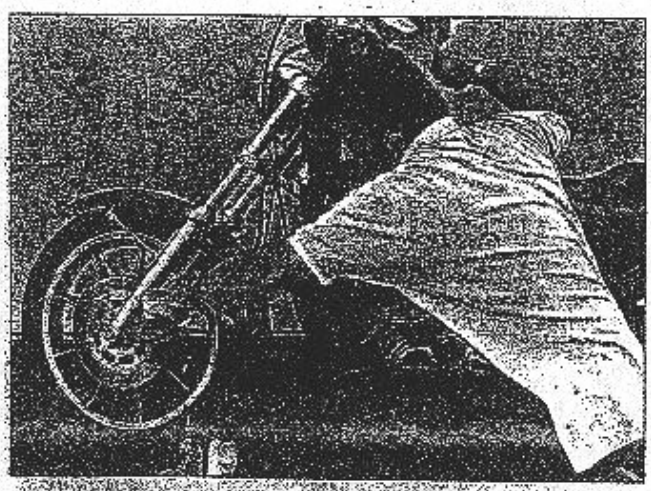
GIMME A BRAKE!

Bleed Your Bike's Brake Lines For Crisp, Smooth Stopping Power!

by DAVID H. SEARLE

Contrary to popular practice, hydraulic disc brakes do require simple routine maintenance. It's entirely possible that you can improve your bike's stopping power and feel significantly with just a half-hour's worth of effort. In fact, most brakes—even those on a brand-new machine—often benefit from "bleeding" the system. Even better news, this job is neither difficult nor particularly messy.

Why can't you simply ignore the system until the brake pads need replacing or the little sight glass in the master cylinder asks you to add more fluid? First, your machine's brake *pads* may be able to last longer than the brake *fluid*, so this is not an accurate indicator. Second, the fluid itself wears out. Most owner's manuals call for replacement of the brake fluid between 10,000 and 15,000 miles, or two years, whichever comes first.



Brake-bleeding is a simple, worthwhile procedure. Be sure not to release the brake hand-lever until you close the bleed screw.

Brake Fluid

With the exception of silicone-based brake fluid labeled DOT 5, the more common DOT 3 and DOT 4 brake fluids are glycol-based. Glycols are a member of the alcohol family. They are "hygroscopic," meaning they attract water. Every brake fluid is also subject to the searing heat of friction between the pads and disc. This is the physical reason that brakes can make you stop, by converting energy into heat. This heating and gradual contamination cause the fluid to decompose. The once-clear fluid that came from the can will become amber-colored, stale and smelly, much the way old gasoline does. The accumulated watery content of the brake fluid will cause corrosion of the parts. Then the pistons may lock in their bores so that the pads no longer retract, creating drag and accelerating wear on the disc and pads. This can become so severe that a rebuild and cleaning cannot correct the damage, and you might end up having to replace expensive parts. This same moisture contamination can also greatly reduce the boiling point of the fluid. Although it's rare, it is possible for brake failure to

occur from the fluid "boiling" or vapor-locking in very heavy braking (very high heat). Just what you don't need on a downhill mountain road!

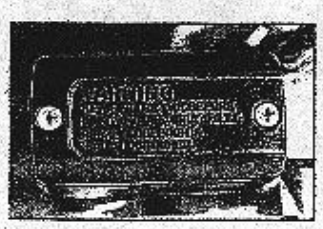
Please heed your motorcycle manufacturer's specifications regarding the type of brake fluid to use. DOT 5 is not automatically better than DOT 3 because it has a higher number. Brake fluids are not like engine oils, where the highest grade available is always best. The crucial detail is that the seals on the hydraulic pistons in the system are formulated for the properties of the recommended fluid. While one machine might not mind the change, another would. We regularly receive warnings from the motorcycle and brake manufacturers stating that switching fluid types can lead to problems. Don't do it.

If you are disappointed that your motorcycle's brakes are not specified to use the "trick" DOT 5 fluid, you should know that this silicone fluid is also several times more expensive than common old DOT 3 or 4. Silicone fluid is also slightly compressible compared to standard glycol-based fluid, and could reduce the "feel" of the brakes. Silicone-based fluid has two advantages over glycol-based. First, it can handle higher temperatures without boiling—approximately 500 degrees for DOT 5, versus approximately 450 degrees for DOT 3 or 4. Second, its insensitivity to moisture means that its boiling point doesn't degrade like DOT 3 or 4 in the presence of water. DOT 3 has a minimum boiling point of about 280 degrees, and DOT 4 about 310 degrees in "wet" tests. Brake fluid manufacturers *do* say that you can use DOT 4 in systems designed for DOT 3 however, since they are both glycol-based.

Glycol-based standard fluids do not need to be *in* your bike's brake lines to attract water. An old can of brake fluid can absorb moisture past a loosely fitted cap. If you're in doubt, don't take chances—buy a fresh can. Also, note that only alcohol and fresh brake fluid are recommended for cleaning the internal parts of hydraulic brake systems that use glycol-based fluid.

Since your very life depends on the proper operation of the brakes, this is certainly an area where an ounce of prevention can be worth a pound of cure.

To check your bike's brake-fluid condition, find a steady surface and turn your bike's handlebars to the position that best levels the master cylinder



The correct fluid type is usually embossed in the reservoir cap, top photo. Carefully remove the screws, the cap, and the bellows, center. First place protective rags around the reservoir, bottom.

necessary to loosen the brake-lever clamp that attaches the master cylinder to the handlebar so that the master cylinder's reservoir can be adjusted farther into a position that puts its cap level. Snug the pivot bolt to hold this position.

Before removing the cap, place some rags around the reservoir or over the gas tank or bodywork directly beneath the master cylinder. Why? Because DOT 3 and 4 brake fluids also make an effective paint remover. They're not especially fast-acting, but why take chances? Thoroughly clean the area around the cap to prevent dirt from falling in and contaminating the fluid. Finally, unscrew the reservoir cap. Carefully lift out the little rubber bellows. This may have some condensation on its upper side, so dry it with paper towels or a lint-free cloth before putting it back. Take a look. Is the fluid amber or brownish? If it is, it's time to

Changing The Fluid

Since you will not want to tip the machine to pour out the fluid, you have a couple of clean alternatives. First, you can bleed the system until the master cylinder has nearly run dry, refill it with fresh fluid, and continue bleeding until only the fresh, clear fluid comes from the bleeder valve. Or you can merely soak up the old fluid in the master cylinder with some carefully folded paper towels, then finish by refilling and bleeding to flush out the stale fluid as before. Since the master cylinder's piston doesn't really move fluid in much volume, you may find the first alternative rather time-consuming. If you decide to soak up most of the old fluid, however, take care not to use an absorbent material that will leave fibers or debris behind in the fluid. The closer this whole operation comes to surgical-room conditions, the better.

Remember that hydraulic systems only work because fluids are incompressible, unlike gases such as air. Fluids can therefore transfer the pressure that the hand lever produces in the master cylinder through the hoses into the calipers. The great engineering advantage of a hydraulic system is that by moving a small piston a great distance, a large piston can be moved a small distance with proportionally multiplied force. The multiplication factor is equal to the ratio of face areas of the slave piston(s) compared to the master piston. Just a single cubic centimeter of air in the system can ruin this whole scheme. This much air could have the brake lever banging into the grip at full stop, reducing the brake pressure enormously, and increasing your bike's stopping distances way into the danger zone.

A simple test for air in the system is to squeeze the brake lever hard several times in quick succession. If the lever seems to pump up, or in compression becomes farther from the handlebar, air is present. This test is not foolproof, however. You may not know that the brake lever is spongy unless you've compared it to the brake lever of an identical machine without air in its lines. Although it is hard to guess the percentage, your chances are probably 50-50 that at least a little air is in the lines of your motorcycle right now, and even a little makes a lot of difference.

Here's how you can get that air out. The actual bleed-screws are small-diameter pipes with hex flats and a tapered-hose fitting on their ends. On

hiding under little rubber dust caps. Be careful. The screws are typically made of brass, so they can be damaged easily with an open-end wrench. Before beginning the bleeding, break them loose with a socket or box-end wrench. Don't actually unscrew them at all, just loosen them enough so they can be turned without a fight. Their position varies with individual brake setups, but logically they will be placed so that they can take out the air that will collect in the fluid cavities behind the caliper pistons. You may or may not be able to leave your box-end wrench on the fitting and still have enough swing space to open and close the fitting adequately, so breaking the screw loose will allow you to use an open-end wrench without damaging anything. A quarter turn is usually sufficient to open and close the fitting. You should find some small-diameter clear plastic tubing that will fit the end of the bleeder screw and is long enough to reach the floor. Put a bottle on the floor to catch the brake fluid.

With a bit of stretching, one person can do the job on motorcycles without large fairings. But if you're working with a full-dresser, the next step is best done with a helper. Make a couple of firm tugs on the brake lever and while maintaining a firm grip, open the bleeder screw until fluid is released down the plastic tube. This will cause the hand lever to bottom on the handlebar, but you *must not release the lever* until the bleed screw is closed or air will be drawn back into the system. You can submerge the end of the tubing in a jar of fluid to reduce the air available to suck back in after several pumps, but clear signals between the person with the wrench and the person squeezing the lever should make this precaution unnecessary.

The plastic tube will clearly show any bubbles being released during the bleeding, and the pumping, holding, and screw opening and closing will be repeated as many times as necessary to achieve clear, bubble-free shots of fluid from the bleeder valve. After each release of fluid, several pumps of the lever will be required to bring the lever back to full extension. When all the bubbles have been expelled, you will immediately feel the improvement.

For dual discs and/or multi-piston calipers, bleed the screw furthest from the master cylinder first, then work back to the closest one. Take care that the master cylinder reservoir does not

Set-up for bleeding: wrench, tubing, catch bottle, brake fluid.

air in from above. Also, *never* reuse the brake fluid you've bled from the system. Air bubbles, water, and other contaminants are probably in the used fluid.

Even if the fluid does not need changing, the bleeding procedure is actually quite simple and worth doing if you have the slightest doubt that your brake system is free of air. Just a few little air bubbles released can make a dramatic improvement in the firmness and response-to-pressure of your bike's brake lever.

Filling Dry Components

Under certain conditions, you may find the standard bleeding procedure just described inadequate. For example, you may have converted to braided stainless-steel brake hoses, rebuilt the calipers or master cylinder, or in some other way gotten entirely dry components that must be refilled. The master cylinder must have fluid pressure behind it in order to be primed so that it can pump fluid through the system, and air won't work for this purpose. In this case you will find that some way of squeezing brake fluid into the bleeder from the *bottom* of the system and forcing the air out the *top* can make a seemingly impossible job easy. The EZE Bleeder syringe kit shown in the accompanying photographs is such a device. Rugged and inexpensive, with two sizes of syringes and adapters for both cars and motorcycles. Be sure to wear eye protection while using the EZE Bleeder—it's possible for the hose to disengage and brake fluid to squirt out. Once a dry system is filled by this device, the last tiny bubbles are evacuated by the standard pumping-and-bleeding technique.

When all the bleeding is finished, fill the reservoir, leaving room for the bellows. If the bellows has extended into a step pyramid shape, flatten it, place it back in the reservoir, snug down the cap, and realign the brake lever on the handlebar. Double-check that the bleed screws are tight, give everything a few healthy squeezes, and check for any leaks. You can wipe up any spilled drops of fluid with plain old soap and water.

Discs And Pads

With your bike's hydraulic system now solid and air-free, turn your attention to the disc and pads. Flood a paper towel with common denatured alcohol (sold in hardware stores as shellac thinner) and wipe the disc. Usually, a significant trace of oil will show up on the towel. Contact cleaner or brake cleaner spray may also be used, and a spray tube will allow a good shot at the brake-pad faces. These sprays are fast drying, as is the alcohol, and it may take a lot of spraying or wiping until the paper towels no longer show greasy traces. Old-style cast-iron rotors will hold more oil than you would imagine, and you may spend some time getting them really clean—but the results will definitely be worth it.

After the cleaning, deliberately test the brakes. *Don't* just go out for a ride and forget what you've done. You could be surprised at all the braking power you were wasting trying to squeeze greasy discs with balloons in the brake lines!

More Information

The EZE Bleeder syringe kit simplifies drawing brake fluid through dry components. It also has many other uses—for example, filling hard-to-reach batteries with water. The cost is $19.95 plus $2.00 for shipping and handling, and can be ordered from:

Shamrock Enterprises
P.O. Box 483, Dept. RR
Long Beach, CA 90801
(800) 331-0896
(213) 499-1043 in CA

GIMME A BRAKE

Today's brakes are great! The ability to stop a 1/2 ton motorcycle quickly by merely squeezing two small fiber pads against a spinning disk is an engineering marvel. The basic operation is simple; a small piston moves a long distance, pushing a column of fluid against a larger piston that moves a very short distance. The rim of the piston forces the pad against the rotor, creating friction which slows the bike down. The system is simple, but working on the rotor and pistons is usually beyond the skills of the average biker. Maintenance is confined to the pads and fluid. A look at each and we will examine how to solve their separate but related problems.

Early brakes consisted of soft pads acting on cast iron rotors. The pads wore quickly and lacked grip when wet, plus the rotors rusted, a trait not endearing to Gold Wing riders. Switching to stainless steel and drilling them made the rust and heat problems disappear. To combat rain, they turned to different pad compounds.

Maintaining your brakes is a easy and necessary job all bikers should be concerned with.

Introducing metal particles into the pads (sintering) gave a vast improvement in wet weather performance and increased pad life, but also added to the heat load. They countered this with a thin layer of insulation between the pad and it's backing plate. Space age technology now gives us a ceramic insulator.

When do your pads need replacement? Most pads have a red line or wear grove built into the pad itself. A quick visual check can tell you their condition. Pads may last longer or shorter than the manufacturers time or mileage span depending on the rider. (Handy tip: when changing pads, wipe the rotor with a clean cloth dipped in rubbing alcohol. Lots of gribie embedded in the rotors.)

Contrary to popular opinion, brake fluid does require simple and routine maintenance. You cannot ignore the fluid until the pads need replacement, as the pads usually last much longer than the fluid. Most manuals call for replacing the fluid after two years, however, under severe conditions fluid may have to be changed after only one riding season. Remember, brake fluid is expected to work under a variety of adverse conditions. In addition to the punishment of the heat generated by the brakes, it is expected to provide corrosion protection to the pistons and absorb the moisture that seeps past the seals.

There are two types of fluid, glycol based and silicone. Most motorcycles come with glycol fluid, either DOT 3 or DOT 4. They are very compatible and can be mixed or interchanged with each other with no problems (DOT 4 is an upgraded Dot 3). Silicone fluid, DOT 5, is totally different and is not compatible with either DOT 3-4. A quick look at each will explain their differences.

Silicone fluid was originally developed for racing purposes. It has a higher boiling point (over 500 degrees) than the glycol fluids (450 degrees) and is non-hydroscopic. (This means it does not absorb moisture.) The good news is that it will not damage paint or plastics if spilled. It is also more expensive and it floats on top of water.

Glycol fluids main disadvantage is that being hydroscopic it attracts and holds moisture. As the moisture content increases it changes color from a clear or light amber to a dark brown. Because the molecules in a fluid are constantly in motion, any water absorbed by the fluid will be equally dispersed throughout the system in a matter of hours. This leaves no pockets of water to accumulate in the calipers. However, once contaminated by water the boiling point of the fluid is lowered considerably. "Wet" tests have shown that DOT 4 can boil at 310 degrees and DOT 3 can cook off as low as 280 degrees. For the average rider this major drawback becomes a major advantage.

Racing bikes get frequent overhauls and their brakes are bled on a regular basis. This prevents any water from accumulating in pockets of the calipers. Touring bikes seldom get this kind of attention, but they are subject to the same heat buildup as racing bikes. The color change that comes with DOT 3-4 signals time for replacement. You get no such warning with silicone based fluids. Non-racing bikes with silicone fluid and touring bikes with contaminated fluid share the same risk. For example: You start down a mountain riding two up, pulling a trailer full of anvils on a hot August afternoon.

I HOW BRAKES WORK

1. Converts Motion into Heat → Rotor & Pads
2. Mass × Velocity = Energy
   1100 Lbs @ 60 mph = 120,000 Lbs
   (Energy doubles every 20 mph!)
3. Hydraulic Systems Operate:
   A. Non-compressible Working Fluid - DOT-3-4-5
   B. Small Piston Moving Long Distance =
      Large Piston Moving Short Distance + Force

II WHY MAINTENANCE IS NEEDED

1. Brake Pads Last Longer than Brake Fluid
2. System is not Perfectly Sealed
3. Corrosion Leads to Costly Repairs
4. Contaminated System Lowers Boiling Point

III WHY NOT CHANGE

1. Seals may not be Compatible with Fluid
2. Visual Check on System with DOT-3-4
3. DOT 5 developed for Racing Conditions
4. DOT 5 Requires more Maintenance

VI DIFFERENCES IN FLUIDS

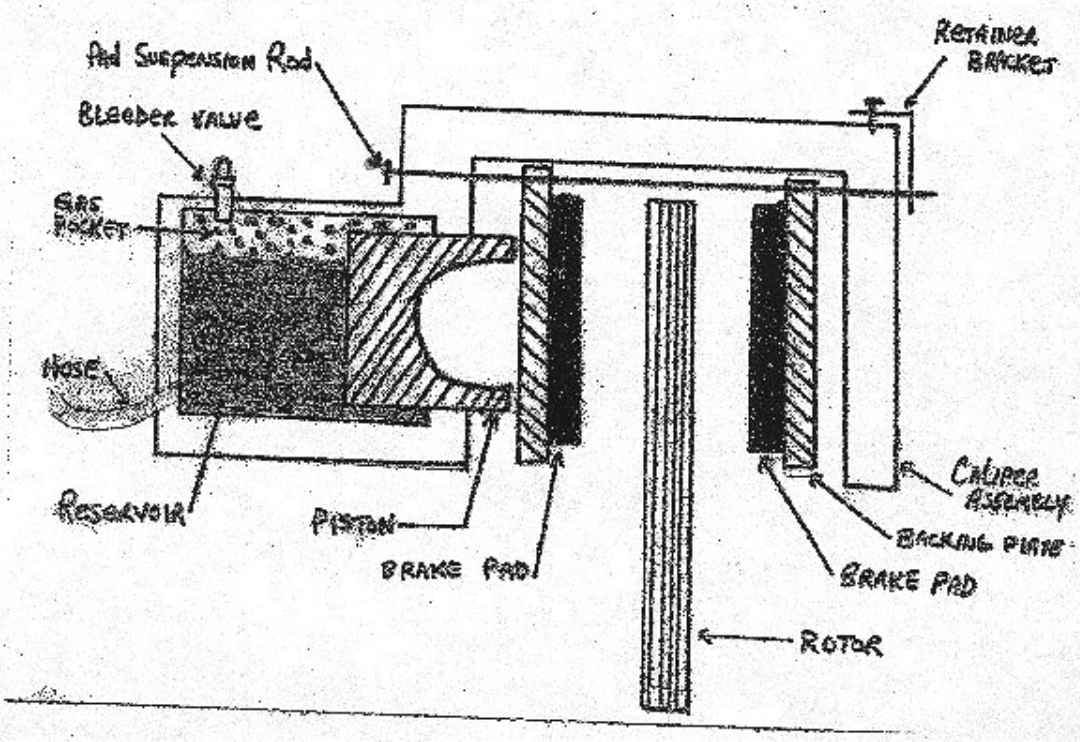
DOT - 3 - 4	DOT - 5
GLYCOL BASED	SILICONE BASED
HYDROSCOPIC - ABSORBS WATER	FLOATS ON WATER
BOILING POINT - 450° F	BOILING POINT - 500° F
CHEAP TO REPLACE	EXPENSIVE
SHOWS CONDITION OF SYSTEM	COMPRESSES EASIER
DAMAGES PAINT & PLASTICS	REQUIRES CONSTANT CHANGING
WET TEST - DOT - 3 = 280° F	WILL NOT DAMAGE PAINT & PLASTIC
WET TEST - DOT - 4 = 310° F	WET TEST - DOT 5 = 212° F

V WHEN YOU RIDE

1. WASH BIKE – MOISTURE ENTERS
2. YOU BRAKE - HEAT IS GENERATED
3. RELEASE BRAKE - PRESSURE EASES
4. BRAKE AGAIN – GONE TO LUNCH

VI THE CLUTCH

1. CONSTANT USE ACTS AS THE SAME AS BRAKES
2. SLOW MOVING BIKE ALLOWS CLUTCH TO ABSORB HEAT



VII HANDY TIPS

1. CLEAN AREA
2. COVER EVERYTHING
3. USE ONLY FRESH FLUID
4. DO CLUTCH
5. CLEAN ROTORS
6. PUMP UP BRAKES