

## Eliminating Hydraulic Leaks in Carwash Tunnels

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The carwash owner/operator's worst nightmare is when the tunnel hydraulic system springs a pressure leak during wash operations. Depending on the hydraulic fluid in the system, whether mineral based hydraulic oil or a water based carwash hydraulic fluid, the impact ranges from a minor inconvenience (water based) to a major catastrophic event (mineral oil). The most serious incidences are as a result of hydraulic high pressure lines spraying onto the vehicles as they go through the wash process. Typically the failures are in the hose material or hydraulic connectors. Seldom does the hydraulic device, motors or cylinders result in this type of occurrence. Motors and cylinder leaks normally are limited to motor shaft seals and cylinder rod seals, which seep rather than spray. Line fittings in the devices are different story. If a motor or cylinder is going to spray it is at the fittings boss and involves the screwed in fitting or the attached hose fitting. The inherent weak points in any hydraulic system are where devices or lines are connected or coupled.

### Why do hydraulic lines and fittings fail?

Pressure hoses, fittings, pipe, and tubes are constantly subjected to numerous mechanical forces. Thermal expansion and contraction, pressure pulsations, vibrations, and positioning movement are just some of the forces that fluid lines and fittings encounter during normal operation. Most fittings in carwash tunnels are mechanical fit and friction types without benefit of elastomer seals. For example: the fittings on the most commonly used motors are NPT (National Pipe Thread). As mechanical forces, especially certain frequencies of vibration are applied over time; the mechanical fit and friction "loosens" creating a potential path for the hydraulic fluid. Pipe and tube couplings and connectors are also susceptible to loosening from the same mechanical forces; all of which become potential points of leakage and failure.

Hydraulic pressure hoses are of remarkably robust construction. These steel reinforced polymers are designed to withstand the dynamic mechanical forces as well as a broad range of chemical exposure. However, hydraulic hose weakness is at the hose ends where the fittings are attached. To attach the hose ends during fabrication; hose integrity is somewhat altered to get the fittings attached to the

hose. Hose failures other than at the hose ends (the weakest point), generally are as a result of slight manufacturing inconsistencies in the hose material; and, over time constant dynamic forces and chemical exposures work to weaken the hose to the point at which a failure occurs. Depending on a large number of variables hose failures can happen very quickly, years or decades later. Hose manufacturers go to great lengths to design and manufacture the most robust product possible. They further provide extensive training to hose fabricators to assure product suitability and safety. In general, properly manufactured and fabricated hose assemblies give many years of satisfactory performance.

Problems with hydraulic fittings can usually be traced back to improper installation and/or length of service life. Some problems are attributed to manufacturing flaws. *(Note: In recent years a large number of Far East produced hydraulic fittings have been marketed into North America. Some have proven to be of poorer quality both in material and manufacture. Even some of the most reputable manufacturers have outsourced production to these companies and fitting quality has suffered. With the influx of these offshore fittings, users are experiencing inordinately higher failure rates.)* NPT fittings are notorious for being difficult to install to assure proper fit and seal. NPT fittings rely on thread to thread friction to seal the connection. Any anomalies in the threads of either connection piece will provide a fluid path. Under torque or over torque also are problematic. The longer the fitting/s has been in service, the higher the probability of failure. The hostile environment of carwash tunnels is particularly harmful to steel hydraulic fittings and stainless steel fittings are cost prohibitive. The longer the fittings have been in service the more corroded they become. Corrosion works its way into the threads of NPT fittings eventually weakening the friction fit causing the fitting to fail. Rarely do new fittings fail but old corroded fittings fail frequently.

Aside from material issues, improper installation and component aging, by far the single greatest cause of hydraulic line failures in carwash tunnels is poor maintenance. Too many carwash owner/operators take the approach "if it ain't broke don't fix it". The robustness of hydraulic equipment and components make it is easy to ignore resulting in dire consequences. Unlike other industries, very few carwash owner/operators are aware of the benefits of Planned Maintenance Programs (PMP). PMP dramatically reduce catastrophic failures and costs associated with them. If the carwash owner/operator were to implement and adhere to PMP for their washes, hydraulic failure rates would plummet.

## Eliminating Hydraulic Leaks

There are a number of preventative actions that can be taken to eliminate hydraulic leaks. Assessing the equipment for leak potential is the first step.

### Equipment Assessment:

Get to know your system. Break out the flashlight, ladder and a yellow or orange marking crayon. Be prepared to get down on your hands and knees to do an in depth inspection. Make sure that the tunnel is as clean as possible. It may be prudent to use a high pressure washer and clean all of the tunnel hydraulic equipment including hydraulic lines. Allow sufficient time for the tunnel to dry before beginning the assessment and inspection. After the initial inspection run the system for 10 minutes actuating the various functions such as positioning cylinders, brushes, conveyors, and soft clothe mechanisms. Re-inspect looking for the present of fluid. If the system fluid has any leak checking property, look for the presence of leak trace.

If there is a maintenance log, review it to ascertain if there are any areas that indicate chronic leak problems. A high incidence of recurrent problems, especially attached with specific components, is a clear indication of a possible design issue. The maintenance log will help in the inspection process but it will also help with prioritizing action steps.

System and equipment age contribute substantially to the likely potential to leaks. It is fair to say; the older the system the more prone it is to leak. High volume systems and systems older than 5 years are at higher risk for hydraulic line failures.

Systems that are predominately hosed verses fixed tube or pipe is more likely to develop leaks. Most hydraulic systems utilize a combination of tube and hose. Tubes or pipes are normally used for main lines and long runs; and, hoses are used for branch lines that power articulated equipment. The more connections, whether hose, pipe or tube present a greater risk for leakage. Look for interconnected short runs and excessively long hose runs; these can all be potential sites for problems.

Also look for where and how lines are attached to structures and equipment; whether they have vibration isolators and dampeners, and what is the mix of fittings (NPT, JIC, SAE, BSP, Metric, etc.), and where attachments occur. Over the course of a system's lifetime it is common to get a mixture of fittings and adapters. Often this occurs when a problem has occurred and it is necessary to get the system fixed in a hurry. Often temporary fixes

become permanent because on one gets around to do a proper replacement.

Evaluate the hydraulic system's motor drive logic. Look to see if motors are connected in series or parallel circuits. The way to tell if it is a series circuit will be the discharge port on one motor will be connected to the inlet port on another. Rather than using parallel circuits, which requires the use of more hydraulic lines, the OEM will design the system in series to save on hosing. This can be a good thing to eliminate lines and hosing and it can be a bad thing because it can reduce system efficiencies. Also, in series logic circuits; if the lead motor in a series should fail, then all other motors downstream become inoperable.

Check the hosing for obvious wear. Jacket checking, cracking, jacket bubbles and discoloration are all indicators of worn hoses. Using the bare hand, run it along the length of hose, and feel for any anomalies. This should be done with some care since abraded hose could have broken wires poking through the external hose jacket. Before doing the hand inspection, visually check the hose for any obvious abrasions. Pay close attention where the hose is attached to the hose end fitting. This is a prime failure point. Grasp the hose at the juncture and pull with moderate force to determine if there is any movement. While grasping the hose at the hose and fitting juncture, move it laterally back and forth to see if there is any movement. If there is any movement, the hose will have to be replaced. Steel lines and pipes should be checked for obvious external corrosion. This is normally nothing to be concerned with, but corroded fittings are. Surface corrosion is to be expected, but corrosion that has gone to the stage where it is causing material pitting represents a potential hazard and the fitting must be replaced. Any fittings, hoses, tubes or pipes that need to be replaced should be marked with a colored marking crayon for later identification.

Determine if the hydraulic system has pulse dampening hydraulic accumulators installed. Most carwash hydraulic systems do not use this component unless there has been a problem with pump pulsation being transmitted through the system; generally recognized with noise or noticeable line and equipment pulsation.

### Problem Elimination:

The first step is to decide how much needs to be done to eliminate potential problems. In some cases it is simply replacing some devices, fittings or hoses. In systems requiring more extensive work, it must be decided if all the work will be done in a single session or if it needs to be done over a longer period in

multiple sessions. Cost is usually a consideration in this decision and whether to spread cost over an extended period of time. Also, extensive work may require taking the system out of service and this needs to be carefully planned. If the decision is to extend the work over multiple sessions then the work must be prioritized with the biggest problems addressed first. Damaged hoses and fittings are clearly the highest priority. For systems requiring extensive work it may require contracting with a fluid power service company.

If there is a mixture of fitting styles, the fittings should all be changed to a single style. My recommendation is to change from NPT to SAE O-ring and JIC (37° flare). These two designs are the most resistant to leakage. Many times motors and cylinders can be purchased with SAE port bosses. These units are highly resistant to leakage at the inlet ports. If the motors and cylinders that you are using don't offer SAE ports, then look to replacing them with units that do. Ultimately if the component can't be replaced with a unit with SAE ports, then fittings should be used that are male to male NPT to JIC. Fluid power has a "rule of thumb" concerning adapters; always adapt on the device and not on the hose.

Replace all fittings that are excessively corroded. If one half the connection is corroded and the other half is not; it is recommended to still replace both fittings, unless the non-corroded side is relative new. In connections keep the mixture of material to a minimum. Steel to steel and aluminum to aluminum reduces galvanic corrosion. Always examine the threads to assure that there is no obvious damage. When attaching the male to female NPT, use pipe anti-seize compounds rather than Teflon pipe tape. Mistakenly some think that Teflon tape seals the connection. This is not true; the tape is for anti-seizing. Therefore, wrapping the threads multiple times is a waste of tape and doesn't seal anyway. I use an old maintenance trick whenever I install new fittings or hoses to help monitor whether or not the threads are backing off; I dab a little colored finger nail polish across the meeting point. If the connection starts to loosen the dabbed on polish will be broken and quickly indicates that the connection needs to be tightened. Once tightened, again apply another dab onto the connection. Care should always be taken when tightening connections. The idea that tighter is better is somewhat a fallacy. The carwash OEM should have provided tightening torques in the Operation and Maintenance Manual. "Over Torquing" can add additional stress to the material causing failure through cracking. Also, in making any type of material connection between threaded pieces, insure that they are not threaded on

the bias and that they thread together without requiring excessive force. If it is taking too much effort or force, then something is wrong.

Vibration dampening is a critical step to reducing leakage. Vibrations are mechanical forces that can be transmitted extended distances. Vibration can cause mechanical "work hardening" in metals leading to metal fatigue causing cracking and mechanical failure. It is important to think of the carwash tunnel as a system and not just an accumulation of individual components. Something that happens in one part of the system can and does impact other parts of the system. Therefore, isolating vibration is an easy fix that will reap huge benefits. All dynamic equipment; whether motors, linear actuators or other devices represent sources of vibration. Particularly problematic are electric motors rotating at 1800 rpm and higher. The rotation and torque produced easily become vibration that is transmitted through the system. Electric motor mounts should be of such a type as to dampen the vibration. Hydraulic fluids are equally capable of vibration and noise transmission. For hydraulic systems that produce pulsation noises; the addition pulse dampening accumulator can reduce the noise as well reduce stresses in the lines caused by the pulsation. All pipes and tubes need to be securely mounted with vibration resistant mounts. If the lines currently do not have vibration mounts, they should be added. Line lengths, whether hose, tube or pipe have to be evaluated and possibly adapted.

Hoses should never be used for extensive long runs unless they are attached to some articulated equipment that requires the hydraulic lines to move. As mentioned before; hoses are best used as branch lines to attach devices such as hydraulic motors and cylinders to the system. Hoses that have too many inline connections are a misapplication of hose. Normally hose length should be kept to  $\leq 3m$  ( $\cong 10'$ ) or less. Longer hose lengths must be supported along the run. To accommodate the need for longer runs, tube or pipe should be utilized, especially in lines larger than 5/8", thus reducing costs. I personally like to use steel tube over pipe because it is easier to fabricate without using a pipe threader. It is probably wise to use pipe when lines sizes greater than 1" is required; tube becomes price prohibitive in the larger sizes. Always use the proper hose ends and don't attempt to bend hose to fit. Hose ends come in straight, 45°, and 90° standard and should be fabricated as such. Most hydraulic hose used in carwash tunnels should be rated at 2500 psi. This rating will provide enough of a safety factor to prevent any type of hose bursting. Do not undersize the hose for the application. The under sizing of hose can and does lead to hose failure. Under sized lines

also creates heat and noise. The carwash OEM should have sized the hydraulic lines correctly when they built the unit; but over time, with emergency repairs, under sized lines can creep into the system. These under sized lines must be replaced in an effective leak prevention program. Unlike hoses, under sized pipes and tubes are not subjected to the same type of failures, but contribute to system inefficiencies. It requires more force to push fluid through too small a line creating a greater pressure drop and elevating heat created by wall friction. I did a project a number of years ago resizing the lines to the proper size and the customer was able to save about 5% in efficiency.

The cost of repairing and updating a system eliminating leaks is inexpensive when compared to the cost of down time and lost sales. However, getting the system repaired and updated is only the beginning point of leak control. A comprehensive PMP is the final answer.

A Planned Maintenance Program, also known as a Preventative Maintenance Program, doesn't have to be overly complicated to be effective. It just requires commitment, discipline and the use of "common sense". Any maintenance plan has to be carefully thought through. Keep the action steps simple so that anyone can do it. More complicated actions may have to be accomplished by higher trained personnel, but that can be planned for. Actions that can facilitate any hydraulic maintenance plan may require the installation of some monitoring equipment.

Every hydraulic power unit should have a working pressure gauge. Over time gauges can become clouded, unreadable and inoperative. To prevent this, make sure it is a fluid filled gauge. This will keep condensation out of the gauge. Also, if the pressure gauge is a "constant reading type"; the installation of a "snubber valve" may extend the life of the gauge by only applying pressure to the gauge when a reading needs to be taken.

If the system doesn't already have a run hour meter; install one. Doing maintenance based on actual operation hours rather than calendar time, makes more sense. Whenever maintenance is performed on any part of the system, the reading on the run hour meter can be recorded creating a maintenance reference point.

If the return filter/s doesn't have a dirt indicator, either mechanical/visual or electronic; install one. This will eliminate "second guessing" when to change return filters. Keeping the hydraulic fluid clean is the secret to extending system lifetime. Clean fluid reduces component wear.

Some carwash tunnels are very dark. The Installation of additional lighting, only to be used during maintenance performance, will facilitate maintenance. Without adequate illumination it is difficult to visually inspect the system. The lighting should be of the type that does not wash out colors such as reds, greens or blues.

Any leak monitoring and prevention program will immensely be aided by using a fluid with a leak trace. Leak trace is suspended in the hydraulic fluid and any leakage will be evident. Some leak trace must be illuminated with UV light in order to be detected, but it is highly effective to detect even the smallest seepage, especially around motor shaft seals and cylinder rod seals. Not many fluid suppliers regularly offer this type of fluid, but all of the synthetic carwash hydraulic fluids offered by MRL HYDRAULICS come with a "Leak Spotter" feature.

Create a maintenance log. It doesn't have to be any more complicated than a journal entry whenever any maintenance is performed. Date it, record the hour meter reading and the action performed. Some like to also record part numbers of replaced or repaired items, who provided them, who did the work, etc.

A PMP schedule is a planning tool. It works as a guide to what needs to be done and when to do it on a regular schedule. Items that become part of the PMP schedule are when to replace return filters, when to take fluid samples, when to lubricate certain components, etc; any action that is part of routine maintenance. Many owner/operators post a weekly schedule for things that has to be done. This facilitates the completion of the actions as a visual reminder.

Here is some of the action items that I recommend that should be in a PMP:

- Do a tunnel walk through three times daily; before opening, midday, and after closing
- Check reservoir fluid levels before opening each day
- On the last walk through of the day inspect the tunnel for leaks paying close attention to motors and cylinders
- Check and record the system pressure weekly
- Check the return filters at least once a week
- On systems with water based hydraulic fluids, perform a viscosity and pH check once per month and record
- Every six months take a fluid sample and send it off for analysis

- Count on replacing the hydraulic fluid every 24 to 36 months whether it is mineral oil based or water based
- Replace branch line hosing every 30 to 36 months and refit pipe and tube fittings every 60 months. This schedule was derived from nearly three decades of experience. Some hosing will not make it to the minimum of 30 months, but changing all the hosing every 2 ½ to 3 years will significantly reduce catastrophic hose failures
- Replace pumps on average every 8,000 hours. Although rated for 8,000 to 10,000 hours; usually by 5,000 hours for gear and vane pumps and 8,000 hours for piston pumps, efficiencies have dropped to below 85%. When the pumps approach or reach only 80% efficiency they should be replaced. When pumps are replaced don't reuse the pump connection fittings, replace them.
- Plan on rebuilding or replacing hydraulic cylinders every 36 to 48 months. When replacing cylinders also replace the fittings
- Hydraulic valves should be replaced every 48 to 60 months. Replace the hydraulic fittings at the same time.
- Systems with flow dividers (porportionator valves) should have each branch flow checked with a flow meter every 6 months. This will require the purchase of an inexpensive in-line flow meter. This will assure that each circuit is providing the flow necessary. This will also indicate the flow divider wear and when it should be replaced.

The hydraulic PMP should be part of a comprehensive carwash tunnel PMP. This involves all tunnel systems. The same principles followed for the hydraulic system can be applied to other equipment such as conveyors, water reclaim systems and pneumatic systems. Implementing a good maintenance program reduces manageable problems and ultimately adds to the bottom line. A little money spent now saves a lot down the line.

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