Brake Fluid Tech

The two most common brake fluids used in the automotive industry are fluids that contain polyalkylene glycol ether and fluid that contains silicone or silicium-based polymer. Both fluids are common but very different in regards to the manner in which they perform. Fluids containing polyalkylene glycol ether are more widely used and are the only fluids that should be used in racing brake systems. Because brake systems may reach extreme temperatures brake fluid must have the ability to withstand these temperatures and not degrade rapidly.

SILICONE-BASED FLUID

Fluids containing silicone are generally used in military-type vehicles and, because silicone-based fluids will not damage painted surfaces, they are also somewhat common in show cars. Silicone-based fluids are regarded as DOT 5 fluids. They are highly compressible and can give the driver a feeling of a spongy pedal. The higher the brake system temperature the more the compressibility of the fluid. This increases the feeling of a spongy pedal. Silicone based fluids are non-hydroscopic meaning that they will not absorb or mix with water. When water is present in the brake system it will create a water/fluid situation. Because water boils at approximately 212ºF, the ability of the brake system to operate correctly decreases, and the steam created from boiling water adds air to the system. It is important to remember that water may be present in any brake system. Silicone brake fluid lacks the ability to deal with this moisture and will dramatically decrease a brake system's performance.

POLYGLYCOL ETHER-BASED FLUIDS

Fluids containing polyglycol ether are regarded as DOT 3, 4, and DOT 5.1. These types of fluids are hydroscopic, meaning that they have an ability to mix with water and still perform adequately. However, water will drastically reduce the boiling point of the fluid. In a passenger car, this is not an issue. In a race car, it is a major issue, because as the boiling point decreases, the performance of the fluid also decreases. Polyglycol-type fluids are two times less compressible than silicone-type fluids, even when heated. Less compressibility of the brake fluid will increase pedal feel. Changing fluid on a regular basis will greatly increase the performance of the brake system. All brake fluids must meet federal standard #116. Three Department of Transportation (DOT) minimal specifications for brake fluid are defined in this standard. They are DOT 3, DOT 4, and DOT 5.1 (for fluids based with polyalkylene glycol ether) and DOT 5 (for silicone based fluids).

MINIMAL boiling points for these specifications are as follows:

Type	Wet Boiling Point	Dry Boiling Point
DOT 3	284ºF	401ºF
DOT 4	311ºF	446ºF
DOT 5	356ºF	500ºF
DOT 5.1	375ºF	518ºF
HTX 600+	421ºF	618ºF

DOT 3 VS. DOT 4 and 5.1

U.S Brake's Ultra HTX brake fluid dramatically exceeds all DOT 3, 4, and 5.1 standards for wet and dry boiling points, lubrication, corrosion protection, and viscosity specifications.

WET VS. DRY BOILING POINT

The term boiling point, when used regarding brake fluid, means the temperatures at which brake fluid will begin to boil.

WET BOILING POINT

The minimum temperatures at which brake fluids will begin to boil when the brake system contains 3% water by volume of the system.

DRY BOILING POINT

The temperatures at which brake fluid will boil with no water present in the system.

MOISTURE IN THE BRAKE SYSTEM

Water/moisture can be found in nearly all brake systems. Moisture enters the brake system in several ways. One of the more common ways is from using old or pre-opened fluid. Keep in mind that brake fluid draws in moisture from the surrounding air. Tightly sealing brake fluid bottles and not storing them for long periods of time will help keep moisture out. When changing or bleeding brake fluid, always replace master cylinder caps as soon as possible to prevent moisture from entering the system. Condensation (small moisture droplets) can form in lines and calipers. As caliper and line temperatures heat up and cool repeatedly, condensation forms, leaving behind an increase in moisture/water. Over time, the moisture becomes trapped in the internal sections of calipers, lines, master cylinders, etc. When this water reaches 212ºF, the water turns to steam. Many times, air in the brake system is a result of water that has turned to steam. The buildup of steam will create air pressure in the system, sometimes to the point that enough pressure is created to push caliper pistons into the brake pad. This will create brake drag as the rotor and pads make contact and can also create more heat in the system. Another way that moisture may enter the system is through diffusion. Diffusion occurs when moisture enters through rubber brake hoses. Using hoses made from EPDM materials (Ethlene-Propylene-Diene-Materials) OR steel braided brake hose with a non-rubber sleeve (usually Teflon) will greatly reduce the diffusion process.

THINGS TO REMEMBER

- A brake fluid's dry boiling point is more important than wet boiling point when used in a racing brake system.
- Racing brake system fluid should be changed often. A system with fresh fluid will have a lower moisture content and therefore perform best.
- Never use silicone-based fluids in racing brake systems.
- Never reuse fluid. Never mix types or brands of brake fluid.
- Purge the system (completely drain) and replace the brake fluid often for maximum performance.

world-class design & engineering

U.S. Brake's design and engineering department uses sophisticated solid modeling CAD and Finite Element Analysis (FEA) software packages to help develop brake products with that perfect combination of weight, performance, and durability. Our high-tech designs are subjected to demanding laboratory and racetrack testing sessions to prove the design before beginning manufacturing.

Brake System Tech

BRAKE PAD BREAK-IN PROCEDURE

It is very important to understand the manufacturer's recommendations in regards to bedding in your new brake pads and rotors. The following guidelines will help ensure that the correct steps are being taken. Some brake pad companies offer pads that are designed with a unique processing stage called burnishing. Burnishing simulates the first few minutes of a pad on the racecar by applying heat and pressure to the pad while in the final stages of production. This process is a great advantage to you because the break-in or bedding procedure normally needed with other types of brake pads has already been started before you install the pads. This eliminates the cost normally associated with bedding in brake pads because you will not need to use your motor, tires, and fuel to prepare your brake pads for racing. It is important to build heat in the pad prior to racing. This step can be done simply by dragging the brake while entering the track or by making two or three hard stops just before taking the green flag. Remember, most brake pads operate best at higher temperatures, so it is best to heat them up before each race by following the above steps.

Non-burnished racing brake pads will require a bedding-in procedure:

1. Slowly build heat in the pad by making slow stops, being sure to allow a minute or two for the pad to cool down while the car continues to move.
2. Repeat above step two or three times.
3. At full speed, make hard racing type stops again, allowing cool-down time between stops.
4. Repeat above steps two or three times or until brake fade is noticed.
5. Allow brake system to completely cool. Your pads should now be race-ready. It is important to remember that the pad and rotor surface must be mated to each other before ultimate performance will occur.

BRAKE ROTOR BREAK-IN PROCEDURE

Again, it is very important to know and understand the manufacturer's recommendation for this step. The following is a guide that covers most manufacturers' recommendations: new rotors should be heated up very slowly and, if possible, use a set of pads that have already been exposed to racing use. For best results, break in the rotor with the same type of brake pad (compound) that you intend to use with the rotor. This will help assure that different friction materials will not build up on the rotor. After the above step has been completed, inspect the rotor-rubbing surface. A uniform polished appearance with no cracks or grooves is what you should find.

BLEEDING THE BRAKE SYSTEM

To assure yourself of a properly bled system, the following guidelines should be followed: always use new fluid. Always use a clear hose and container so you can view the fluid as it exits the system. Always begin bleeding with the furthest caliper from the master cylinder. Always push the pedal slowly all the way down and allow pedal to remain up momentarily to refill master cylinder bore. DO NOT jab the pedal. Only open bleeders the amount needed to spray fluid out. Opening bleeders too far can cause air bubbles to form. While pressure bleeding is much easier than manual bleeding, it is important to manually bleed the system every so often. This allows a check of fluid flow that would not normally be seen while using the pressure bleeding method.

MASTER CYLINDERS

It is important to match the proper size master cylinder with the vehicle's weight, type of racing, and driving style. Several important points to remember are as follows: the smaller master cylinder bore will create higher pressure in the system; the larger master cylinder bore will create more volume in the system, and will tend to give the pedal a firmer feel and less pedal travel.

BRAKE CALIPERS

Caliper selection is a very important part of a correctly operating brake system. The type of racing, weight, car, surface, and driving style are all elements that should be considered when choosing a selection of calipers. Besides the overall size and style of the caliper, it is important to know what size caliper pistons will be best for your application. Larger pistons will create more pressure on the brake pad backing plate. The opposite is true with small caliper pistons. Some calipers are designed with multi-size pistons to aid in proper proportioning of brake pressure and help assure less pad taper.

DUCTING AIR TO BRAKE SYSTEM

Heat created by brake system components can sometimes cause problems that are hard to diagnose. Many times, racers blame the problem on brake pad fade. Fade is almost always caused by heat. In most cases, removing the heat from the rotor and caliper area can rid the system of fade. Brake ducting is used to force hot air away from the hot component. By removing the heat, the component will operate cooler. For best results, force cooler air across the components making sure that the air that is being removed has a path to follow that will not allow the heat to build up someplace else. Duct size should be as big as the application will allow, and directed in the shortest and straightest route possible. It may be helpful to experiment with duct locations. On dirt cars, try to install the duct in areas that don't see an excessive amount of dirt or mud, and install a fine mesh screen in the duct hose to help trap dirt. On asphalt and road race cars, try to install duct on flat areas, avoiding areas that allow air to pass over the duct inlet. If the application allows, use one duct hose directed to the center of the rotor and another directed to the caliper area, preferably directed down toward the top of the caliper; this will force hot air from the pad area. Many types of ducts are available for different applications. Be certain to match the correct duct with your application.

ROTOR AND BRAKE PAD TEMPERATURE

Before choosing a brake pad (compound), it is very helpful to know what temperature your system operates at. System temperature will change depending on the size of track and driving style. It is very important to factor in the change to assure your system works correctly. Most racing pads work best at certain temperatures. Running a pad that works best at very high temperatures will not give the best results if the temperature is lower than the specified range. The same is true when using a low temperature pad in a high temperature situation. Many problems can be avoided by using heat-sensitive paint on rotors, pads, and calipers. This type of paint burns off when the specific temperature is reached, allowing you to pinpoint how hot the component is getting during race conditions. Tire pyrometers do not accurately tell you what temperature the components are because of the cool-down time involved.

RECOMMENDED BRAKE TIPS

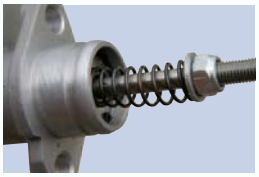
- Always use fresh high temperature fluid. Completely drain and purge system often.
- Follow a checklist regarding brake system maintenance.
- Never hold hot brakes on for long periods while not moving.
- Know your operating temps, and monitor temperature when changing components.
- Replace caliper O-rings often.
- Use hard brake line wherever possible.
- Use safety wire to secure rotor and caliper bolts.
- Mount calipers with bleed screws up.
- Only use residual pressure valves as a last effort.
- Bleed dual master cylinders separately by disconnecting push rod from balance bar on first master cylinder, and then repeat on the second.
- For best results, when changing brake pads, use the same rotor and pad compound combination to help guard against glazing of pad or rotor surface.
- When changing pad compounds, bead blast rotor friction surface to remove old pad material buildup.

Fluid level indicator marks

Aluminum Master Cylinders

U.S. Brake engineers started with a clean sheet when they designed the new line of master cylinders. Utilizing experience from both the U.S. Brake product line as well as the very popular AFCO master cylinders, the new model offers the great performance that you would expect from a U.S. Brake product.

With a one-piece design that incorporates a high-capacity reservoir and precisely machined / polished cylinder bore, the new design makes efficient use of space and materials.



External return spring

RACER NOTE: *When rebuilding brake master cylinders and calipers, always lubricate internal parts with brake assembly fluid before installation. This will keep seals and o-rings from becoming damaged by dry cylinder walls and pistons.*

DESCRIPTION	PART #
3/4" BORE	2011-1512
7/8" BORE	2011-1514
1" BORE	2011-1516

MASTER CYLINDER PARTS	PART #
LID	2012-2050
GASKET	2012-2051
WIRE	2012-2052
PUSH ROD	2012-2053
SPRING (PUSH ROD)	2012-2054
BOOT	2012-2055
REBUILD KIT - 3/4"	2011-1512K
REBUILD KIT - 7/8"	2011-1514K
REBUILD KIT - 1"	2011-1516K
STRAIGHT FITTING (1/8"NP X 3/16"IF)	7010-0026
90º FITTING (1/8"NP X 3/16"IF)	7010-0027

- *External return spring maintains positive pedal feel and helps prolong pad life by ensuring quick reaction to released pedal force*
- *Precise-fitting lid held firmly in place by heavy gauge retainer*
- *Slim design rubber boot allows easy installation into most pedal assemblies*
- *Unique, built-in minimum and maximum fill tabs are easy to read and make quick work of checking fluid even in dark pit areas*
- *Common dual-mounting bolt patterns for most racing applications*
- *Models come in 3/4", 7/8", and 1" bores*
- *Designed for standard 1/8" fittings for easy replacement*

AFCO Conventional Master Cylinder Rebuild Kits

M.C. REBUILD KITS	PART #
REBUILD KIT - 3/4"	40412K
REBUILD KIT - 7/8"	40414K
REBUILD KIT - 1"	40416K

Caliper Pressure Gauge

- *Screws into bleeder to test pressure*
- *Ideal for diagnosing brake problems*

DESCRIPTION	PART #
GAUGE	85161

Brake Fluid

U.S. Brake Ultra HTX 600+ Brake Fluid

U.S. Brake's Ultra HTX brake fluid was specifically formulated for racing under the most demanding conditions. Ultra HTX's high wet and dry boiling points give you maximum protection against vapor lock and other problems associated with high brake system temperatures. U.S. Brake's Ultra HTX sets a new standard for brake fluid performance.

- *Exceeds D.O.T. 3, 4, and 5.1 requirements*
- *Virtually eliminates vapor lock*
- *Non-silicone*
- *16.9 oz. hermetically-sealed bottle*
- *600º+ dry boiling point*

DESCRIPTION	PART #
BRAKE FLUID ULTRA HTX 600+ CASE (12 BOTTLES)	9501-7600
BRAKE FLUID ULTRA HTX 600+ SINGLE BOTTLE	9501-6600

RACER NOTE: *Master cylinder bores are built with close tolerances. Stroking the master cylinder dry can cause damage to the internal rubber seals causing leaks, soft pedal, and lack of pressure. Never clean a master cylinder with carburetor cleaner or similar products as they will cause seal damage.*