



It's not your father's race car anymore. With custom radiators, heat exchangers, fuel injection, dry sumps and power steering systems, correct plumbing on today's off-road vehicles is a complex, but important undertaking.



RACE CAR PLUMBING

EXPLORING THE LATEST TECHNOLOGY

Ever stop to think about how many linear feet of hose it takes to manage oil, water, fuel, brake fluid, and air on an average off-road race car? Plumbing controls every function on the car; brakes, engine oil, cooling, and more. Consider all the hose ends and connections that could inadvertently be left loose or fail. If the routing isn't done properly, a hose could be pinched or rubbed through. If the improper product is used in high temperature areas, it could burn through causing a leak and possibly a fire.

The point is that there are endless opportunities for catastrophe with plumbing on a race car, both in product failure and the human element. Typically, these failures are very expensive when you factor in the cost of blown engines, crashed cars and junked gearboxes. For example, an oil line failing because of improper specifications that yard sales your

shiny new race engine or a brake line failing causing the "big one." Race cars and engines are expensive, so why would anyone try to save money by using cheap or inadequate plumbing?

This month's article by Marty Fiolka (starting on page 72)

detailing what went into completing *Dirt Sports'* immaculate new Alumi Craft's plumbing provides a nice look at the specifics of one particular application. But, for this edition of Competition Corner, we'll take a more general overview at the latest technology in race car plumbing, as well as discuss some good practices and applications with all types of hose, fittings, and accessories.

"Pay attention to every detail when plumbing your off-road race vehicle. It's an area where it doesn't pay to cut corners..."

SIMPLE SPECIFICATIONS

Let's cover some basics first. Race cars and aerospace walk hand-in-hand. Most plumbing on any race car today is "AN,"

a term that stands for Army Navy. AN type fittings use a 37-degree seat to seal them. Be very careful because there are still some SAE fittings out there that look very similar and have the same thread dimensions in certain cases – but SAE fittings have a 45-degree seat! As you might imagine, this will create big problems. A good race car mechanic will always take the time to double check everything they do. Be sure to do the same.

MATERIALS

Steel-braided hose has been around for many years. It's hard to say when it first found its way into racing, but it was around at Indianapolis way back in the 1950s. Aeroquip was a leader in the aircraft industry and this is where steel-braid line really came to prevalence. The stainless-steel braid makes this hose very durable against chaffing, while the inner hose is typically comprised of long-lasting rubber. The major brands today, along with Aeroquip, are Earls, Russell, XRP, BMRS, Fragola, and Goodridge.

Stainless-braided hose is still used in aircrafts and motorsports, but in recent years Teflon-convoluted hose with Nomex jacketing has become the state-of-the-art. Most of the major suppliers now have Teflon hose with a Nomex or Nylon jacketing. Teflon convolute hose will typically have crimped hose ends.

There are several advantages to Teflon-convoluted hose. First, it won't collapse when it's used in a suction application or is under vacuum unlike rubber hose. Convoluted Teflon can also be bent around corners without kinking and is very flexible.

Brown and Miller Racing Solutions (BMRS), used on *Dirt Sports'* Plug N' Play, has become one of the leaders in the plumbing industry when it comes to AN hose and fittings. They're a very forward thinking company that has recently introduced some of the latest in plumbing technology. I spoke with Wade Brown at BMRS on the advantages of using Teflon convoluted hose. He highlighted a few key points that everyone with a race car should take note of.

"Teflon is chemically inert. It's compatible with most any chemical, even acids. Rubber hose isn't compatible with all fluids. Chemicals in unleaded fuel are much more concentrated than in leaded fuels and will deteriorate rubber hose much more significantly," noted Brown.

He went on to say, "Teflon is rated to 400

degrees F versus 250 degrees F with most rubber hose and it can live in the harshest environments. Teflon hose is more compact in regards to the outside diameter compared to stainless-steel braided hose so it is easier to route in tight areas on the car or truck. It's much stronger and will be less prone to crushing than rubber or stainless-steel braided rubber hose."

Most Teflon hose uses a Nomex or Polyester jacketing, both of which are very durable and scuff resistant. In addition, BMRS just introduced its High Temperature Polymer (HTP) jacketing. It has the same temp rating as Nomex but is more durable and, best of all for the off-road crowd, dirt doesn't stick to the material nearly as easily as other materials.

Finally, two other advantages to Teflon are higher-pressure ratings than rubber and much lighter weight. These materials are not inexpensive, but they have proven themselves in many high-level racing applications.

FLOW RATE

It's important to discuss a myth on Teflon convoluted hose; flow rate. I've heard some mechanics and engine builders say that convoluted hose is restrictive and has a lower flow rate than smooth-bore hose. They feel the ridges created by the convoluted interior walls slow down flow. In a normal range of flow seen on any race car, this is not an accurate statement. Diameter is the primary restrictor or regulator of most any hose. Talk to a fluid dynamics engineer and you'll get a lesson on boundary layer and laminar flow.

It is true that when you induce extremely high flow rates that convoluted hose will fall behind smooth-bore hose. But, these flow rates are way higher than what we would typically see in any racing situation today. According to Brown, a Top Fuel dragster is the only thing that far exceeds the rating of a hose as far as flow. They will push 100 GPM through a -12 line! The bottom line is that convoluted Teflon hose is sized to handle the rated flows for the given AN size.

One thing that is crucial when using convoluted hose, however, is to take extra care in cleaning them between race preps, as they are susceptible to holding residue more than the old-fashion smooth bore rubber lines. This is especially true on engine and cooler lines, and crucial if there has been a component failure that may leave metal shavings in the system.

HOSE ENDS

There are three basic hose end assemblies when talking about race-car plumbing; push-on, threaded sleeve, and crimp collar/sleeve.

Push-on hose ends are used with fabric braided rubber hose. Basically, you have a barbed male end that you grease and push into the appropriate diameter hose. The pressure ratings are very low with this style fitting and this type hose assembly should only be used in low-pressure and low-flow applications.

Most people are familiar with threaded reusable style hose ends as it's been the typical hose end used for many years with steel-braided line. All race mechanics have assembled their share of hoses with these style hose ends. Anyone who has done this has also drawn blood from the sharp stainless braid while pushing the outer sleeve over the hose. It's easy to do this assembly process incorrectly if you don't know what you're doing. Taking the time to assemble these correctly will save time and effort down the road.

The latest in hose ends are the crimp-on variety used with Teflon convoluted hose. Although crimp-on hose ends aren't a new thing (they've been around for many years in the high-pressure hydraulic industry), it is relatively new technology to the race car plumbing world. It has become so standard in other forms of motorsports that many race teams now have their own in-house crimping machines.

HARD LINES

Hard lines are one of the best means of transferring fluids in any race car. When done properly, this method is the strongest, most reliable, and sanitary way for many plumbing needs. The flow is optimum through properly sized hard lines, the pressure rating is extremely high, and hard lines won't kink or crush. Indy Cars use hard lines to plumb radiators and oil lines in some cases. It's especially effective in very high-temperature areas like around turbo chargers and exhaust where there exists the very real possibility of burning a normal hose. Most hard line is either aluminum or stainless seamless tubing.

Using hard line is a very good way to plumb the lower radiator outlet to the pump. First of all, that is the suction side of the water system. A rubber hose will suck shut unless it's a radiator hose with an internal spring. Finding an off-the-shelf lower radiator hose that fits your application can be a challenge. In the

case of a complex off-road race car chassis, it's even more difficult. The radiator is typically mounted in an awkward location, which makes a hard line the only way to go.

There are two primary ways of connecting hard line to the source; silicone hose with hose clamps or Wiggins clam shell quick connectors. When hose and hose clamps are used, the hard line must have beads rolled on the ends to insure the internal pressure doesn't blow the hose off.

Conversely, there are two ways to build hard lines. One is to incorporate a selection of mandrel bends that come in various angles (mostly 90's and 45's). Using the bends and straight tubing, you cut, fit, and weld the segments to route the hose through the chassis. The second way is much better and uses a more modern method. It involves creating a solid model of the hard line and bending the tubing on a CNC mandrel bender. This method is the best way because it eliminates the cutting, splicing, and weld joints that could potentially fail. For the rough off-road environment, this is also the recommended way. BMRS has this equipment and the capability of doing this complete process. If you can make a decent pattern using wire or flex tubing, BMRS can scan this pattern, digitize it, and make the line. We outlined this process in the August issue of *Dirt Sports*.

QUICK DISCONNECTS

Quick disconnects (QD's) are used in applications where you need to disconnect hoses frequently or quickly. They can greatly reduce the time it takes to change engines, brakes, rear ends, or transmissions. There are several options available depending on quality and application.

There are QD's that are totally "dry break" (zero inclusive), which means that they seal each side upon disconnect and you don't lose any fluid or pressure. Others are what I would call semi-dry break, which means you may lose a small amount of fluid as you disconnect but when they are disconnected, they are closed and sealed.

The highest quality QD is made by Staubli. They are expensive, but when you need the best, totally dry break QD, this is the choice and Staubli has a huge selection. One example of where to use a Staubli QD is on brake lines or clutch lines. You can literally disconnect a brake line and re-connect the line without bleeding. We use Staubli in Indy Cars to help expedite very quick engine changes. It elimi-



High-end quick disconnects, like these from Jiffy Tite, are finding their way into many applications. They work great for oil, fuel and water lines and are even rebuildable.

nates the need to bleed the clutch or brakes, thus saving a lot of time. Imagine being in the middle of the Baja and having to swap out various brake or drivetrain assemblies. Using this type of fitting would save at least 15 minutes, which could be the difference in winning or finishing second.

Another very high-quality QD that is affordable and great value is made by Jiffy Tite. They come in many sizes, are all aluminum, and work great for any application except brake lines or clutch cylinder lines. The Jiffy Tite QD isn't zero inclusive like the Staubli but will work great for oil lines, fuel lines, water lines, etc. Another feature to the Jiffy Tite system is that it's rebuildable.

The next style QD is the Wiggins fitting which use a double o-ring/sleeve/clam shell to create a perfect connection without creating any restriction. It's the connection of choice for hard lines and allows a small degree of angularity in the connection. Wiggins are very convenient for tight areas where it may be hard to use a wrench on a

hose end and disconnect and assemble very quickly. Wiggins makes sleeves that can be welded on hard line or it can be done in a hose-end application. They are very high quality and moderately expensive.

PRESSURE TESTING

One thing you may not know is that most top-quality race car mechanics pressure test all of their hose assemblies and hard lines after they are fabricated. When doing this, the procedure is to take the pressure to 1.5 times the rated pressure on the hose. It's preferable to fill the hose with water and check for any leaks. The hose can be submerged in water also. This will also soak any jacketing or sleeving, creating a potential messy situation, but is worth it in the end.

Pay attention to every detail when plumbing your off-road race vehicle. It's an area where it doesn't pay to cut corners and will usually bite you, taking money out of your race budget. Attention to detail is absolutely imperative. **DS**



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