TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 6

BRAKE FLUID

Without a doubt, brake fluid is near the top of most enthusiasts' lists of boring brake subjects. It may even rival the ashtray and cup holder for the all-time most boring vehicle part ever. Yet in spite of its low score on the "cool-o-meter," brake fluid is one of the most vital components to your vehicle's brake system performance, and ultimately to its overall safety.

How then can it be neglected for years and years and years at a time? This may not surprise you, but some people don't change their brake fluid for the entire life of their vehicle and don't even think twice about it.

But don't worry—help has arrived. You're about to learn everything you ever need to know about the very lifeblood of your vehicle's brake system. If you're not itching to run to the garage with a bleeder bottle by the time you're done reading this chapter, you might want to check your pulse.

Time, temperature, and moisture are the three primary enemies of your vehicle's brake fluid. The only visual indication of degraded brake fluid performance is a change in fluid color over time from light yellow (the beaker on the right) to a dark, muddy brown (the beaker on the left). (Randall Shafer)

Brake Fluid 101

Brake fluid's functional responsibility is to transmit the force from the master cylinder piston or pistons to the calipers at the four corners of the vehicle. It does this by allowing itself to be pressurized. Based on the hydraulic gain of the brake system, there may be an increase in the force delivered to the calipers, but the brake fluid and distribution system fundamentally do not provide any gain on their own. This relationship was covered in Chapter 3, but can be summarized by the following equation:

Caliper input pressure (psi) =
Master cylinder pressure (psi)

The brake fluid found in the master cylinder reservoir is not pressurized, even during brake application. This fluid is drawn into the hydraulic circuit only as needed due to long-term changes in brake system volumetric consumption, such as when brake pads are worn down to their backing plates. (Randall Shafer/Delphi Corporation)

While that may sound simple, there are several other demands placed on the brake fluid that could prevent it from performing its intended function. For this reason, the National Highway Traffic Safety Administration, or NHTSA, an agency of the Department of Transportation, or DOT, has established a Federal Motor Vehicle Safety Standard, or FMVSS, dedicated to brake fluid performance.

FMVSS116

In FMVSS116, NHTSA has identified no less than 14 properties of brake fluid worthy of government regulation. By law, if the fluid cannot pass one or more of the 14 requirements the product cannot claim compliance to DOT standards.

If all of FMVSS116 were to be duplicated here in this book, over 22 pages of text would be required. The sidebar provides a more detailed list of these items, but for now it makes the most sense to summarize four of the key requirement categories from the perspective of the typical automotive enthusiast.

The Fluid Should Not Solidify

As stated a few paragraphs back, brake fluid is able to transmit force across a distance because it able to be pressurized. While this may be obvious, the pressurization of brake fluid is much easier to accomplish when it's in its natural fluid state than when it is frozen solid in the brake lines and hoses.

Therefore, a critical requirement for brake fluid is that it must maintain its fluid state even in the presence of extremely low ambient temperatures. Because ambient

One of brake fluid's most important characteristics is its ability to maintain a fluid state even in the presence of extremely cold ambient temperatures. For this reason alone, water would make a very poor brake fluid in climates where temperatures drop below freezing! (Randall Shafer)

temperatures routinely fall well below 32 degrees F, this immediately eliminates water from the list of potential brake fluids.

The Fluid Should Not Vaporize

As stated a few paragraphs back, brake fluid is able to transmit force across a distance because it's able to be pressurized. While this may be just as obvious as it was moments ago, the pressurization of brake fluid is much easier to accomplish when it's in its natural fluid state than after it has boiled into gaseous form in the brake lines and hoses.

Brake fluid fade occurs if the brake fluid vaporizes during use (note that this is quite different from *brake pad fade*, which is covered in Chapter 9) and is characterized by a brake pedal that falls nearly to the floor of the vehicle when pressed by the driver. This increase in pedal travel is accompanied by a partial or complete loss of deceleration capability, which results in extended stopping distances. This condition tends to make drivers a bit uncomfortable, to say the least.

Therefore, a critical requirement for brake fluid is that it must maintain its fluid state even in the presence of extremely high ambient temperatures. However, there is a large amount of heat generated by the brake system itself. In fact, the heat coming from the brake system can greatly overshadow any effects of ambient heat. Remember from Chapter 1 that rotor temperatures of hundreds of degrees Fahrenheit are not all that uncommon, even in everyday driving.

For this reason, the *boiling point* of brake fluid is one of its important physical attributes. In fact, to the racer it may be the single most critical performance criteria.

The Fluid Should Not Attack Seals

Before you get the impression that I'm referring to the protection of an endangered species, this requirement simply implies that brake fluid should not adversely affect the performance or longevity of the hydraulic seals in the master cylinder, proportioning valves, and calipers. This requirement not only applies to chemical compatibility, but also to any lubricating properties that the fluid may need to possess.

(Author's note: no seals were harmed in the writing of this book.)

Of paramount important to the racer, brake fluid must also maintain its fluid state in the presence of extremely high temperatures. For reliable performance on the track, dry boiling points well over 500 degrees F are often required. (Wayne Flynn/pdxsports.com)

Brake fluid fade occurs when the brake fluid changes in state from a liquid to a gas. Unfortunately for the driver, brake fluid in vapor form is much more compressible than it is in liquid form, resulting in little, if any, braking effectiveness. Under these circumstances, the best one can hope for is a gravel trap to stop the car. (Wayne Flynn/pdxsports.com)