



**THE EXPERT
STEWART
SANDERSON**

Having worked as a tuner for 17 years, Stewart 'Stu' Sanderson is one of the most-respected names in the business. A Level 5-trained fuel-injection technician, Stu has worked for a Ford Rallye Sport dealer, a well-known fuel-injection specialist and various tuning companies.

Eight years ago he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508400, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

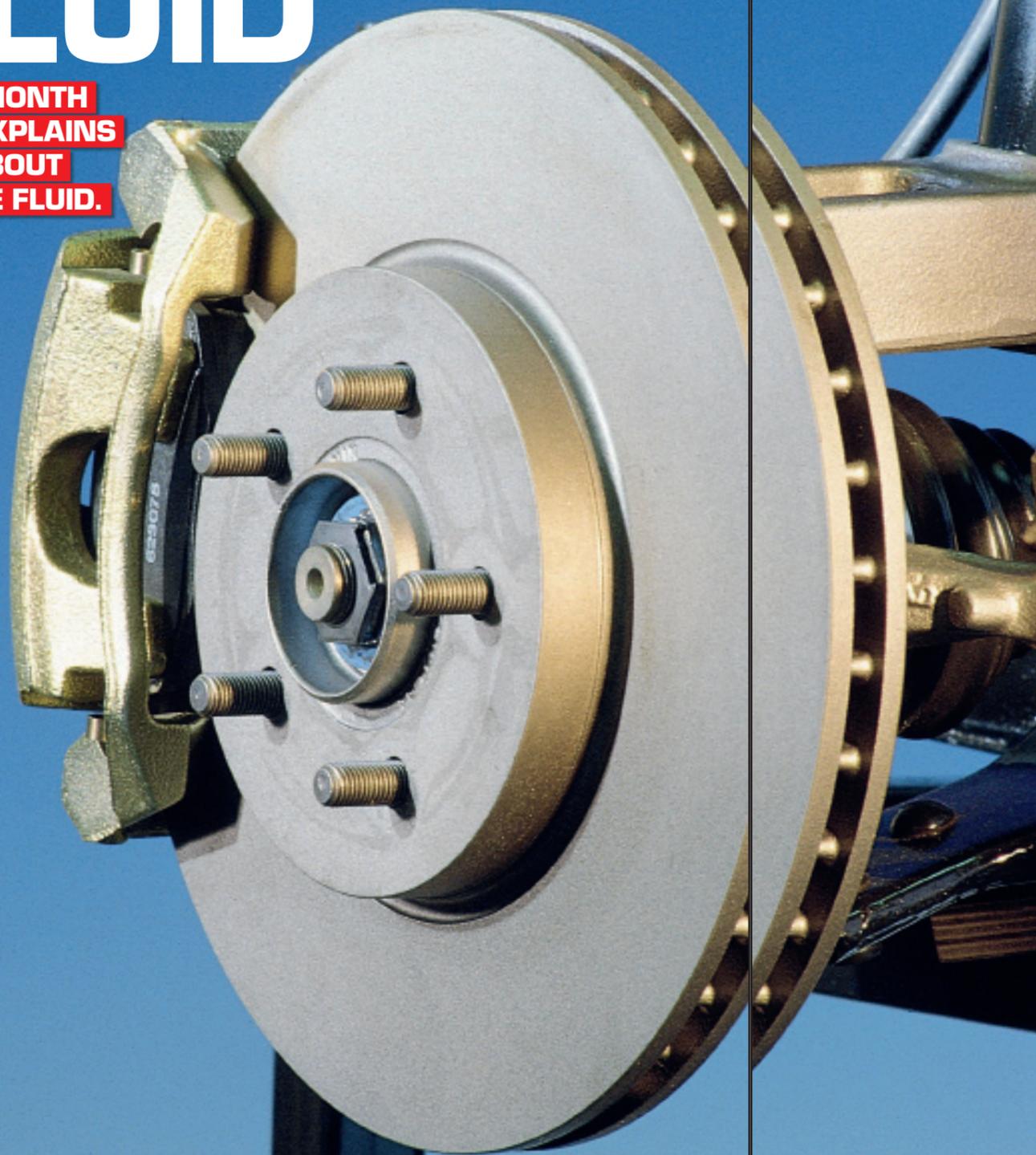
He is the creator and administrator of www.passionford.com, which he started in 2003. It has grown rapidly from a few friends contributing, to one of the biggest Ford communities on the web.

Stu's enviable knowledge of the workings of modern-day Ford performance engines means that every month he's just the man to explain how and why things work, and importantly how they can be improved.

TECH

BRAKE FLUID

**THIS MONTH
STU EXPLAINS
ALL ABOUT
BRAKE FLUID.**



Hopefully you've read my last two articles on fluids; the first on water cooling and how it works and last month's about lubricating oils, how they work and how to keep them cool. This month I want to move to a commonly forgotten fluid that is technically more important than your cooling water and your lubricating oil: brake fluid! If this doesn't work properly you or others might die... Now that's what I call an important fluid!

**WHERE TO FIND
BRAKE FLUID**

Brake fluid runs through your braking system and connects all the different braking components via the brake lines running around and underneath your car. Ultimately brake fluid is the only thing that actually connects your brake pedal to your brake calipers at the wheels. When you press on the pedal, you are moving the brake fluid and using it to apply pressure to the brake caliper pistons and grab the brake disc, causing it to slow your vehicle down.

Every engine bay I can think of has a brake fluid reservoir where you can view the brake fluid level and top it up if required. Please read the manual before doing so though as some will appear overfull until the engine is running, thus looking fine until you actually start the engine.

WHAT IS BRAKE FLUID?

Brake fluid is a relatively simple form of hydraulic fluid, specially formulated to be extremely hard to compress. It is used to transfer force under pressure from the place where it is created, which in this case is our brake pedal, to where it is required, our brake calipers.

Most brake fluids used today are glycol ether based, but mineral oil and silicone-based fluids are also available. Brake fluids must meet certain requirements as defined by various standards set



Fluid levels need to be checked regularly

by organisations such as the SAE. Virtually all brake fluids sold today conform to a well-known rating system known simply as DOT, which stands for Department Of Transport. We commonly see DOT 3, DOT 4, DOT 5 and DOT 5.1 fluids in our shops.

Sadly, most enthusiasts will opt to buy the highest number they can find, and normally, that is the DOT 5, as 5.1 is not readily available. Unfortunately for them, this is a step backwards for an enthusiast. Find out why later.

SERVICING

All you would normally need to do in a day-to-day situation is visually inspect the fluid level to ensure you have an adequate amount in the reservoir. Brake fluid should not drop substantially from one month to the next. It's safe to say you should only notice a tiny drop in level as your brake pads wear down over a period of many thousands of miles. If you notice a sudden loss, you definitely have a brake fluid leak and need to identify and rectify it before you next drive the car.

**DOES IT NEED
CHANGING?**

The answer is a resounding YES. It

needs changing every two years at the longest without fail, yet I would estimate that seven out of 10 cars on today's roads are driving around with old brake fluid in them and are accidents waiting to happen.

Brake fluid is hygroscopic, which means to absorb water. This means brake fluid naturally absorbs water over time. You may wonder why we don't just create fluid that doesn't absorb water but the fact is, the last thing we want in our brake lines is a non-hygroscopic fluid! Bear with me...

Moisture in the air makes its way into your



Brake fluid has different ratings so make sure you get the right stuff for your car

BRAKE FLUID INFO

PRODUCT	DRY BOILING POINT °F	WET BOILING POINT °F
DOT 3	401	284
DOT 4	446	311
DOT 5	500	346
DOT 5.1	509	356



Brake fluid needs changing at least every two years

Braking systems via the caliper piston seals, the microscopic pores in the rubber brake hoses, the nylon master cylinder reservoir and various other rubber seals in the hydraulic system. Sadly, there is nothing we can do about that and if we left this moisture where it landed the water would rot our braking system from the inside out, causing many accidents and fatalities. Now, because our brake fluid is designed to absorb the water chemically, the concentration levels of absorbed water are kept to an absolute minimum and as a result the water is simply collected and contained within the fluid pending your two yearly changes. Another benefit

corrodes metal. Have you ever wondered why your seemingly great looking brake lines have perforated from the inside? Well, now you know that it is normally due to excessive contact with high concentration levels of water. The second issue is the one that is more commonly dangerous. All fluids have a boiling point, and brake fluid's is very high. It needs to be high because it is in direct contact with the brake calliper pistons, which are pressing on the disc pads creating immense heat and slowing down your car. You can reasonably expect brake caliper pistons to reach 200 degrees Fahrenheit during average braking manoeuvres so we need a fluid that is capable of maintaining its properties at that temperature

"ALL FLUIDS HAVE A BOILING POINT, AND BRAKE FLUID'S IS VERY HIGH."

is that in very low temperatures, the water that made its way into your brake lines can't turn to ice. The results of that being allowed to happen simply don't bear thinking about. As long as we change the fluid regularly we should be OK, as the water content will remain suitably low and brakes should operate as per the intended specifications. What if we don't change the fluid? What if we have been told the fluid was changed and it hasn't? Well, having excess water in your brake fluid can cause a number of issues; the first is probably more obvious than others. Water

and far above it. We need to be aware that as the concentration of moisture increases we experience a strong decline in the fluid's boiling temperature. **WHAT IF THE FLUID BOILS?** During normal braking you are unlikely to boil the fluid, but this can give a false sense of security. As old water-contaminated fluid tends to work adequately during normal use the first time you find out your fluid boils easily will often be when you're flying up the motorway, adhering to all speed limits of course, and someone pulls out on you so you slam the brakes

DOT RATINGS

The DOT brake fluid rating system was introduced to bring some accountability to the braking system fluids available. It also meant we could look at a fluid and know its dry boiling point and wet boiling points, which are pretty much all we need to be concerned with. Dry boiling point is our fluid's boiling point when brand new with no water content absorbed at all. Wet boiling point is the same fluid with 3.7per cent water by volume measured.

DOT 3
DOT 3 fluids are usually a glycol ether-based fluid as this is the cheapest way to produce the fluid properties required to conform to DOT 3 criteria. A DOT 3 fluid must have a minimum dry boiling point of 401 degrees F and a minimum wet boiling of 284 degrees F.

DOT 4
DOT 4 fluids must have a minimum dry boiling point of 446 degrees F and a minimum wet boiling point of 311 degrees F. These fluids are also usually glycol ether based. They will also normally have a percentage of a substance called borate ester in them, as this chemical is excellent at increasing fluid's dry and wet boiling points.

A consequence of this chemical is it degrades with time meaning a DOT 4 will be more stable during the early part of its life than the latter. Once contaminated with water its boiling point actually falls off faster than a DOT 3 fluid does. You must also remember that there are DOT 3 fluids out there with a better dry and wet boiling point than some DOT 4s so don't

simply presume that because a fluid has attained a minimum spec of DOT 4 that it must be the best choice. Shop around and compare figures.

DOT 5
This fluid was a totally new mix of fluid and was originally designed for the military. It is a fluid that is non-hygroscopic, has a nice high boiling point and doesn't even damage paintwork. However, as a side effect it is somewhat more compressible than a DOT 3 or DOT 4 fluid, which leads to spongy pedals that no performance enthusiast could live with.

Even more dangerously, any water that does make its way into the braking system will exist as pure water globules, which means they will be vaporised under heavy braking at extreme temps with disastrous consequences to the braking efficiency! My advice is to ignore these fluids and don't use them in your road car's braking system and never in racing applications.

DOT 5.1
This fluid is the result of modern chemistry and is not related to the DOT 5 fluids in any way. It's a true glycol ether-based fluid yet it out performs the original DOT 5 specification that historically required the use of synthetic materials. It's not commonly used but it's out there and on paper it is a great brake fluid. Some manufacturers call it Super Dot 4 or DOT 4 Plus, as chemically it's far nearer to a 4 than a 5 and they don't want people thinking it's related to the commonly avoided DOT 5.



on hard. The immense heat builds in the calipers and your pedal starts to go soft and your braking effort declines!

Bang... Another accident statistic, and the driver rarely mentions his soft pedal as often he won't even remember it, he only remembers he couldn't stop in time and crashed. I'm convinced many accidents could've been avoided with regular fluid changes, especially those on fast A and B roads that require regular hard use of brakes with spirited driving, as this is when the fluid is most likely to boil.

If you drive enthusiastically and generate a lot of heat in the brakes and start to boil the fluid you'll start to lose your pedal pressure and 'feel'. It will feel spongy and perhaps travel further than normal.

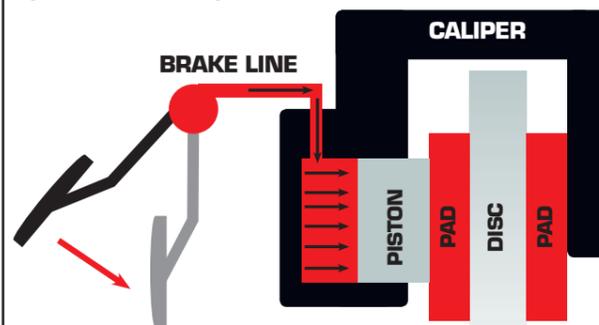
It's the same feeling as having air in your brakes, because that's



Bias pedal boxes have two brake fluid reservoirs

OPERATION

When you put your foot on the brake pedal, the brake fluid transfers the pressure to the caliper pistons and then forces the brake pads against the disc, causing friction and therefore deceleration



what boiling the fluid causes – gas pockets in your brake fluid. As you boil any fluid you generate gas pockets and gas is compressible which leads to your compressing the gas with your braking effort but not transferring as much energy to the brake fluid, thus your calipers don't work as hard.

It can be really scary at high speed and soon have you reaching for your wallet for a well needed brake upgrade such as more air ducting, bigger discs and calipers or exotic materials. However, all this can be a waste of money when all you needed was a fluid more suited to your driving style. This is where the different types of fluid come in but even then, it isn't as simple as meets the eye.

UPGRADES

Standard brake fluid can be improved upon, but I strongly suggest that you seek professional advice before you change a DOT rating in your braking system.

If it was designed for DOT 3 it may not like DOT 4 chemicals floating around in it. Generally speaking it is fine to move upwards a spec, ie DOT 4 is usually fine in a system designed for DOT 3 but make absolutely sure before you make any kind of changes to your car's safety systems. We cannot be held responsible for problems resulting from following guidelines in this feature, so be safe and get proper advice.

PRODUCT COMPARISON

If you have decided that it's time to buy some good brake fluid, this chart should give you some idea of what's available.

Be aware that some is very expensive such as the Castrol SRF, but it is the best on the market, although it is intended

for racing applications. My personal favourite at the time of writing, and the one we sell here is Motul RBF 600. It's a great

product at exactly the right price and it has never let me down yet on the road or even the Nürburgring.

PRODUCT	DRY BOILING POINT °F	WET BOILING POINT °F
Castrol SRF	590	518
Motul RBF 600	593	420
ATE Super Blue	536	392
Valvoline Synpower	503	343
DOT 5.1	509	356
DOT 4	446	311
DOT 3	401	284

(DOT 5 left out as I don't believe it's a suitable fluid for Fast Road cars)

