydraulic systems rely on the heat transfer characteristics of the reservoir. If system fluid levels become too low there isn't enough fluid in the system to haul away produced mechanical heat and dwell long enough in the reservoir to take full advantage of the tank cooling effect. By maintaining proper fluid levels it enhances the cooling effect. Thus, in systems with water based fluids, low system level will build up heat quickly and accelerate water evaporation.

In some systems that are not equipped with hydraulic dump valves and rely on the pressure relief valves, heat can quickly build up if full system pressure is dumped over the relief valve for any length of time. In a five horsepower system dumping over the relief will produce around +3.0 kW in heat directly dumped into the reservoir. An investment of < $100.00 in a solenoid operated dump valve will eliminate this problem. If purchasing a new system it would be wise to have it installed if it does not come normally with the system.

Another common problem in some systems is the use of water based hydraulic fluids in systems that contain non-anodized aluminum. Most of the problems that I have observed have been with aluminum reservoirs. Although most are painted on the outside the inside is bare non-anodized aluminum; the water base fluid attacks the aluminum and the fluid becomes milky in color and soapy in texture. This chemical combination defeats the properties of the fluid and will not allow the system to function properly. If uncorrected it will lead to system failure. Aluminum reservoirs are not good applications for water based fluids. If one insists on using water based fluids, the reservoir will have to be either suitably internally coated or replaced with a mild steel reservoir. I would not recommend the substitution with a plastic tank since valuable heat transfer would be lost. If a plastic tank is used then an external system cooler will also have to be used.

Another common issue is elastomer compatibility. Prior to the installation of water based fluids the hydraulic components must be checked for seal and hose compatibility. Some types of elastomers are subject to attack by glycols. Incompatible seals and hoses can lead to premature failure of components and costly down time.

Just as in oil hydraulic systems, water based hydraulic systems also need to be adequately filtered. After conversion from oil to water based fluid operators, will have to monitor the return filters closely since the water based fluid will scrub the varnishes and residues left behind by mineral oil. These byproducts will quickly accumulate in a properly sized filter and require, initially, more frequent filter changes. Just as in a water system the addition of a dirt gauge is beneficial; it also makes sense in a system that has been converted. In addition, the use of paper media filters such as used commonly with mineral oil will have to be changed to a non-paper media such as fiberglass. Normally these are no more expensive than paper media filters and will perform well with the water based fluids. Once the system is clear of all oil residues, the filter maintenance program is much the same as in oil based systems.

Even with the higher maintenance when water based hydraulic fluid is used; I have to admit a preference for it over mineral oil based fluids. The positive benefits gained for carwash systems make it ideal and properly maintained will enhance overall system performance and life.

Some general maintenance tips involve common sense. Whenever the system integrity, whether water, oil, or water based, is broken; such as a component change, replace the return filters. Maintain system fluid levels. Keep the reservoir area clean and unobstructed. Fix leaks as soon as they are observed.

To aid in the detection of leaks in a hydraulic system, use whenever possible a fluid that has a leak detector built in. This is normally a benign dye additive that will fluoresce when exposed to ultraviolet light. It will quickly identify motor shaft seal leaks, cylinder rod seal leaks, and hose and fitting leaks. Since it is suspended in the fluid, any fluid that might get on a vehicle's surface will be easily rinsed away.

Since the introduction of water based hydraulic fluid into the carwash industry in the mid-1990s by Pinnacle Solutions, founded by Ron Holms and Milad

Shabo; there are thousands of satisfied users. However, there are a number of carwashes that had bad experiences with water based fluids in their systems. When I investigated such incidences I found that the systems were such, that they should have never been converted from mineral oil in the first place. I have found that there was something in the system design or application that did not lend itself well to water based fluids. In addition, some systems could not be supported because of poor maintenance practices. In those cited cases the solution was the conversion back to mineral oil based fluids.

For those who are contemplating conversion to water based fluids I would strongly recommend consultation with a fluid power professional for a system evaluation. Some fluid suppliers now employ application specialists free of charge to the customer. Application review can pinpoint potential problems before going through the time and expense of conversion. The application review can also provide recommendations to the basic system to enhance overall operation.

Let's summarize:

- Setup and stick to a planned maintenance program.
- Check system health routinely by taking fluid samples.
- Repair leaks as they happen.
- Keep the heat down.
- Install filter dirt indicators.
- Before converting to water based fluids review your system with a professional
- Use a hydraulic fluid, whenever possible, that contains a leak detector dye.
- Replace components with like components.
- Keep spare parts handy like replacement valve coils.
- Do not use paper media filters with water based fluids.
- Do not use water based fluids with non-anodized aluminum components.
- Take a longer view, small expenditures made now will result in larger savings later.

All industries benefit from good maintenance practices. The carwash industry will learn in time that routine maintenance will pay off with better bottom lines.

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