Hydraulic Fluid Testing

by Rick Astley

For at least the last 60 years, most cars have used hydraulic systems to transmit the action of pressing the brake pedal, to that of operating the pistons that push the shoes or pads against the brake drums or rotors. The technology was also soon extended to the clutch operation. The big advantage of hydraulics with pistons over cables with levers is that the pressure in a hydraulic line will automatically equalize across the whole system, whereas a single stretchy brake cable will transmit less force to the wheel it operates. Also, in general, hydraulic systems require less maintenance that those using cables, which have to be frequently adjusted against slack and have to be lubricated in their sheaths and around pivot points.

Hydraulics requires the use of an incompressible medium and most liquids fit that description, so why not simply use water instead of special hydraulic oil? While water would be a very inexpensive hydraulic fluid, there are a number of disadvantages to using it over especially formulated hydraulic oil.

1. **Boiling point/Vapor pressure.** While operating, brakes get very hot and that heat is transmitted in part to the hydraulic fluid. If it were to be allowed to boil, as it well might if water were used, the resulting vapor would be highly compressible, reducing braking pressure very significantly.
2. **Freezing point.** It's almost self-evident that it wouldn't be a good thing if our brakes or clutch ceased to operate every time the temperature dropped below freezing.
3. **Lubrication**. The seals in the system that keep the fluid from leaking and that slide against the walls of cylinders benefit from the superior lubrication afforded by oil over water.
4. **Corrosion**. Any water in the hydraulic system tends to cause unseen corrosion starting on the inside of the steel hydraulic tubing.
5. **Organic growth**. Unlike water, specially formulated oil resists the growth of mold and other organic effects.

In the North America, the Society of Automotive Engineers (SAE) have standardized specifications for hydraulic oil, classifying them under Department of Transportation (DOT) numbers, the most commonly known being DOT 3, 4 and 5. ISO 4925 mirrors the SAE standards and the DOT designations are now recognized worldwide. If your car can use DOT 3, it can also use DOT 4, but the reverse may not be true because DOT 4 can resist higher temperatures and a vehicle system designed for Dot 4 might boil DOT 3 oil. DOT 5's formulation is based on silicone and it is immiscible with DOT 3 and 4 and must not be mixed with it.

The big disadvantage of DOT 3 and 4 oils is that they are miscible with water and will absorb it. That is not the case with DOT 5, but from my own experience, I don't advise using it. My MGB-GT V8 had a heavy clutch and I wanted to make sure that over time it didn't suffer from a softened action due to water ingress. I had the benefit of an all new system – tubing and cylinders; so, with no cross contamination possible, I used DOT 5 silicone based oil. However, the clutch master cylinder was a standard MG part and I now understand that its seals were designed to swell, and thus work better, when in contact with DOT 3 and 4 hydrocarbon based (actually polyglycol-ether) oil. However, there is no swelling when the seals are used in DOT 5 silicone based oil. My almost new clutch system failed at the master cylinder after only a few months use. The slave system, from a modern Range Rover was fine, so while I cannot prove it, I believe that DOT 5 oil is detrimental to elastomeric hydraulic components designed for use in our old MGs.

We live in an often damp climate and the hydraulic oil resides under a not-very-well-sealed cap in the master cylinders, where it has a large surface area exposed to air containing water vapor. Over winter we hibernate our cars and during that period, the oil in the master cylinder may well absorb quite a lot of moisture, which can cause the problems listed in 1-5 above. Once we start to drive the cars, each time the brake or clutch is operated some fluid moves from the tubing into the master cylinders and out again, causing gradual mixing of the water infused hydraulic fluid in the reservoir with that in the rest of the system. Hydraulic fluid testers are now very inexpensive; the one pictured here costing $6.99 on Amazon USA. If a test of the fluid in a brake or clutch reservoir reveals a water content greater than 3%, I think it is worthwhile syringing it out (a turkey baster works well) and replacing it (and the kitchen turkey baster afterwards too!). However, don't just grab that economy size opened bottle of fluid you have had on the shelf for years, because that too may have absorbed water over time; so test it first.

If you've reason to believe that water contamination extends into your car's whole hydraulic system, then flushing it out and exchanging it would seem like a good preventative measure, though not an easy one. One of our members had a fire around a rear wheel of his MGB and although neither the exact cause, nor the chicken-egg sequence of events, could be established with certainty, it is believed to have been caused by a dragging brake shoe having boiled the brake fluid that burst a rubber hydraulic line to the brake drum, the oil then catching fire, perhaps from contact with the exhaust. DOT 4 oil boils at 230°C (446°F) but if contaminated by only 3.7% water, the boiling point lowers to 155°C (311°F), a significant change that could well make the difference between experiencing a problem or not.

Links:	Brake Fluid Tester Pen:	Amazon.com	Amazon.ca	
	Turkey baster:		Amazon.com	Amazon.ca