



Overcoming Three Common Design and Maintenance Challenges in Hose Applications



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Overcoming Three Common Design and Maintenance Challenges in Hose Applications



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Introduction

Formed hose and hose/tube assemblies have long been used to solve fluid handling system design challenges such as installation in confined areas or those necessitating a tight bend radius. While both approaches have specific benefits—ease of replacement for formed hose and smaller allowable minimum bend radius for tube assemblies—they also introduce some potentially costly drawbacks:

- Increased cost to inventory designed-to-spec replacement parts

- Potential for leakage in hose/tube assemblies due to multiple connections

When combined with the other environmental and usage factors that can adversely affect hose performance and life expectancy, it's clear that better solutions are needed to improve hose performance while avoiding costly downtime and system repair.

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Issues Affecting Hose Performance

Fluids are the lifeblood of industrial and mobile equipment and as conduits for these fluids, hose assemblies are critical to system performance. While hoses have a finite lifespan under normal conditions, it's helpful to understand that their service life can be adversely affected by a variety of factors.

These factors include:

- Elevated temperatures
- Extreme cold temperatures
- External abrasion
- Ozone
- Fluid incompatibility
- Fluid velocity
- Tube washout from abrasive media
- Static charge build-up from media/velocity
- Exceeding bend radius and kinking hose
- Twisting the hose when routed
- Connection issues – coupling insertion, crimp too loose, crimp too tight

The frequency of the occurrence of many of these issues has been increasing due to continuing end-product evolution that has generally reduced available space and increased the ambient temperature within that space. Following is a detailed look at these issues.

Heat aging or overheating of the hose assembly can cause the inner tube or cover to stiffen and begin to crack as the polymers in the elastomeric rubber compounds break down or harden under high temperatures.

Extreme cold or temperatures below recommended limits can cause the inner tube and/or the hose cover to develop cracks.

Abrasion due to rigorous applications or excessive rubbing of the hose against an external object can wear away the cover and eventually the reinforcement layers, causing a hose assembly to burst and leak. It's been estimated that 80% of hose failures are attributable to external physical damage.

Exposure to ozone can lead to aging of the hose, resulting in fatigue crack growth, degradation and failure.

Incompatible fluids can cause the inner tube of the hose assembly to deteriorate, swell and delaminate. The inner tube can also partially wash out in some cases. System contamination and external leakage can be a direct result. The fluid must be not only compatible with the inner tube, but also the outer cover, fittings and even O-rings.

continued next page



Heat aging



Abrasion



Fluid incompatibility

Issues Affecting Hose Performance continued

A concentrated **high-velocity stream of fluid** can cause tube wash out or erosion. In order to avoid tube erosion, use a flow capacity nomogram to determine the proper hose size based on the recommended maximum velocities.

Tube erosion due to abrasive media can damage the inner tube of the hose.

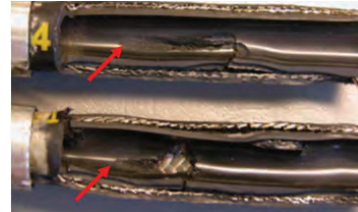
Static charge build-up can lead to electricity discharging through the hose walls, causing electric arcing potentially causing a pin hole in the hose.

A failure to meet the **minimum bend radius** or kinking the hose can impede the flow of fluids and quickly lead to hose assembly failures, particularly in narrow spaces such as engine compartments.

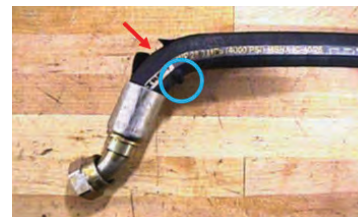
The tube and cover typically crack at the outside of the bend and buckle at the inside of the bend. In vacuum or suction applications, exceeding the bend radius can cause the hose to flatten in the bend area, hindering or restricting the flow.

Twisting the hose when routing or during assembly will damage the hose cover, reducing hose life or causing failure. Twisting the hose can also twist its reinforcement, resulting in a reduction of pressure capability.

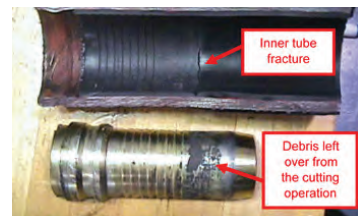
Finally, **connection issues** can also lead to hose assembly failure. When a hose assembly is not properly assembled, it can create very dangerous situations. Fittings need to be pushed on completely to meet the recommended insertion depth. If the hose insertion depth is not met, fittings can blow off. The last grip in the coupling shell is essential to its holding strength on the hose.



Tube erosion



Minimum bend radius exceeded

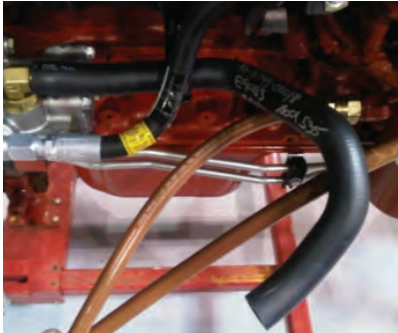


Improper hose assembly



Improper insertion depth

Benefits/Drawbacks of Formed Hose or Hose/Tube Assemblies



In the past, OEMs (original equipment manufacturers) have had to rely on formed hose or hose/ tube assemblies to solve fluid handling system design challenges involving confined routing or tight bend radius, because standard hoses could not meet those application requirements. Both options do offer specific advantages.

Because they are manufactured to fit into a specific position, formed hoses make assembly easy and ensure replacements can be readily dropped into the system during maintenance or repair. Tube assemblies can be designed to have a higher heat dissipation rate, greater temperature operating range and smaller allowable minimum bend radius.

On the other hand, tube assemblies can require multiple connections, where formed hoses typically require fewer connections and thus offer fewer potential leak points. Formed hose can also reduce the number of fittings needed to build the product and ultimately can reduce potential warranty claims or repairs.

However, while both formed hose or hose/tube assemblies can satisfy design requirements, they also come with some significant and potentially costly drawbacks:

- **Inventory cost.** OEM use of formed hoses necessitate repair shops or maintenance departments carrying an extensive and costly inventory of designed-to-spec replacement formed shapes to avoid costly downtime for replacement if a formed hose fails.
- **Leakage.** Multiple connections in hose/tube assemblies increases the risk of leakage, which can lead to more frequent repairs and related downtime.

While formed hoses and hose/ tube assemblies have been, for a long time, the ‘only game in town,’ the deck has been stacked against the players: application designs where tight bends were the rule, not the exception, have proliferated. That hoses with their limited bend radius, multiple connections (and possible leak paths) would fail was a given; the only question was when failure would occur. The resulting warranty costs (for manufacturers) or service costs (for customers) is further exacerbated by the loss of productivity until repairs are made.

As a result, OEMs and end-users have long been in search of an alternative that can address key hose-related equipment requirements.



Three Key Hose-Related Equipment Requirements

Requirement #1:

Withstand extreme bends and tight routing without kinking



With turf-care equipment such as commercial mowers, a consistent challenge has been to route hoses in the engine compartment's confined space without exceeding their acceptable bend radius.

Agricultural and construction equipment also experience bend radius issues, further aggravated by the rugged conditions in which the equipment operates. In the case of agricultural equipment, it's the tight engine space that presents a problem, while on construction equipment it's the suction return lines that can experience bend radius issues.

Unfortunately, OEM hoses have thus far been unable to meet that challenge without kinking and, in some cases, cracking. The result can lead to any of the following: reduced engine performance, damage or even failure; premature hose failure; increased warranty claims; unacceptable equipment downtime and high maintenance costs—any of which are unacceptable to the OEMs and the customers they serve.

Requirement #2:

Reduce potential for leaks in assemblies with multiple connections



The logistics of fuel transfer in narrow spaces or in areas where multiple bends occur frequently require a series of bent hoses joined with connections or with some combination of hose and tube assemblies. Examples of such situations include an SCR system that used 12 formed hoses to transfer coolant and a commercial bus design that relied on long lengths of copper tubing for coolant transfer—tubing that had to be bent and brazed to run throughout the available system pathway.

However, in addition to the inherent issue relating to design to eliminate or at least minimize exceeding a hose's bend radius, each connection in any design represents a potential leak point. This can lead to an unacceptable failure rate and increased expense—both for the OEM who may have to warranty the assembly and for the equipment owner dealing with the risk of system failure and the likely resulting cost of downtime.

Requirement #3:

Eliminate the need for extensive and costly replacement inventory and related replacement time



Formed hoses are not interchangeable, off-the-shelf items that can be adapted to fit multiple requirements. Instead, each one is manufactured to specifications relating to an individual location within the system. The same is true of hose/tube assemblies, because they are designed to fit the requirements of specific fluid pathways.

This means that service/repair facilities have only two options. They must either stock a range of sizes and components for faster replacement or incur the cost of prolonged downtime while the replacement hoses or tubes are sourced, delivered and installed.

Furthermore, adding to the cost of maintaining and managing a dedicated inventory of formed hose and tube assemblies is that each may require a matching inventory of adapters and special fittings.

An alternative, albeit an unacceptable one, would be to improvise with components to force a fit. This solution, however, risks damaging the equipment and the hoses, reduces service life and invites premature failure that could create a safety concern.

But even if all the components are in stock, the installation of formed hoses or hose/tube assemblies in tight routing applications requires significant time and labor. Ultimately, the failure rate, the need for suitable inventory and the cost and complexity of maintenance not only adds to the overall costs associated with the use of formed hoses or hose/tube assemblies but also adversely impacts productivity and profitability at both the OEM and user maintenance/repair levels.

This result is the familiar but unwelcome 'rock-and-hard place' scenario: reduce costs by restricting inventory or reduce maintenance downtime by stocking sufficient quantities of all needed components.

A third choice—a single-source reliable solution that meets all requirements effectively and economically—seemed unlikely, until the development of a highly flexible hose product: E-Z Form™ hose.



A Uniquely Flexible Alternative to Formed Hose and Hose/Tube Assemblies

Recognizing that the market needed a safer, more reliable and cost-efficient alternative to formed hose and hose/tube assemblies, Parker developed the E-Z Form hose series: a system-based solution to challenging application problems.

E-Z Form hose's extreme flexibility is due to its unique corrugated construction. E-Z Form hose incorporates a wire helix within its construction that allows the hose to provide full suction capability, superior kink resistance and minimal force-to-bend. The design allows



for extreme bends without compressing the interior radius or kinking, making it ideal for tight applications and confined spaces where formed hose might normally be required.

Parker E-Z Form Hose is manufactured with premium grade, heat-resistant rubber for maximum service life, making it suitable for oil-resistant or high-temperature applications. Its performance is backed by more than a decade of success in a wide range of industries and applications:

- Aerial equipment
- Agriculture
- Construction
- Forestry
- Heavy equipment
- Industrial engines
- Material handling
- Military
- Mining
- Municipalities
- Power generation
- Refuse/trash hauling
- Transportation
- Turf care





E-Z Form hose eliminates the need for a dedicated inventory or excessive minimum production quantities of pre-formed hose and metal tubing. The hose can be cut to fit, making it suitable as a replacement for formed hoses and hose/metal tubing assemblies when used in the same type of applications or conditions. And unlike other hoses

that consume more footage to ‘round out’ the required bends, the extreme bend radius that E-Z Form hose can achieve without compromising performance means less hose is needed —an additional cost savings.

Furthermore, maintenance on an existing system by using E-Z Form

hose versus formed hose or hose/ tube assemblies is more cost- and time-efficient. Repairs can be made quickly, reducing costly downtime. And E-Z Form hose is qualified with Parker crimp couplings, offering further leak-free performance through permanent worry-free connections.

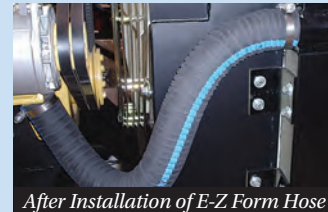
Example 1:

Engine Coolant Application

Replacement of a radiator hose that was kinking at the connection due to sharp bend radius. Uses E-Z Form GS Series 7395 hose.



Before E-Z Form Hose

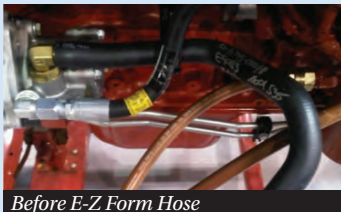


After Installation of E-Z Form Hose

Example 2:

Oil Transfer Application

Oil transfer hose that was subject to kinking was replaced with E-Z Form MP Series 7219 hose.



Before E-Z Form Hose



After Installation of E-Z Form Hose

Example 3:

High Temperature Oil Suction and Return Application

Replacement of a formed hose on a power steering pump with E-Z Form HT Series 7399 hose.



Before E-Z Form Hose



After Installation of E-Z Form Hose

E-Z Form Hose Specifications

E-Z Form Hose is currently available in three series for several application types:

E-Z FORM™ GS Coolant/Heater Hose – Series 7395

Series 7395 meets SAE J20R2 D-1 (performance) and is an extremely flexible, lightweight low-pressure hose designed to handle air, coolant, mild chemicals and water. The hose construction incorporates premium grade high-temperature EPDM materials that are resistant to commonly used engine coolant formulations and that provide

electrochemical resistance to inhibit striations and rusting of hose-to-metal interfaces.

The hose provides full suction/vacuum capability, electrochemical resistance and has a cover that is resistant to abrasion, mild chemicals, heat and ozone.



E-Z FORM™ MP Oil Suction & Return Hose – Series 7219

Series 7219 is an extremely flexible, lightweight, low-pressure oil suction/return hose, small-bore vehicle fuel fill connector line and large-bore fuel line for larger engines, with a cover that is resistant to oil and weathering.

Compatible with refined fuels such as biodiesel (to B20 in dedicated and non-dedicated service), diesel, ethanol and gasoline, it's the perfect product for suction and return lines that help power hydraulic accessories and tools associated with heavy-duty engines and equipment.



E-Z FORM™ HT High Temperature Oil Suction & Return Hose – Series 7399

Series 7399 is an extremely flexible, lightweight, high-temperature (302°F/150°C) petroleum-based oil suction/return hose designed to resist cracking and deterioration from the extreme heat generated by Tier IV engine compartments of buses, cranes, trucks and mobile/heavy-duty off-road equipment.

It may also be used in non-SAE power steering applications.

The unique corrugations are tightly pitched and precision-engineered, providing extreme flexibility. The cover is resistant to high-temperature oil in high-temperature environments.





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