BRAKE FLUID FACTS

It May Be Time for a Complete System Flush

With a customer complaint of a fading brake pedal, most technicians automatically assume friction as the culprit. Installing a new or different type of friction formulation may not satisfy the pedal fading symptoms, especially if the brake fluid is contaminated. There is a difference in pedal fade due to overheating of the friction and gassing, which requires an excessive pedal effort, compared to brake fluid gassing, which results in a spongy or dropping pedal sensation. It can be frustrating for the technician, who must make the diagnosis based on the customer's description, as the symptoms may not be present during normal braking.

Unfortunately, little consideration is given to the brake fluid. Moisture contaminated fluid can promote a fading pedal symptom during aggressive braking conditions, and then revert to normal braking once the system dissipates the heat. In addition, the contaminated fluid can promote internal corrosion, damaging costly brake system components. This article will address some conditions that result from contaminated fluid or fluid that has lost its corrosion inhibitors. The information may change some of your brake service recommendations.

Brake fluid is an integral part of the braking system. Its responsibility is to transfer the force under hydraulic pressure from the master cylinder to the calipers and wheel cylinders. To function properly during varying braking temperatures, the fluid must be free of contaminates. This is imperative in maintaining a high boiling point, which is necessary to prevent gassing or vapor pockets from forming in the fluid, resulting in pedal fade or a dropping pedal sensation due to the compressibility of the vapor or gas. Most do not associate pedal fade with contaminated fluid.

CONTAMINATED FLUID

It is impossible to determine the condition of the brake fluid by its color. Some fluids contain additives that dissolve the dye from the seals, promoting a discoloration of the fluid. Some vehicle manufacturers specify a mileage or time interval for a complete brake system flush and fill, and other vehicle manufacturers state "as required," or "when system contamination occurs." The accepted industry standard for a system flush is 2 years or 24K miles. In the past, the only field testing available was limited to a moisture test. The contamination problems involve much more than moisture. Some new technology is available to identify the presence of system contamination, and it offers a more complete evaluation of the condition of the brake fluid. In fact, the procedure better illustrates the condition of the fluid to the customer, making the need for the service more convincing.

Brake fluid is hygroscopic and will absorb moisture, and this can be a major problem for the braking system. The moisture may enter the system through the brake hoses, seals, master cylinder cover, etc. It is imperative that you keep the brake fluid container tightly sealed when not in use, as the fluid can become contaminated on the shelf. The braking system can absorb 2% of its volume in moisture in 12 months. A Dot 3 rated brake fluid with a 3% moisture accumulation will encounter a 25% drop in the boiling point. A Dot 4 fluid has a higher boiling point than a Dot 3 fluid, but its wet boiling point may drop more rapidly than the Dot 3 fluid when subjected to moisture. Both the Dot 3 and Dot 4 fluids are comprised of mixtures of glycols and glycol ethers. In addition, the Dot 4 fluid contains borate esters. Both fluids are compatible with the systems and the internal components, but may respond differently when exposed to moisture. Systems filled with the Dot 4 fluid will require more frequent flushes than systems containing the Dot 3 fluid.

MOISTURE AFFECTS PERFORMANCE

Brake fluid with a 3% moisture content or higher may not exhibit a brake performance problem under normal braking conditions. The brake system may perform perfectly when cold, and then encounter pedal fade during aggressive braking, such as on mountainous terrain, or when pulling a loaded trailer or camper. The deterioration in performance is due to the moisture-laden fluid in the calipers or wheel cylinders being exposed to high heat, causing the fluid to boil and vaporize. The vapor is a gas and is compressible. When this occurs, a spongy pedal sensation or a total loss of pedal may be encountered. Once the system cools, the vapor reverts to a liquid and normal braking is restored. Remember, water boils at 212 degrees F. When brake fluid temperatures reach this level, the water turns to a vapor or gas, which is compressible, resulting in a pedal dropping sensation. The moisture in the system may not be evident until periods of aggressive

or extended braking, and that is certainly not the time to encounter a spongy or dropping pedal sensation.

MOISTURE PROMOTES CORROSION

Moisture can promote internal corrosion within the system. The corrosive condition may not be caused from moisture contact with the components as much as a deterioration of the corrosion inhibitors in the brake fluid. If the corrosion inhibitors are present in the fluid, a 5% moisture accumulation will not cause corrosion in the system. Instead, that level of moisture will degrade the corrosion inhibitors in the fluid. Once this has occurred, a minute amount of moisture will promote corrosion of the components. Within a 36 month period, 91% of the corrosion inhibitors in the fluid may be lost. Fluid maintenance is imperative. The brake fluid comes in contact with a minimum of six different types of metals, rubber components, plastic, and a wide range of temperatures. The fluid must be compatible with the materials and maintain stable performance characteristics over a broad range of temperatures.

TESTING FOR CONTAMINATED FLUID

In the past, the condition of the brake fluid has been limited to a moisture test. Unfortunately, by the time the fluid fails the moisture test, major system damage may have already occurred. Moisture in the system depletes the corrosion inhibitors in the fluid, resulting in damage to the internal components. Caliper bores, wheel cylinders, the master cylinder and costly ABS components may become pitted, resulting in sticking or binding components and seal leakage. Some new technology named FASCAR (Fluid Analysis by Stimulation of Copper Alpha Reactions) has made field testing for fluid contamination possible. The test is performed by dipping a test strip (Strip Dip) into the fluid in the master cylinder reservoir and then waiting for 30-120 seconds for the test results. The reaction zone of the test strip will change color in relation to the condition of the fluid (see Fig. 1). Compare the color on the test strip to the color graph provided. The presence of copper indicates that system corrosion is occurring. The copper alloy in the brake lines is the first metal susceptible to the corrosive elements. Fluid that measures 200 PPM (parts per million) of copper or higher should be removed with a system flush.

Do not be misled by mileage, as it has nothing to do with the age of the fluid. Fluid in a 10K mile vehicle may have aged more than a like vehicle with 30K miles. Factors such as the customer's braking habits, pulling or hauling a heavy load, extreme brake temperatures, mountainous driving, etc., will affect the condition of the fluid and the actual breakdown of the corrosion inhibitors. Brake fluid wears out or becomes contaminated and must be replaced to maintain the integrity of the braking system.

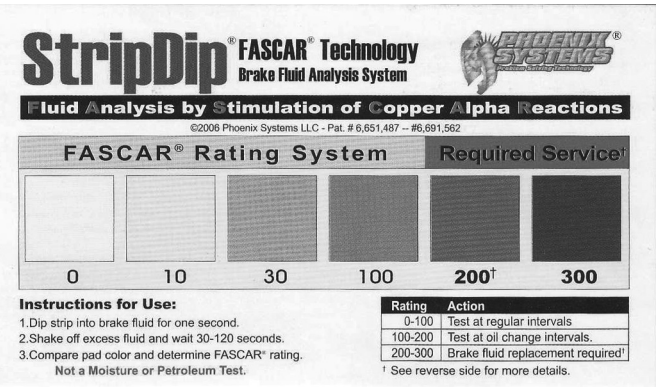

Fig. 1

SOME FLUID FACTS

The brake fluid must be compatible with the materials within the braking system and maintain stable performance characteristics over a broad range of system operating temperatures.

For automotive use, the three most common types of brake fluid are Dot 3, Dot 4 and Dot 5. The Dot 5 fluid has limited application, primarily military use vehicles. The differences in the fluids are in the boiling points (see Fig. 2), with the exception of the Dot 5 fluid, which is a silicone based fluid and is not compatible with other fluids. The silicone fluid is non-hygroscopic; therefore any moisture in the system will accumulate in low areas, promoting corrosion. The silicone fluid can damage the seals, as it lacks additives that lubricate the rubber components. The silicone based fluids are compressible, resulting in a soft or spongy pedal sensation. While the Dot 3 and Dot 4 fluids could conceivably be interchanged, some vehicle manufacturers caution against this procedure. To be safe, only install the fluid specified by the vehicle manufacturer.

	DOT 3	DOT 4	DOT 5
Dry Boiling Point	401°F	446°F	500°F
Wet Boiling Point	284°F	311°F	356°F

Fig. 2

In the above illustration, a dry boiling point is fluid that does not contain moisture (fresh from a sealed container). The wet boiling point reflects fluid that contains moisture. If the brake temperature exceeds the fluid's boiling point, vaporization or gassing of the fluid can occur, resulting in a spongy or dropping pedal sensation.

Brake fluid, like antifreeze, wears out and must be replaced in order to restore the integrity of the system for both performance and protection of the internal components.

LARRY HAMMER
TECHNICAL SERVICES