THE GREAT DOT BRAKE FLUID CONTROVERSY

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Battle of the DOTs

DOT 3-4 Verses DOT 5. Which brake fluid should I use?

From Oak Okleshen #35 "With regards to the DOT 3-4 verses DOT 5 brake fluid controversy, here is an article sent to me by Mr. Steve Wall. It is one of the most professional treatments I have seen on the subject".

[I had to condense this article from 6 pages to 1 due to space limitations -ed]

Brake Fluid Facts
by Steve Wall

As a former materials engineering supervisor at a major automotive brake system supplier, I feel both qualified and obligated to inject some material science facts into the murky debate about DOT 5 verses DOT 3-4 brake fluids. The important technical issues governing the use of a particular specification brake fluid are as follows:

1. Fluid compatibility with the brake system rubber, plastic and metal components.
2. Water absorption and corrosion.
3. Fluid boiling point and other physical characteristics.
4. Brake system contamination and sludging.

Additionally, some technical comments will be made about the new brake fluid formulations appearing on the scene.

First of all, it's important to understand the chemical nature of brake fluid. DOT 3 brake fluids are mixtures of glycols and glycol ethers. DOT 4 contains borate esters in addition to what is contained in DOT 3. These brake fluids are somewhat similar to automotive anti-freeze (ethylene glycol) and are not, as Dr. Curve implies, a petroleum fluid. DOT 5 is silicone chemistry.

Fluid Compatibility

Brake system materials must be compatible with the system fluid. Compatibility is determined by chemistry, and no amount of advertising, wishful thinking or rationalizing can change the science of chemical compatibility. Both DOT 3-4 and DOT 5 fluids are compatible with most brake system materials except in the case some silicone rubber external components such as caliper piston boots, which are attacked by silicon fluids and greases.

Water absorption and corrosion

The big bugaboo with DOT 3-4 fluids always cited by silicone fluid advocates is water absorption. DOT 3-4 glycol based fluids, just like ethylene glycol antifreezes, are readily miscible with water. Long term brake system water content tends to reach a maximum of about 3%, which is readily handled by the corrosion inhibitors in the brake fluid formulation. Since the inhibitors are gradually depleted as they do their job, glycol brake fluid, just like anti-freeze, needs to be changed periodically. Follow BMW's recommendations. DOT 5 fluids, not being water miscible, must rely on the silicone (with some corrosion inhibitors) as a barrier film to control corrosion. Water is not absorbed by silicone as in the case of DOT 3-4 fluids, and will remain as a separate globule sinking to the lowest point in the brake system, since it is more dense.

Fluid boiling point

DOT 4 glycol based fluid has a higher boiling point (446F) than DOT 3 (401F), and both fluids will exhibit a reduced boiling point as water content increases. DOT 5 in its pure state offers a higher boiling point (500F) however if water got into the system, and a big globule found its way into a caliper, the water would start to boil at 212F causing a vapor lock condition [possible brake failure -ed.]. By contrast, DOT 3 fluid with 3% water content would still exhibit a boiling point of 300F. Silicone fluids also exhibit a 3 times greater propensity to dissolve air and other gasses which can lead to a "spongy pedal" and reduced braking at high altitudes.

DOT 3 and DOT 4 fluids are mutually compatible, the major disadvantage of such a mix being a lowered boiling point. In an emergency, it'll do. Silicone fluid will not mix, but will float on top. From a lubricity standpoint, neither fluids are outstanding, though silicones will exhibit a more stable viscosity index in extreme temperatures, which is why the US Army likes silicone fluids. Since few of us ride at temperatures very much below freezing, let alone at 40 below zero, silicone's low temperature advantage won't be apparent. Neither fluids will reduce stopping distances.

With the advent of ABS systems, the limitations of existing brake fluids have been recognized and the brake fluid manufacturers have

been working on formulations with enhanced properties. However, the chosen direction has not been silicone. The only major user of silicone is the US Army. It has recently asked the SAE about a procedure for converting from silicon back to DOT 3-4. If they ever decide to switch, silicone brake fluid will go the way of leaded gas.

Brake system contamination

The single most common brake system failure caused by a contaminant is swelling of the rubber components (piston seals etc.) due to the introduction of petroleum based products (motor oil, power steering fluid, mineral oil etc.) A small amount is enough to do major damage. Flushing with mineral spirits is enough to cause a complete system failure in a short time. I suspect this is what has happened when some BMW owners changed to DOT 5 (and then assumed that silicone caused the problem). Flushing with alcohol also causes problems. BMW brake systems should be flushed only with DOT 3 or 4.

If silicone is introduced into an older brake system, the silicone will latch unto the sludge generated by gradual component deterioration and create a gelatin like goop which will attract more crud and eventually plug up metering orifices or cause pistons to stick. If you have already changed to DOT 5, don't compound your initial mistake and change back. Silicone is very tenacious stuff and you will never get it all out of your system. Just change the fluid regularly. For those who race using silicone fluid, I recommend that you crack the bleed screws before each racing session to insure that there is no water in the calipers.

New developments

Since DOT 4 fluids were developed, it was recognized that borate ester based fluids offered the potential for boiling points beyond the 446F requirement, thus came the Super DOT 4 fluids - some covered by the DOT 5.1 designation - which exhibit a minimum dry boiling point of 500F (same as silicone, but different chemistry).

Additionally, a new fluid type based on silicon ester chemistry (not the same as silicon) has been developed that exhibits a minimum dry boiling point of 590F. It is miscible with DOT 3-4 fluids but has yet to see commercial usage.