Aeroquip

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HOW to analyze hose failure

INTRODUCTION

Everyone in maintenance encounters hose failures. Normally, the hose is replaced and the equipment goes back on line. Occasionally, however, the failures come too frequently—the same problems keep popping up. At this point, it is the task of maintenance to determine and correct the cause of these repeated failures.

Failure to look into the problem, if the fault lies with the hose, will result in not only the repeated loss of hose lines, but may also cause unacceptable unscheduled downtime. If the problem lies with the equipment, failure to determine the cause could eventually result in the loss of the equipment. A little effort in the beginning can help you avoid a big headache in the long run.

Every failure should be analyzed, even if that analysis is as basic as deciding that the failure was normal and acceptable.

However, if the failure rate is unacceptable, you should probe a little deeper to determine the cause of the failure and to correct the problem.

Hose failures fall into five major categories:

1. Improper application—using the wrong hose for the job.
2. Improper assembly and installation.
3. External damage.
4. Faulty equipment.
5. Faulty hose.

IMPROPER APPLICATION

Beginning with a common cause of hose failure—improper application—compare the hose specifications with the requirements of the application.

Pay particular attention to the following areas:

1. The maximum operating pressure of the hose.
2. The recommended temperature range of the hose.
3. The vacuum service rating of the hose.
4. The fluid compatibility of the hose.
5. The cycle time of the equipment (impulse life).

Check all of these areas against the requirements of the application. If they don't match up, you need to select another hose. It's a good idea, at this point, to call on your local hose distributor for assistance in selecting the proper hose. Aeroquip distributors are well equipped to perform this service for you. Distributor personnel attend special Aeroquip sponsored training courses in hydraulics and hose application. Or, if your problem is particularly difficult, the distributor can call on the services of Aeroquip's Field Engineering staff.

When you call on the distributor or manufacturer for help, make sure you provide all the information needed to solve your problem. Use the following check list when describing your problem:

1. Send in a sample of the hose or provide the part number and date of manufacture. This information is supplied on the layline of the hose. For example, FC195-08,1Q88 is Aeroquip FC195 ½-inch hose manufactured in the first quarter of 1988.
2. Mention the type of equipment on which the hose is used and the location of the hose on the equipment.
3. Provide the brand name and number of the fluid carried by the hose.
4. Give the maximum and minimum temperatures, both internal and external, of the system in which the hose operates. Remember that temperatures can vary widely from one part of your equipment to another. Try to get a reading as close to the failed hose as possible.
5. If the hose is bent, give the size of the bend radius along the inside of the curve, or send along a tracing of the curve on a piece of paper. If the hose flexes, say so.

6. Give the maximum volumetric (gpm) flow through the hose (not always the same as the pump gpm as in cylinder circuits).
7. List the maximum pressures, both static and surge, to which the hose is subjected.
8. Describe the environment in which the hose operates.
9. If the hose is used in vacuum service, say so.

By providing the distributor or manufacturer with complete information, you will get a better and quicker answer to your problem.

IMPROPER ASSEMBLY AND INSTALLATION

Other major causes of premature hose failure are improper assembly and installation procedures, involving anything from using the wrong fitting on a hose, to poor routing of the hose.

Aeroquip provides excellent training material that offers assistance in combatting this problem. A little time spent in training could pay big dividends in reduced downtime.

By making use of the free materials available from Aeroquip, you can improve your hose assembly and installation techniques. Contact Aeroquip for details.

EXTERNAL DAMAGE

A crushed hose is an example of external damage. However, the hose may also be abraded and/or corroded. These are problems that can normally be solved once the cause is identified. The hose can be rerouted, clamped or an abrasion guard can be used.

In the case of corrosion, the answer may be as simple as changing to a hose with a more corrosion resistant cover, or rerouting the hose to avoid the corrosive element.

FAULTY EQUIPMENT

Frequent or premature hose failure can be the symptom of a malfunction in your equipment. This is a factor that should be considered since prompt corrective action can sometimes avoid serious and costly equipment breakdown. Aeroquip Bulletin 2027A (How to Troubleshoot Hydraulic Systems by Using Your Senses) is available to help you spot problems in a hydraulic system.

FAULTY HOSE

Occasionally, a failure problem will lie in the hose itself. A likely cause of a faulty hose is old age. Check the layline on the hose to determine the date of manufacture. The hose may have exceeded its useful life.

If you suspect that the problem lies in the manufacture of the hose (and don't jump to this conclusion until you have exhausted the other possibilities) contact your supplier. With modern quality control procedures, the odds of a faulty batch of hose being released for sale are extremely small. So make sure you haven't overlooked some other problem.

ANALYZING FAILURES

A physical examination of the failed hose can often offer a clue to the cause of the failure. The following list suggests 23 symptoms to look for and the conditions that could cause them.

1. SYMPTOM:

The hose tube is very hard and has cracked.

CAUSE:

Heat will leach the plasticizers out of the tube. Plasticizers give the hose its flexibility.

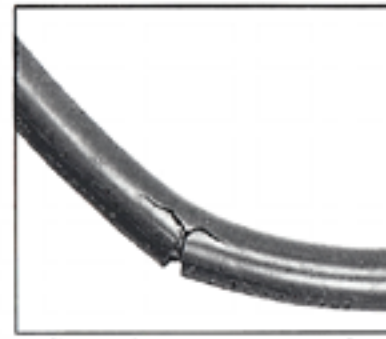
Aerated oil causes oxidation to occur. This reaction of oxygen on a rubber product will cause it to harden. Any combination of oxygen and heat will greatly accelerate the hardening of the tube. Cavitation would have a similar effect.

2. SYMPTOM:

The hose is cracked both externally and internally, but the elastomeric materials are soft and flexible at room temperature.

CAUSE:

The probable reason is intense cold conditions while the hose was flexed. Most standard hoses are rated to -40°F (-40°C). Military specified hoses may be rated to -65°F (-54°C). Many



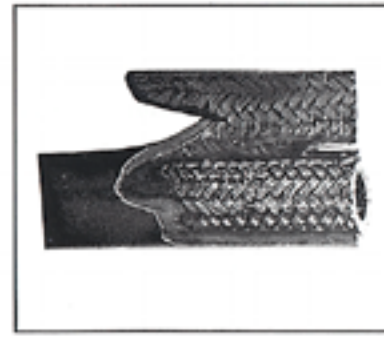
Teflon* hoses are rated to -100°F (-73°C).

3. SYMPTOM:

The hose has burst and an examination of the wire reinforcement, after stripping back the outer cover, reveals random broken wires running the entire length of the hose.

CAUSE:

This could indicate a high frequency pressure impulse condition. The SAE impulse test requirement for double wire braid reinforcement (SAE100R2) is 200,000 cycles at 133% of maximum operating pressure. The SAE impulse test requirement for a four spiral wrapped reinforcement (SAE100R12) is 500,000 cycles at 133% of maximum operating pressure. If the



extrapolated impulses in a system amount to over a million in a relatively short time, a spiral reinforced hose would be the better choice.

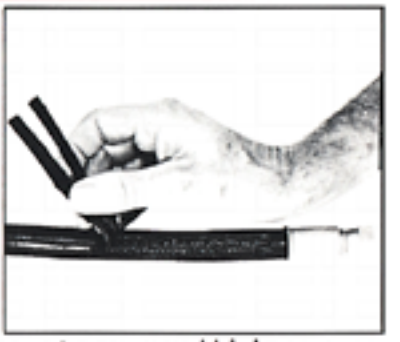
*Teflon is a DuPont trademark.

4. SYMPTOM:

The hose has burst, but there is no indication of multiple broken wires the entire length of the hose.

CAUSE:

This could indicate that the pressure has exceeded the minimum burst strength of the hose. Either a stronger hose is needed or the hydraulic circuit has a malfunction, which is causing unusual high pressure conditions.



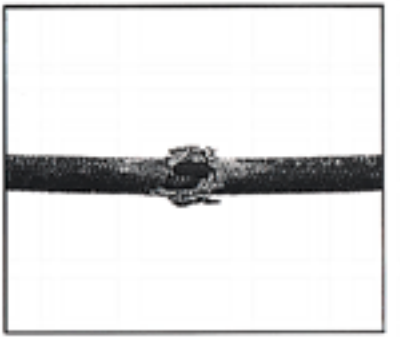
5. SYMPTOM:

Hose has burst. An examination indicates that the wire reinforcement is rusted and the cover has been cut, abraded or deteriorated badly.

CAUSE:

The only function that the cover has is to protect the reinforcement. Elements that may degrade or remove the outer covers are:

1. Abrasion
2. Cutting
3. Battery acid
4. Steam cleaners
5. Chemical cleaning solutions
6. Muriatic acid (for cement clean up)
7. Salt water
8. Heat
9. Extreme cold



Once the cover protection is gone, the reinforcement is susceptible to attack from moisture or other corrosive matter.

6. SYMPTOM:

Hose has burst on the outside bend and appears to be elliptical in the bent section. Or in the case of a pump inlet (suction) line, the pump is noisy and very hot. The pressure line from the pump is hard and brittle.

CAUSE:

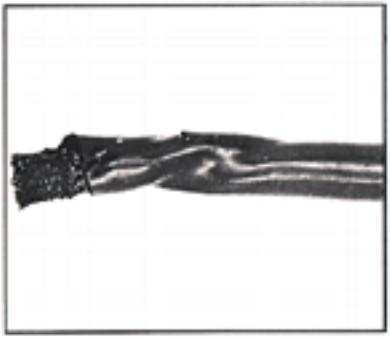
Violation of the minimum bend radius is most likely the problem in both cases. Check the minimum bend radius and make sure that the application is within specifications. Note: It is permissible to lower the minimum bend radius when the pressure is reduced. Check with your supplier. In the case of the pump inlet line, partial collapse of the hose may cause the pump to cavitate, creating both noise and heat. This is a very serious situation and may result in pump failure if not corrected.

7. SYMPTOM:

Hose appears to be flattened out in one or two areas and is kinked/twisted.

CAUSE:

Torqueing of a hydraulic control hose will tear loose the reinforcing layers, and allow the hose to leak through the enlarged gaps between the braided plaits of wire strands.



Be sure there is never any twisting force on a hydraulic hose.

8. SYMPTOM:

Hose tube has broken loose from the reinforcement and has collapsed the I.D. of the hose. In some cases, the tube may protrude into the hose fitting.

CAUSE:

A probable cause is high vacuum or the wrong hose for vacuum service. Vacuum is not recommended for any hose that does not have a full fabric braid over the tube unless some sort of internal support coil is used. Even though a hose is rated for vacuum service, if it is kinked, flattened out, twisted or bent too sharply, this type of failure may occur.

9. SYMPTOM:

Hose has burst about six to eight inches away from the end fitting. The wire reinforcement is rusted. There are no cuts or abrasions of the cover.

CAUSE:

Improper assembly of the hose and fitting can allow moisture to enter around the socket. The moisture may "wick" through the reinforcement. The heat generated by the system may drive it out from around the fitting area. But, six to eight inches away, it will be entrapped between the tube and cover causing severe rusting of the wire reinforcement.

10. SYMPTOM:

There are blisters in the cover of the hose. These blisters contain oil.

CAUSE:

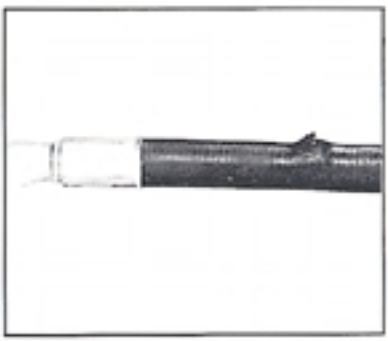
A minute pin hole in the tube is allowing the high pressure oil to seep between it and the cover. Eventually the oil will form a blister wherever the cover adhesion is weakest. This could be caused by either a faulty tube or incorrect assembly of the fitting.

11. SYMPTOM:

Blistering of the cover where a gaseous fluid is being used.

CAUSE:

High pressure gas (above 250 psi) is effusing through the pores of the tube, gathering under the rubber cover and eventually forming a blister wherever the adhesion is weakest. Specially constructed hose with a perforated rubber cover is available for high pressure gaseous applications. Your supplier can advise you on the proper hose to use in this situation.



12. SYMPTOM:

Hose blew out of the hose fitting.

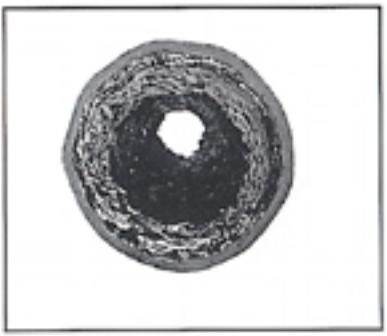
CAUSE:

Misassembly may be the problem, due to:

1. Using the incorrect fitting on the hose, such as a tube size fitting on a full bore hose, a non-skive fitting on a skive hose or a hose and a fitting designed by different manufacturers.
2. Incorrect assembly procedures due to insufficient or incorrect lubrication, improper positioning of the fitting on a hose or incorrect selection of crimp and swage dies. A crimped or swaged fitting must be properly positioned on the hose for correct assembly; always mark the fitting position before crimping or swaging the fitting.
3. Incorrect hose length. (Often an assembly is too short to allow for proper operation under pressure.)

13. SYMPTOM:

The tube of the hose is badly deteriorated with evidence of extreme swelling. In some cases the tube may be partially "washed out."



CAUSE:

Indications are that the tube is not compatible with the fluid being conveyed. Even though the fluid is normally compatible, the addition of heat can be the catalyst that can cause tube deterioration. Consult your hose supplier for a compatibility list or present him with a sample of the fluid being conveyed for analysis. Make sure that the operating temperatures, both internal and external, do not exceed the recommendations of the fluid or hose manufacturer.

14. SYMPTOM:

Hose has burst. The hose cover is badly deteriorated and the surface is crazed.

CAUSE:

This could be simply old age. The "crazed" appearance may be the effect of weathering and ozone over a period of time. Try to determine the age of the hose. Some manufacturers print or emboss the cure date on the outside of the hose. As an example, an Aeroquip hose may say "1Q76," which means that the hose was manufactured during the first quarter (January, February or March) of 1976.

15. SYMPTOM:

Hose is leaking at the fitting because of a crack in the steel tube, adjacent to the braze on a split flange shoulder.

CAUSE:

Because the crack is adjacent to the braze and not in the braze, this is a stress failure that could be brought on by a hose that is trying to shorten under pressure, but has insufficient length to do so. Aeroquip has cured dozens of these problems by lengthening the hose assembly or changing the routing to relieve the forces on the fitting.

16. SYMPTOM:

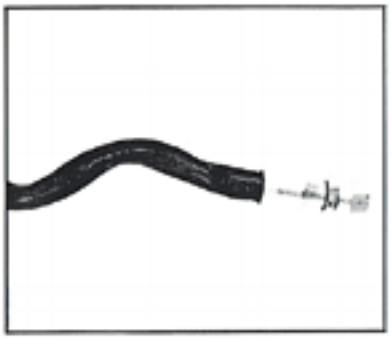
A spiral reinforced hose has burst and literally split open. The wire is exploded and badly entangled.

CAUSE:

This hose may have been too short to accommodate the change in length occurring while it was pressurized.

17. SYMPTOM:

Hose is badly flattened out in the burst area. The tube is very hard downstream of the burst but appears normal upstream of the burst. (Note: Fluid flows in one direction only, i.e., pump to control valve or return line.)



CAUSE:

The hose has been kinked or twisted either by bending it too sharply or by squashing it in some way so that a major restriction was created. As the velocity of the fluid increases through the restriction, the pressure decreases to the vaporization point of the fluid (which is cavitation). This condition causes heat and rapid oxidation to take place. Heat and oxidation harden the tube of the hose downstream of the restriction.

18. SYMPTOM:

Hose has not burst but it is leaking profusely. A bisection of the hose reveals that the tube has been washed away to the reinforcement.

CAUSE:

This failure would indicate that erosion of the tube has taken place. A high velocity needle-like fluid stream being emitted from an orifice and impinging at a single point on the hose tube will hydraulically remove a section of it. Be sure that the hose is not bent close to a port that is orificed.

Where high velocities are encountered, contamination in the fluid can cause considerable erosion in bent sections of the hose assembly. This process would be similar to sandblasting.

19. SYMPTOM:

The hose has pulled out of the hose fitting. The hose has been considerably stretched in length. This may not be a high pressure application.

CAUSE:

Insufficient support of the hose. It may be necessary to support long lengths of hose, especially if they are vertical. The weight of the hose, along with the weight of the fluid inside the hose, is being imposed on the hose fitting. This force can be transmitted to a wire rope or chain by clamping the hose to it, much like the utilities support bundles of wire from pole to pole. Be sure to leave sufficient slack in the hose between clamps to make up for the possible 4% shortening that could take place when the hose is pressurized.

20. SYMPTOM:

The hose has not burst, but it is leaking profusely. An examination of the bisected hose reveals that the tube has burst inwardly.

CAUSE:

This type of failure is commonly referred to as "tube blow down." It may be associated with very low viscosity fluids such as air, nitrogen, freon and other gases. What happens is that, under high pressure conditions, the gases will effuse into the pores of the tube, charging them up like miniature accumulators. If the pressure is suddenly reduced to zero, the entrapped gases literally explode out of the tube, often tearing holes in it. In some hose constructions, a second tube made from plastics, such as nylon, is used.

Very high velocities in hydraulic systems may also cause "tube blow down." Using a hose with a larger inside diameter will usually solve this problem.

21. SYMPTOM:

A Teflon hose assembly has collapsed or kinked internally in one or more places.

CAUSE:

One of the most common causes for this is improper handling of the Teflon assembly. Teflon is a thermoplastic material which is not rubber-like. When bent sharply, it simply collapses or kinks. This type of failure is localized in one area and is radial. If the Teflon tube is folded longitudinally in one or more places, this could be the result of heat (which softens the tube) along with vacuum conditions.

Because of additional tension of the wire braid reinforcement inherent with this type of hose, there is always a radial tension on the tube trying to push it in. Many manufacturers offer an internal support coil that will eliminate this problem. When the required bend radius is small, convoluted Teflon hose may be the answer.

22. SYMPTOM:

Hose fittings keep blowing off of thermoplastic hose.

CAUSE:

Providing the right fitting for the hose has been selected and properly attached, the probable cause of failure is heat. While under compression, thermoplastic has a tendency to soften and flow out of the compression area when subjected to high temperatures.

23. SYMPTOM:

A hose assembly with a Teflon tube has developed a pin hole leak or several pin hole leaks.

CAUSE:

This situation may occur when a petroleum base fluid, with a low viscosity, is flowing at a high velocity, which can generate high voltage static electricity. The high voltage is seeking a ground connection, and the stainless steel reinforcement is an excellent ground. This causes an electric arc, which penetrates through the Teflon tube as it travels to the reinforcement. Specially constructed Teflon tubes are available that have enough carbon black in them to be conductive. They will "drain off" the static electricity and preclude this problem.

Rapid cycling from a fluid (steam) hot agent in the hose to a cold fluid (tap water) in the hose can produce a similar failure.

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