From the experts

At Powerbrake it's a strict policy 'form follows function'. We are dedicated to designing and manufacturing products that work!

Brake system basics

The tuning scene in South Africa faces the potentially dangerous situation in that we have tuners all over the country making cars go faster and yet there is very little knowledge about how to bring your brake system up to a level that matches the engine mods on your car. The following summary should give you a basic understanding of how your brake system works and allow you to make qualified decisions regarding brake upgrades that are available.

The brake system on your car works by converting the momentum of the car (dynamic energy) into thermal energy (heat). For brake component manufacturers the challenge is to manage how much heat is being produced by a specific vehicle's brakes and how best to deal with that heat.

The amount of heat that is produced by your brake system is a direct result of three factors:
1) The weight of your car,
2) The speed that you are braking from, and
3) How often you apply the brakes as well as the amount of cooling time you allow between brake applications.

The real catch is that the temperature increases do not follow a linear curve – they are exponential. In other words – If you double the weight of a car, the brakes will generate twice as much heat. If you double the speed from which you are braking, the brakes will generate four times as much heat. If you double the weight and speed, your brakes will produce eight times as much heat. Of course this is an extreme example but it illustrates just how much extra weight (think heavy ICE installs) and extra speed (think about all those engine mods) influence brake temperatures.

A practical example

Let's assume that you drive a typical hot-hatch weighing in at around 1100kg's with driver on board. For our example we will assume that the car is fitted with standard 239mm front ventilated brake discs weighing 3.7kg's each. By running the above scenario through Powerbrake's custom software, we can calculate that one emergency stop from a speed of 120kph to standstill will result in a rise in front disc temperature of approximately 164 deg C.

Now let's add 250kg's of extra weight into the car in the form of a heavy ICE install and one extra passenger. The same emergency stop from 120kph would result in a rise in front disc temperatures of approx. 205 deg C.

Now let's up the speed a bit and assume that you perform the same emergency stop but this time from 160kph. This single stop would result in a rise in front disc temperatures of approx. 376 deg C. That's 56% more heat being generated in a single stop by adding just one extra passenger, a sound install and 40kph to your traveling speed!

The real food for thought though is that we used the phrase "rise in disc temperature" in the above examples. That's to remind you that if you are having a spirited drive and applying the brakes frequently in succession, your discs won't have enough time to cool down sufficiently between brake applications. This leads to a compounding effect with regards to disc temperatures.

Here is an Example:

Let's assume that you were having a spirited drive through a mountain pass. You apply the brakes hard on the entry to corner number one and we assume that the disc temperatures go from 0 to 150 deg C (remember - you are not braking all the way to a standstill).

When you come off the brakes the discs will start to cool as they are designed to. However, if the corners are relatively close together on the pass, by the time you reach corner number two, the discs are still at 100 deg C. The disc temperatures then rise by the same amount as they did into corner one, so your disc temperatures now climb to 250 deg C. Again, the discs will cool a bit before the next turn and let's say they are at 180 deg C when you brake hard into turn three. When you exit turn three your discs are sitting at 320 deg C.

The point is that by turn six or seven your disc temps can easily have reached temperatures in excess of 500 or 600 deg C at which point you will be experiencing serious brake fade with standard discs, pads and brake fluid. This same logic applies to fast driving from intersection to intersection in urban areas.

Results of extreme brake temperatures

Excessive brake temperatures are the enemy in braking terms. If you run standard discs, pads and brake fluid over their maximum operating temperatures (MOT) you will experience brake (which can be potentially deadly) and very high wear rates on your discs and pads (which can be expensive to keep replacing).

There are essentially two types of brake fade.

- The first and more common type is referred to as "pad fade". This occurs when your disc temperatures simply exceed the max operating temperature of the pad compound that you are using. Your brake pedal will remain relatively firm but it will feel as if the car is just not slowing down quickly enough regardless of how hard you press the brake pedal.
- The second type of brake fade is referred to as "fluid fade". This occurs when the brake fluid behind the pistons in your calipers reaches its boiling point and boils turning from a liquid into gas bubbles. Gas is far more compressible than liquid, so your brake pedal gets longer and longer, eventually going straight to the floor. In the brake industry, this is referred to as vapor lock.

The really scary thing about vapor lock is that when you are actually on the brakes, you are pressurising your brake fluid, which temporarily raises the boiling point. The fluid is most likely to boil the second you come off the brakes (when the fluid is extremely hot and the pressure comes off the fluid, hereby lowering it to its normal boiling point). You will only realise that your fluid has boiled when you get to the next corner and hit the brakes only to discover that your pedal goes straight to the floor with very little brake effect.

Anyone who has experienced vapor lock will tell you, it is **NOT** something you want to experience first hand!

Driving style

Firstly, small changes to your driving style can make huge differences to disc temperatures. The most important point is to try and allow enough cooling time between brake applications.

If you are having a spirited drive and need to perform a number of hard brake applications in quick succession, try to limit these to five or less before driving on for a while without braking, hereby giving the discs time to cool down. Avoid stopping your car when the discs are extremely hot.

Discs act as impellers – pumping air through the cooling vanes in order to cool down. When you stop, there is no airflow, which is a killer for disc temperatures.

People often say to us that they 'only' drive their car on the road and never take part in track days but they are still overheating their brakes.

Bear in mind that the distances between corners on the average race track are usually far longer than the distance between traffic lights on the street. That allows cooling time and airflow.

For those readers that like to scream from intersection to intersection, be aware there is nothing harder on your brakes than hard robot-to-robot abuse.

The distances between intersections are too short for sufficient cooling. Also, sooner or later you end up having to come to a complete stop if you catch a red light, which means that your discs are extremely hot and there is zero airflow to cool them. Remember that race cars never stop with their discs at peak temperatures. The drivers normally do one or two cool-down laps after a race, during which they hardly touch the brakes and there is plenty of airflow to cool the discs prior to stopping in the pits.

Matched brake upgrade kits:

If you find that your brakes are overheating, leading to brake fade and accelerated disc/pad wear, you essentially have two options.

The first option is to fit discs and pads that are designed to operate effectively at the temperatures that your brakes are reaching.

The second option is to change your driving style.

The challenge you face is deciding which pad compound to match to which disc design in order to squeeze the maximum performance and durability from the brake system on your car. There is a real misconception in the market that you can simply take any performance brake pad, run it on any disc design/ material and you will be upgrading your brakes.

IT SIMPLY DOESN'T WORK THAT WAY.

The secret to optimising brake performance is matching a disc design and pad compound that have been developed and tested to perform optimally at the disc temperatures generated by a particular vehicle and driver.

Performance and race disc manufacturers, Powerbrake, produce a range of four different fast-road and race disc designs and spend an enormous amount of time testing different disc and pad combinations using state of the art brake dyno's as well as conducting continuous on-car testing using sophisticated data-logging equipment. Powerbrake stock over twenty different high-performance street and race pad compounds, which they source from four of the world's leading pad manufacturers. When developing one of their Matched Upgrade Kits for a particular vehicle, they include the pad compound best suited to both the Powerbrake disc design in the kit as well as the vehicle weight and various other brake system characteristics.

In other words, Powerbrake's Matched Upgrade Kits contain components that have been tailored to the target vehicle in question. Of course different owners of the same vehicle model may have very different driving styles and for this reason

Powerbrake offer different categories of upgrade kits for most popular vehicles. With over 700 kits in their range, there is a good chance that no matter what you drive or how you drive, they have an upgrade kit that has been specifically developed to maximise performance and durability of the brakes on your car.

Also available from Powerbrake and their distributors, is a range of high-temperature brake fluids with boiling points of up to 312 deg C - compared to standard DOT 4 fluids, which will boil at around 235 deg C.

Thanks to Clive Murphy, Powerbrake. This article was truly enlightning.

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Powerbrake
Stop Faster