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Tech Tips

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TECHNICAL TRAINING SCHEDULE - SPRING 2013

Feb 2013	Location	Course
Thur 14th	Cork	Efficient Diagnostics - €240 or €200 for Members
Fri 15th	Dublin	Diesel Particulate Systems- €240 or €200 for Members
Sat 16th	Dublin	Efficient Diagnostics- €240 or €200 for Members

April 2013	Location	Course
Wed 17th	Dublin	New Technology €160
Thur 18th	Cork	Electronic Diesel Control 1 - €240 or €200 for Members
Fri 19th	Cork	Diesel Particulate Systems - €240 or €200 for Members
Sat 20th	Dublin	Electronic Diesel Control 1 - €240 or €200 for Members

CPD

Certificates Issued for all courses

Instructor - Steve Carter

Efficient Diagnostics

Efficient Diagnostics - Course Content:

The aim of this course is to provide the technician with the necessary information and practical expertise to efficiently diagnose modern vehicles. This course is suitable for experienced and inexperienced people, and provides the essential information on performing your diagnosis in the proper and most effective way.on.

Diesel Particulate Systems

Diesel Particulate Systems - Course Content:

The aim of this course is to provide the technician the necessary information and practical expertise to service, understand, repair and diagnose the modern diesel emission cleaning systems. The course covers many systems including Diesel Particulate Filters (DPF), Selective Catalytic Reduction (SCR) and AdBlue.

Electronic Diesel Control 1

Electronic Diesel Control1 - Course Content:

The course will provide the technician with the knowledge of diesel fuel and electronic circuits required to understand and repair these systems. At the end of this course the technician should be able to demonstrate knowledge of how these systems work and how to use oscilloscopes and meters for the performance of a correct diagnostic.

New Technology

New Technology- Course Content:

The perfect introductory course for further modules or to get caught up on recent technology. A one day training seminar consisting of a central presentation, discussions and practical information on Dual Mass Flywheels (DMF), Diesel Particulate Filter Systems (DPF), Hybrids, Pïezo injectors and much more.

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Gates, Johnson Controls, Monroe, Pierburg, SKF, SWF, TRW, Valeo, Varta, Walker

TECH TIPS

Let's get technical...

At this stage, no one can be in any doubt as to the importance of technical knowledge and training for the aftermarket.

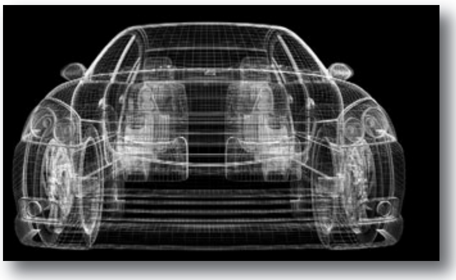
This third edition of Tech Tips covers a wide range of topics including turbochargers, injectors, timing belt/pulley replacement and diagnostics. I hope you have benefited from the previous 2 editions of Tech Tips. If you have mislaid them, let me know and I will send you a copy with your next magazine.

There are many courses now available to help you brush up on your technical knowledge, logon to www.autobiz.ie/training or scan the QR Code below for details on upcoming courses.

We welcome your input; email me at john@autobiz.ie.

John O'Callaghan, Technical Editor

autobiz.ie/training



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Tech Tips

CV joints - the next step

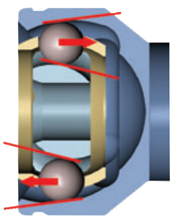
Constant Velocity (CV) joints are essential components of the drivetrain. They transmit tremendous torque from the differential to the wheels, while allowing steering movements and spring deflection. Erwin den Hoed, an independent journalist for Dutch automotive magazine, *Auto en Motortechniek*, explains the ruggedness and advantages of CV joint designs and introduces the next step in CV Joint evolution.

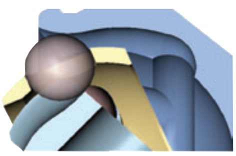
More than 50 years ago, a breakthrough came with the launch of the Austin Mini and the front-wheel drive. Since then, the front-wheel drive principle has not only been implemented in compact class vehicles, but has also been used in luxury class cars. Today, about 64% of all cars world-wide are fitted with front-wheel drive, and about 13% with four-wheel drive. The technological advances achieved in CV joints have made an essential contribution to this development. Without them, the front-wheel drive, as we now know it, would not have been possible.

The main requirements for modern driveshafts and CV joints are:

- Reliable transmission of engine torque at constant velocity, and under acceleration.
- Angles of up to 50° to allow steering and suspension movement.
- Driveshaft plunges of up to 50 mm at the output of the differential, to allow suspension movements
- Maximum vibration decoupling between the engine-transmission assembly and the wheel suspension, thus maintaining the comfort of vehicle occupants.
- A long, trouble-free service life

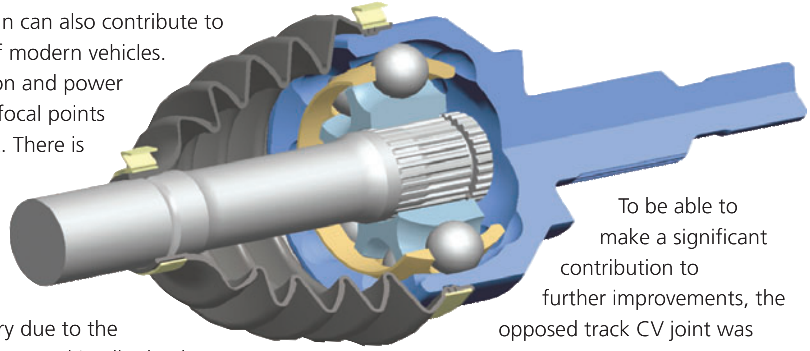
The main requirements for a CV joint as far as the driver is concerned, is that they are durable and reliable. They will function without fail or bother. As a mechanic, you need to rely on the manufacturer to provide a well made and durable CV joint that was carefully designed and rigorously tested. Relying on a budget or generic brand could easily end up as false economy, in the event of a premature failure of the replacement part. Installing a quality part from a trusted manufacturer will bring peace of mind to you and your customer.





S-shaped tracks

Opposed sets of tracks



Driveshaft design can also contribute to the efficiency of modern vehicles. Weight reduction and power density are the focal points of development. There is also a trend towards greater applied operating angles, necessary due to the increase in spring travel in all-wheel/4 wheel drive and sport utility vehicles. The efficiency of the driveshaft and the maximum allowed operating temperature, are becoming increasingly important in this respect.

This article is concerned mainly with the outboard fixed CV joint. The basic Rzeppa design that dominates these joints (named after its inventor Alfred Rzeppa) goes back to the

early 1930s. The original design has proven itself in as many as 100 million vehicles since then. Over the years, fine adjustments to the design, improvements to materials, heat treatment and lubricants and the optimisation of production processes have led to continuing advances in the technology. Alfred Rzeppa originally proposed a clutch element with constant velocity properties, consisting of inner race, outer race, cage and balls as coupling links between tracks. Another significant development came in 1972, when a new longitudinal track form (UF) was introduced (i.e. a straight track segment), which allowed the maximum angle to be increased. Since the market launch in 1972, the UF version of the CV joint has been the basic benchmark for future developments.

To be able to make a significant contribution to further improvements, the opposed track CV joint was developed as the alternative to the Rzeppa joint. The resulting Countertrack joint can be considered a significant technological advancement compared to the Rzeppa joint. The power density has been increased by more than 15%, while at the same time friction losses have been reduced by more than 30%. For the same installation space, the rated torque of the Countertrack is about 25% higher than that of the Rzeppa joint, which corresponds approximately to a doubling of the life of the joint in the vehicle. For special applications with high installation angles and therefore high temperature loads, rated torque can be increased by 40% compared with the modern Rzeppa joint.

Complex considerations arose in the development of the new design: track shape and profile, fatigue and contact wear on the balls, number of balls, materials and heat treatments, lubrication, etc. An interesting note is that there is a fine balancing act between the number, size and spacing of the balls and the overall strength and longevity of the CV joint. Today, the largest market share belongs to the design with six balls, which is the one originally proposed by Rzeppa. The end result of the design of the Countertrack is a CV joint that is more efficient and has a longer service life for all vehicles on the road.

In extensive validation tests, the Countertrack CV joint showed outstanding performance in direct comparison with the traditional Rzeppa joint, and especially in comparison with the UF joint. Expect to see more of this new design as push for efficiency and lower emissions continues.

GKN SPIDAN Original GKN Parts LÖBRO

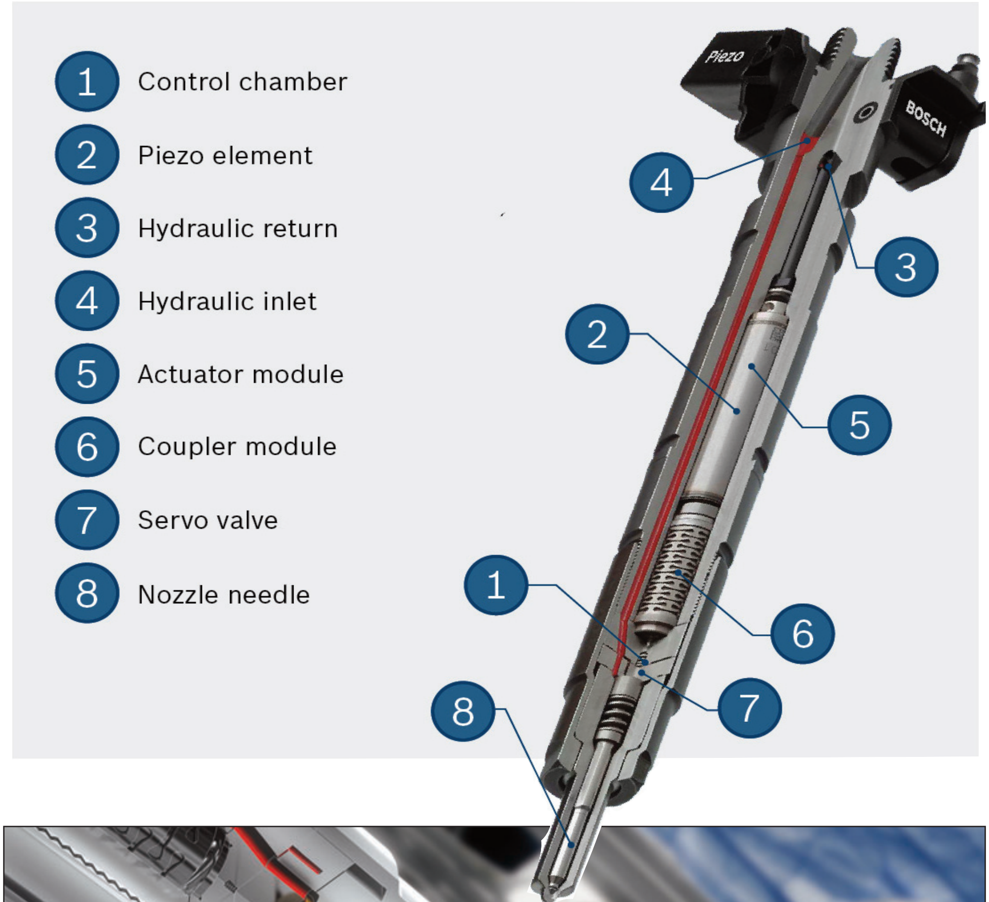
Piezo common rail injectors

Piezo common rail injectors may seem to be the same as older injectors, but they are very different. Bosch raises an important safety issue that every mechanic should be aware of.

During a recent training course, an older member of the group asked me, "what's all the fuss about? Not disconnecting Piezo common rail injectors whilst the engine is running? I pull the wires off petrol port injectors and crack off the injector pipes on old style rotary diesel pumps to find out which cylinder is misfiring. Why can't I do this with Piezo injectors?"

The difference is disconnecting Piezo injectors while the engine is running could possibly kill you and the engine. Piezo injectors work by passing a current through a Piezo stack in one direction to expand the Piezo crystals, then discharge them to ground to make them contract to their original size, this expansion and contraction operates a servo valve, this servo valve controls fuel pressure above the injector needle. The Piezo injectors are operated by up to 200 volts, 15 amps. This has the potential to kill you, and if you manage to disconnect the injector whilst the Piezo crystals are expanded, they will not be able to discharge to ground. This will cause the crystals to remain in their expanded state keeping the injector open.

The fuel pressure within the rail can be as high as 2000 Bar at higher engine speeds/loads, and even at idle it will be several hundred Bar. At this high pressure, the engine would not be able to burn the excessive amount of fuel being continuously injected and it would only take a few engine revolutions, to spray enough fuel into the combustion chamber to cause a hydraulic lock and serious engine damage. The full operation of Piezo and solenoid operated common rail injectors are explained in the Bosch training course VSD 15.



Check the OE reference to get the correct part

Dayco's technical team provides some important technical advice about auxiliary belt tensioners for some Alfa Romeo, FIAT, GM, Saab and Suzuki engines

For the Irish aftermarket, Dayco provides two seemingly identical auxiliary belt tensioners for the engines fitted to a number of popular models, from Alfa Romeo, FIAT, Saab, Suzuki and Opel. The Dayco references for these tensioners are APV1088 and APV1156.

Despite their apparent similarities, there are actually substantial differences between the two tensioners, due to the different type of fastening bolt fitted on each component. Tensioner APV1088 uses an Allen head bolt, while APV1156 features a Torx head bolt. The difference is due to the contrasting assembly equipment used on the car production lines of the various vehicle manufacturers.

Therefore, to ensure a correct match between the original tensioner fitted during the vehicle's manufacture and a subsequent replacement, it is crucial that the original equipment (OE) reference number and the Dayco number correspond.

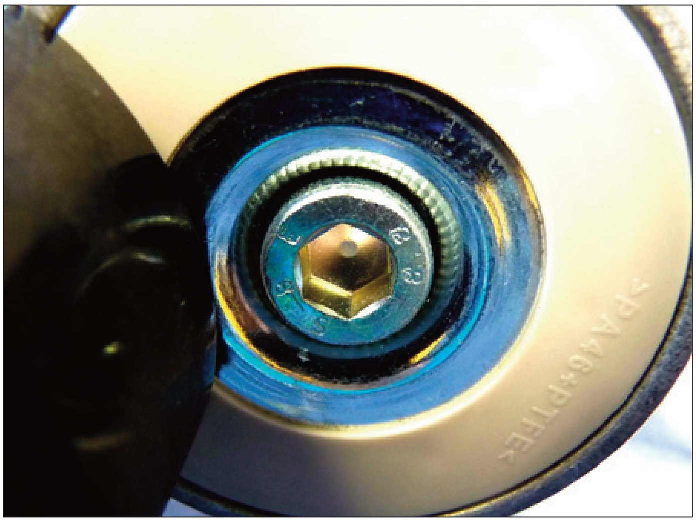
The included table clarifies the applications and will help to ensure the correct tensioner is selected, but particular care must be taken when undertaking a secondary repair, when the tensioner on the vehicle could already have been replaced and may not be the original part.

In the event of a secondary replacement, it is advisable to check the correct OE number for the vehicle through a reliable parts identification system such as TecDoc, and irrespective of the bolt specification used on the tensioner to be replaced, refer to the table to ensure the correct Dayco replacement is installed in order to facilitate the correct repair.

The complete list of vehicle applications for tensioners APV1088 and APV1156 can be found on the Dayco website: www.dayco.com or email: info.uk@dayco.com.

DAYCO

OE Reference	Vehicle Manufacturer	Bolt Specification	Dayco Reference
46817548	FIAT	N/A	APV1088
55190813	Opel/Saab	N/A	APV1088
51758385	GM	N/A	APV1088
55184522	FIAT	Allen head	APV1088
55184980	FIAT	Allen head	APV1088
51773551	FIAT	Torx head	APV1156
52202380	Opel	Torx head	APV1156
17054-79J50-000	Suzuki	Torx head	APV1156
17540T79J50-000	Suzuki	Torx head	APV1156



Dayco Tensioner APV1088 with an Allen head bolt for GM and some Opel/Saab and FIAT models.

Use the table above to properly identify the correct replacement

Dayco Tensioner APV1156 with a Torx head bolt for Suzuki and some Opel and FIAT models.

Use the table above to properly identify the correct replacement

What looks complex could be simple to fix

There are many things that can cause a car to run poorly. Some are hard to diagnose and expensive to repair. Michael Breen of J&M Breen Distributors explains how some repairs, once properly diagnosed, could have a simple, easy solution.

A dealer had taken a car in on trade, a 2009 Toyota Avensis D4D with only 90,000 kilometres on it. During a 40 kilometre drive, he soon discovered that the car had a significant problem that would have to be repaired before he could sell it on. The car was not running smoothly, it was unresponsive and the exhaust was dirty at times. Without knowing the exact history of the car, thoughts of expensive repairs loomed in his head.

The car was brought into the garage and after a few basic checks and inspections, the problem was identified. Fortunately enough in this case, the cause was an accumulation of sludge, varnish and soot in the air induction system that had accumulated to such an extent, that it had began to interfere with the operation of the throttle plate and EGR valve.

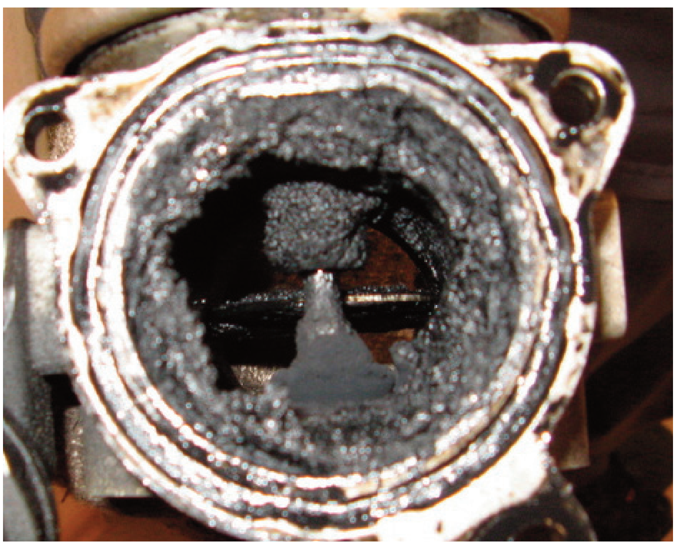
This can be the result of many things, but the leading causes are: longer than recommended service intervals, being limited to city driving only and inferior/improper oil for the application. The long service intervals and improper oil are becoming more common with car owners trying to save money whenever and wherever they can, but it is, of course, a false economy in the long term. Extensive city driving is a fact of life for many drivers in Ireland, and as a garage, you can make many aware of the need to have their air intakes cleaned before they become clogged and rob them of performance and fuel economy.

The process of cleaning the air intake is simple and straight-forward, and no special tools are required. All a mechanic has to do is to open the air induction system somewhere behind the air filter and spray the cleaner into the induction air while the engine is running. The spray is used in short bursts, while keeping the engine speed steady at around 2,000 RPM's. A typical treatment only requires half of a spray can, so one can will treat two cars. Be prepared for and don't be alarmed by a large amount of fumes and soot from the exhaust while using the cleaner, all of the accumulated grime has to go somewhere.

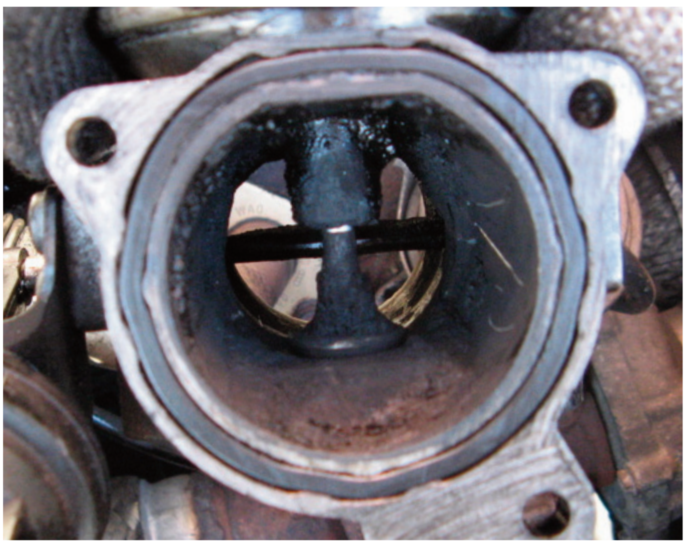
Improvements in badly clogged engines will be noticeable immediately. In the case of the Avensis that was driving so poorly, it was cured. The car was responsive and ran clean and was ready for resale. What had started as a potential costly situation had been resolved quickly and economically.

The photographs below show typical results that can be expected after a single treatment.
The "before" photo may be similar to what many diesel cars that are brought to you for servicing may look like. If you do find a customer's car that looks plugged up, I can't imagine many car owners deciding not to have this problem sorted out, thereby saving money on every tank of diesel.

J&M Breen Distributors
Kanturk



This car was running poorly. The accumulated sludge, varnish and soot obviously would be causing problems.



The same car after a single cleaning treatment. The result: a smoother running engine.

Tech Tips

Torque and Power

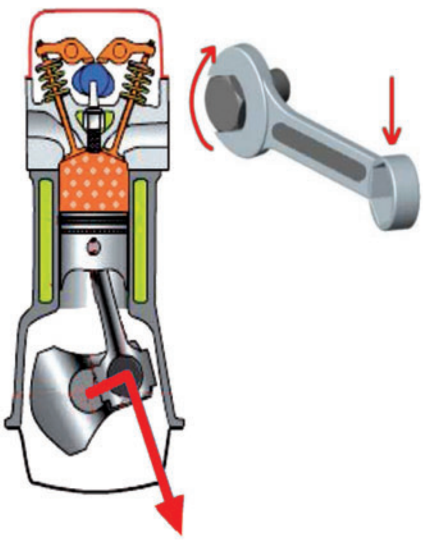
Torque and power are the vital statistics of an engine, but often they are poorly understood or completely mis-understood. Because of our links to England, our European present and a romantic relationship with horses, we also have a confusion of units. The Institute of the Motor Industry (IMI) sets out to explain where these terms come from and what they mean.

Torque

We all use torque wrenches, so the idea of torque should be clear. Just for clarification, here's a bit about it. Torque is a twisting force; that when applied it will, or will try, to turn something. This means that torque doesn't need to be moving anything, it might just be trying to. Importantly, you cannot apply a torque if there is no resistance. Torque is measured in Newton metres. This is the International System (SI) and they named it after Isaac Newton. Pounds feet is also commonly used but makes further calculations of Brake Thermal Efficiency and Specific Fuel Consumption clumsy. Look on your torque wrench for a quick conversion. A rule of thumb: 80Nm is about 60lbft or Nm = lbft x1.35.

Torque is the result of a force acting at a distance from the centre of rotation. Increasing the applied force, or the radius, increases the torque. Torque is simple to calculate: torque = force x radius.

Engines cannot produce static torque, so the torque has to be measured while the engine is running. Torque measurement is done with a brake dynamometer which can be electrical, hydraulic or friction.



Torque is easy to understand, you apply a force that may cause an object to rotate, but it may also not rotate

Work is a force applied over a distance, like pushing a car. Power takes into account how long it takes to push the car, more power means you will be able to push it more quickly.

Work

Work is done when a force is applied and movement takes place. If a bolt is being tightened and movement takes place, then work is being done. But if a bolt is tight and no movement takes place, then no work is being done. In both situations torque is applied. Here is where confusion can happen. Work is also measured in Newton metres; this time it is the force applied in Newtons and the distance moved in metres. If you apply a force of 400 Newtons to make a car move 20 metres, you have done 20 x 400 = 8000Nm of work. To distinguish Nm of torque from Nm of work, we use the unit Joule for work so you have done 8000 Joules or 8kJ of work.

Power

Power is the rate at which work is done and is measured in Newton metres per second or Watts, named after James Watt. Let's do some harder work. The challenge is to push the same car a distance of 200 metres as fast as you can. It takes 400N to move the vehicle, so the work done is 400N x 200m = 80,000 Joules or 80kJ. Let's say it took 200 seconds; then the power you put into moving the car would be:

$$\frac{80{,}000\text{ Joules}}{200\text{ seconds}} = 400\text{ Newton metres per second}$$

or 400 Watts. Now let's say another man is set the same challenge and completes it in 160 seconds, so the power would now be:

$$\frac{80{,}000\text{ Joules}}{160\text{ seconds}} = 500\text{ Newton metres per second}$$

or 500 Watts. Same work, different power. The faster that work is done, the more power is required.

So to recap:

Torque is equal to **force x radius** and is measured in **Newton metres.**
Work is equal to **force x distance moved** and is measured in **Joules**.
Power is equal to **force x distance/time** and is measured in **Watts**.

So how does this work in engines? The diagram to the right shows a dynamometer, that is simplified version of a real dynamometer. It uses a rope brake "B" to put a frictional load onto the flywheel. The amount of load is adjusted at "C" and the tension in the rope is indicated on a spring balance at "A". Power is force x distance calculated over time. If we consider the amount of power being generated over 1 minute: The force will be the force indicated on the spring balance. The distance will be the circumference of the flywheel multiplied by the number of rotations it makes in 1 minute. The time will be 60 seconds. So our calculation will be:

$$\text{Power} = \frac{\text{force x } 2\pi r \text{ x } n}{60 \text{ seconds}}$$

where r is the radius of the flywheel and n is the number of revolutions per minute.

But have you noticed there is both force and radius in the Power and Torque equations? If we replace them we get:

$$\text{Power} = \frac{2\pi nt \text{ Watts}}{60} \quad \text{or}$$

$$\text{Power} = \frac{2\pi nt \text{ kilowatts}}{60{,}000}$$

So let's say our engine is turning at 200 rpm and the spring balance measures 400N and the radius of the flywheel is 1 metre:

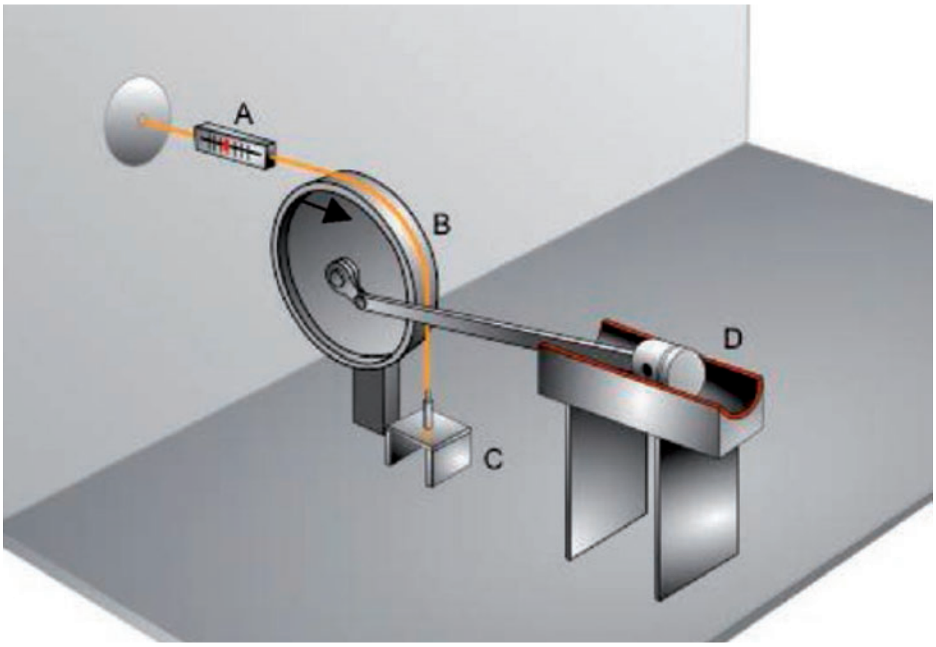
$$\text{Power} = \frac{400\text{x}2\text{x}3.142\text{x}1\text{x}200}{60000} = 8.4 \text{ kW}$$

This power is called Brake Power, because a brake is used to control the engine speed.

Brake horsepower (BHP)
When engines were first developed, they were compared with what they were normally replacing, horses. In the early 1700s, James Watt conducted an experiment to find out how powerful a horse was and calculated that it could raise a 33,000 lb weight one foot in height in one minute, or more reasonably 330 lbs raised 100 feet in one minute. This became the standard in the UK and the US. Europe, however, adopted another version of horsepower: PS DIN (Pferdetarke Deutsches Institut fur Normung), which just means horse power German Standard. Since the 1970s, the Irish motor industry has dithered - you will see power quoted in kW, BHP and PS DIN.

$$\text{BHP} = \frac{\text{torque (lbft) x } 2\pi \text{ x rpm}}{33000}$$

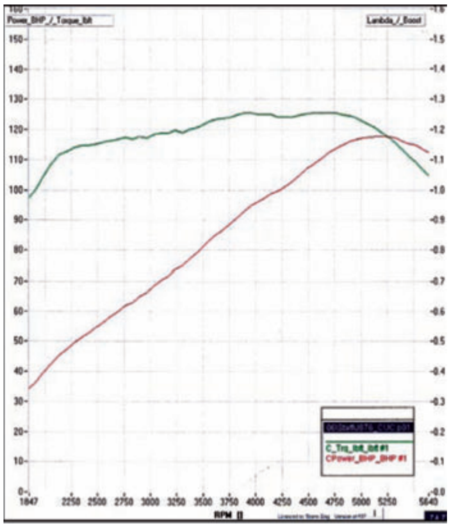
Converting kW to BHP:
1PS DIN is equal to 0.735 kW.
1BHP (US) is equal to 0.745 kW



A simplified version of a dynamometer testing an engine. This simple arrangement can determine the torque and power of the engine being tested.

If you like, 100BHP is 74.5kW or 100PS DIN is equal to 73.5kW.

Torque and power curves
Engine power is the result of torque and speed. The more torque an engine can produce, and the faster it can do it, the more power the engine will develop. The problem with engines is that they cannot produce the same torque across the engine speed range. The reason for this is mostly to do with volumetric efficiency, which is how effectively the cylinder is filled and is an entirely different topic that we won't get into here. Normal


A typical torque/power graph for a mid-performance, naturally aspirated, petrol engine

everyday engines are designed to produce their highest torque at midrange - about 2000rpm for diesel and 3500rpm for petrol. This makes the engine flexible and improves drivability.

Performance engines will be designed to rev higher and will generally arrange the maximum torque higher in the engine speed range. This gives them much more power. They do their hardest work faster. As you can imagine, there is a limit to the speed of an engine in terms of the stresses on the components. Above is a torque/power graph for a mid performance, naturally aspirated, petrol engine. As you can see, the torque (green) is low at low rpm's as the camshaft timing and overlap interferes with the air flow, and low again at high rpm's as the induction tract and valve timing restrict the air entering the cylinder. However, the power curve (red) shows that even though the torque is dropping at 4700, the power is still building. Think of our formula; both torque and speed contribute to engine power, so even though the torque is dropping the engine is still producing that torque at higher speed. It is only when the rate of fall of torque is greater than the rate of increase in speed that the power starts to drop.

The torque and power curves describe the driving characteristics of the vehicle and the type of gearbox that is needed.

In a future article, we will be looking at performance curves for modern petrol and diesel engines and how they can be modified.

Driveshaft inspection

Driveshafts and constant velocity (CV) joints are bespoke components for which high quality, proper installation and handling is critical. They transfer torque from the differential or gearbox to the wheels and are constantly subjected to extremely high stresses. GKN gives some tips about driveline removal and installation, along with a refresher on best practices.

Age-related wear is among the most commonly occurring cause of damage to the outboard (wheel side) and inboard (transmission side) joints, closely followed by damage resulting from defective boots, the use of inferior quality grease, and unfortunately, improper handling frequently occurring during installation and removal. Since it is inherently difficult for customers to identify problems with driveshafts or to describe these problems accurately. Mechanics have much to gain in terms of maximizing customer satisfaction by recognizing damage to the driveshaft early on and informing the customer. However, how can damage to driveshafts and CV joints be detected with certainty and without error?

Test drive

While cornering pay attention to noises. Clicking or knocking when cornering is caused by the drifting of the balls over a pit worn in the joint. Grinding noises may be the result of excessive rotational play between the joint and the shaft. Pay attention to vibrations in the steering wheel. Vibrations that intensify with increasing speed can be caused by excessive play in the joints or by a bent or damaged shaft.

Inspection

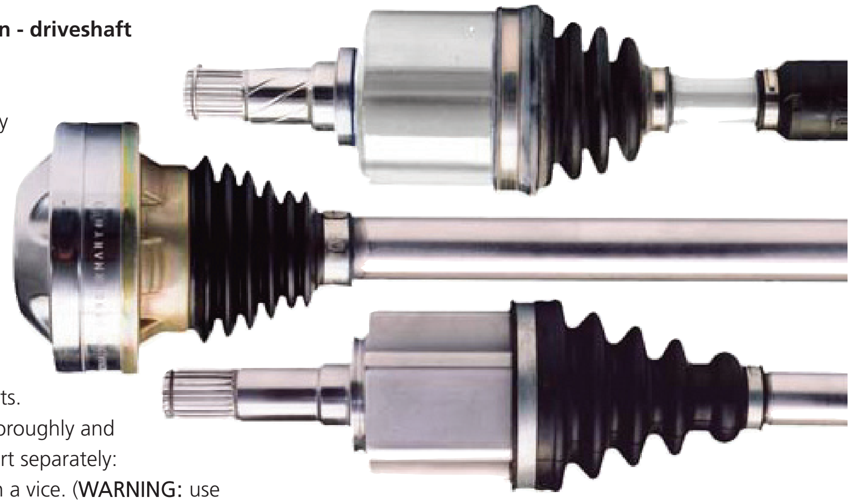
Driveshaft inspection should be performed as part of a regular maintenance routine. Normal vehicle maintenance and recognition of component deficiencies is necessary to prevent serious mechanical problems, as well as driver discomfort. Failure to perform normal maintenance may also void the vehicle warranty.

Routine inspection - driveshaft installed

• Check the driveshaft for a tight fit at each end.
• Check cleanliness of the driveshaft, CV joint and boots. Grease contamination is a clear sign of a problem.
• Check the shaft for damage and for bent or missing parts.
• Check the boots and clamps: torn, slipped and porous boots are the most frequent cause of failures
• Check the slip spline for excessive radial movement
• Check the joints for excessive radial movement
• Check the joints in all possible steering angles

Routine inspection - driveshaft removed

Proper fault recognition can only be complete if the driveshaft is checked while off the vehicle.



• Dismount both driveshafts and joints.
• Clean all parts thoroughly and then check each part separately:
• Place driveshaft in a vice. (WARNING: use aluminium or soft jaws only! Steel jaws will cause damage to the shaft)
• Both joints must rotate smoothly without any binding and must not have excess radial movement.

Fault recognition can only be complete if the driveshaft is checked while off the vehicle. Dismount both driveshaft and joints. Clean all parts thoroughly and then check each part separately.

Driveshaft removal

• Raise the car on a lift up to working level and remove the wheel.

• Apply the brakes and unscrew the bolts from the differential side joint if present.

• Remove drive shaft nut, loosen the wheel carrier and pull the driveshaft out of the wheel hub. If required, use special tools recommended by the car manufacturer.

• Pull out driveshaft. Clean wheel hub housing and differential flange surface. For driveshafts with integrated transmission journal, pull the driveshaft with reinforcing rod out of the gearbox housing. Some oil may drain when the driveshaft is removed.

• Avoid overstretching the plunging joint by leaving the shaft hanging down while still fixed to the gearbox housing. This may cause extreme pressure on the ball cage in the CV joint, which is likely to cause a break or damage.

Driveshaft installation

• Clean wheel hub housing and differential flange surfaces. Surfaces must be free of dirt.

• Centre the joint on the differential flange and fit/fix into place. Driveshafts with reinforcing rods must be inserted in gearbox housing until they lock. For gearboxes with a lock ring on the spline, the lock ring has to be fully engaged. Use any special feed tools recommended by the car manufacturer. Comply with the indicated tightening torques and sequence specified by the car manufacturer.

• Insert driveshaft into wheel hub. Always remember to use all new parts provided. Use any special tools recommended by the car manufacturer as required.

• Tighten the wheel carrier. Use new bolts and tighten to the manufacturers specification. Consider any security measures used by the manufacturer, such as shear pins, etc.

• Check the driveshaft after installation by pulling the joint. and driveshaft.

• Apply washer on outer end of the CV joint. Apply and torque driveshaft nut according to specifications of the car manufacturer. Only a new nut should be used! Never re-use the old nut.

• Mount the wheel and test drive the vehicle.

Opel belt replacement guide

The 1.8i 16V C 18 XE engine – with varying engine displacement – is used in a number of Opel models. Serious mistakes can be made when the tension pulley is adjusted. To ensure that changing these belts goes smoothly, ContiTech Power Transmission Group provides a step by step installation guide.

When timing belts are changed, the tension pulley, the guide pulley and the water pump should be replaced too. Opel recommends replacement after 60,000 km or every four years. When carrying out a replacement, mechanics need a tool to lock the camshaft, for instance the Multilock from the Conti Tool Box. On an Astra F, it takes about one hour to replace the parts.

Preparatory work

Identify the vehicle using the engine code, which can be found on the outer edge of the transmission mounting flange on the engine block (fig. 1). Disconnect the battery. Remove the air filter, the air intake hose and, on engines with the code C 18 XE/XEL, the air mass sensor.
Support the engine and remove the right engine mount, the auxiliaries and the V-ribbed belt. Dismount the power steering pump and the air-conditioning compressor, and remove the timing belt cover.

Removing the timing belt

Turn the crankshaft to the right until the control mark on the crankshaft pulley aligns with the indicator on the engine block (fig. 2).
On camshaft pulleys with a single control mark, make sure that the mark on the camshaft pulley is aligned with the mark of the valve cover.
On camshaft pulleys with two control marks, check that the "INTAKE" and "EXHAUST" control marks are aligned with the marks of the valve cover (fig. 3).
Lock the camshaft with the locking tool (fig. 4).
Note: If the timing belt is removed without locking the camshafts, the camshafts may turn and the timing belt can no longer be mounted properly. If this happens, the camshafts can be put back into position using improper methods.
Remove the crankshaft screw and loosen the tension pulley screw.
Turn the tension pulley to the right until the pointer is at the left stop. The tab attached with a hexagon socket screw must move clockwise downwards. Use a hexagon socket here.
You can now remove the timing belt.
Drain cooling water and remove the tension and idler pulleys and the water pump.

Installation of the timing belt

Replace idler pulleys and water pump.
Note: When installing the water pump, make sure that it is positioned correctly. The nose of the `water pump must be placed in the recess of the rear timing belt housing (fig. 5).
Install the new tension pulley. Make certain that the counter support on the back of the tension pulley (base plate of the pulley) is positioned between the contact surfaces on the engine block and not next to them (fig. 6).
Install the new timing belt against the rotational direction starting at the crankshaft gear.
Turn the tension pulley with the adjusting cam to the left until the pointer is at the right stop. The hexagon socket screw moves counterclockwise upwards. Use a hexagon socket. Then tighten the new tension pulley slightly.
Note: This is an especially important step. If this is not done, the belt drive will start making noise in a short time due to insufficient tension.
Rotate the engine by hand, in the running direction, at least twice after removing the locking tool.
Loosen the screw on the tension pulley, and turn the tension pulley to the right until the pointer is aligned with the notch in the bracket (fig. 7).
Tighten the screw on the tension pulley with a force of 20 Nm.
Turn the engine by hand two more times, check the setting and adjust if necessary.
Install the components in reverse order of removal. Fill up the cooling water and vent the cooling system.
Record the replacement of the original ContiTech timing belt on the supplied sticker and affix it in the engine compartment (fig. 8).
Test run the engine and take a test drive.

Continental CONTITECH

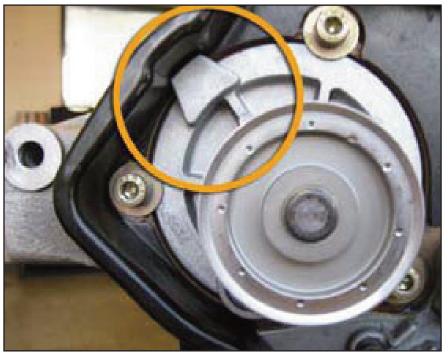


Fig. 3

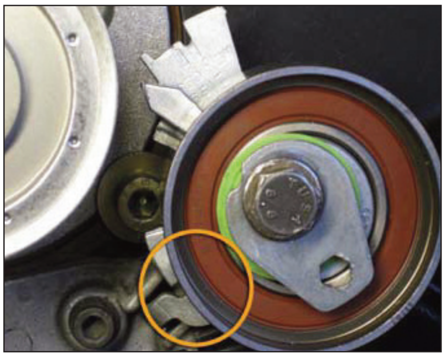


Fig. 4

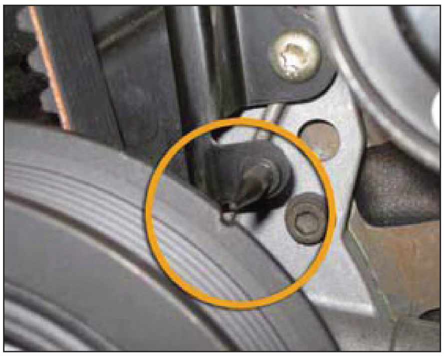


Fig. 1

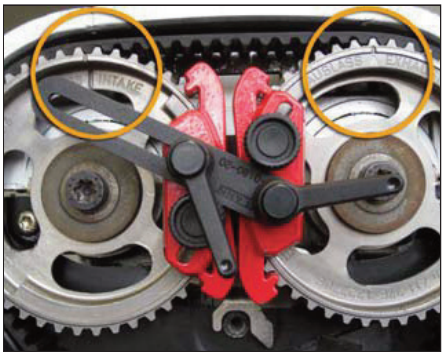


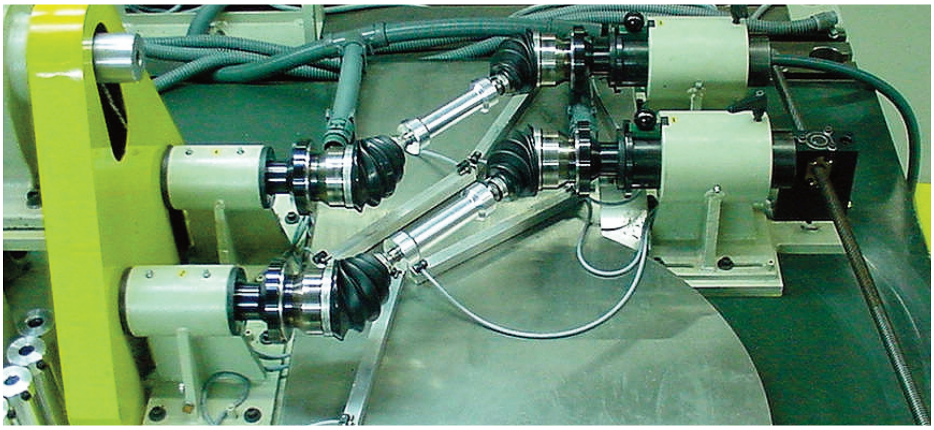
Fig. 2

Fig. 5

Athletic axles

Modern cars and 4x4s are big and heavy. They have huge torque, preferably a high spring ratio, a considerable wheelbase and yet they are manoeuvrable. If there is one place where all these properties pose major demands then it is the driveshafts. Erwin den Hoed, from Dutch automotive magazine, *Auto en Motortechniek*, reveals the latest developments from GKN.

A driveshaft faces a tough job. It has to transfer the engine torque from the differential to the wheels. With a rigid rear axle with an unsprung differential, the driveshaft has to be strong enough not to be twisted by the drive torque, but nothing advanced is required.
If the differential is suspended independently of the wheels, or if it needs to be possible to steer the wheels, then it is a different story. In that case the axle needs to be able to turn a corner, and that's were ingenuity and engineering come into play.
Ford engineer Alfred Rzeppa solved that problem in 1927, when he dreamed up a design with six balls in a cage, which transmited the torque from an inner to outer race (or the other way round), irrespective of the angle at which the races are to one another. This basic idea has been improved upon over the years, but is still the fundemental design of all modern constant velocity (CV) joints.



GKN conducts some very strenuous testing on their axles and CV joints

Change of length

A car's suspension and steering lead to a further complication: the axle must be variable in length. This can be solved by using a sliding joint in the axle, but a CV joint with an extended outer race also does the job. A sliding joint comes at the expense of the angle of rotation that the CV joint allows. A fixed CV joint allows a greater angle of rotation, necessary to achieve the steering lock required. That is why a sliding or plunging CV joint is generally mounted on the gearbox of a front-wheel-drive vehicle and a 'fixed' CV joint is mounted at the wheel hubs.

Shorter turning circle

The angle the fixed CV joint can form determines the turning circle of the car. Engineers have always been on the look out for ways to improve their constant velocity joints in this aspect. The shape of the races, in particular, has been the subject of constant research. For 'premium front-wheel-drive vehicles', for example, GKN uses the under-cut-free series races. These are flat towards the end where a conventional race bends. That is how a UF-CV joint can achieve angle of rotations of up to 50°, a clear three degrees more than fixed CV joints with more conventional races. This may not sound all that impressive, but it means that an Audi A6, despite having a wheelbase 12 cm longer than a Peugeot 407, has a half metre smaller turning diameter.

Opposed tracks

There are other design considerations for races in a CV joint. Large drive torques at high angles of rotation lead to heat creation in the CV joint. The cause of the heat generation is friction, created because the loads on the balls force the CV joint in an axial direction. The problem can be solved by not allowing the open side of the races to point the same way (as Rzeppa did), but in opposite directions to the interior and exterior of the CV joint-housing. Then the loads cancel each other out. GKN calls these races 'opposed tracks' and this advancement is the most important development in the constant velocity joint since Rzeppa invented it. The 'opposed track principle' leads to less heat being generated in the joint. As a result, they can be made smaller and lighter and yet handle the same drive torque. The first car which was fitted with this was the Volvo XC90 V8. GKN uses this design for the Range Rover as well.

The next step - Countertrack CV joints

At the end of last year, elaborating on the opposed track design, GKN presented its latest development in races, the Countertrack CV joint. With the Countertrack, the races are not just opposed, they are S-shaped. The next stage on the undercut free race allows angles of rotation as great as 52°. GKN believes that we will soon be encountering these high-tech CV joints on the road, but it is not letting on which cars it will be in.

Wearing part with an eternal life

Normal wear on CV joints is virtually negligible. In principle, a constant velocity driveshaft can easily last the life of a car. Despite this, they can be classified as typical wearing parts. Two reasons can be identified for this. The first is improper use of the vehicle. If someone is hell-bent on wrecking things, then they can wreck a CV joint too. An example is rapid acceleration from a stop with the steering wheel turned sharply. Performed often enough, this will guarantee early wear of the CV joints.
The second cause is the rubber boot. If it tears or is damaged in some other way, grease can escape from the CV joint, whilst dirt and moisture can find a way in. The CV joint is then destined for early failure. It is therefore vital to check these rubber boots and replace them if necessary.
If replacement is required, the easiest solution is a universal shaft boot. This can be installed without completely disassembling the shaft. It works with a cone or a boot slider.
Mounting an original shaft boot requires more work, but can ensure improved quality. It is tailor-made for exactly that CV joint and model.
Damage to CV joints is often indicated by click-clack noises of the balls over their races when turning, or with changes in loads. If the noises occur when driving in a circle on full lock, then you can suspect the wheel-mounted CV joints. Wear to the ball races of the gearbox-mounted CV joints can be heard when turning, as they are forced to slide in and out.
Where replacement is required, the parts manufacturers as a rule provide good removal and assembly instructions. It is very important to follow these instructions closely.

Further drive axle tips:

- Use the proper grease and apply it correctly; half in the joint, the other half in the rubber boot.
- Replace all circlips, retaining clips and other fastening elements as well.
- Pay attention to torques and use the tools recommended.
- If you are only replacing the rubber boot, then remove all of the grease from the CV joint and replace it.
- Do not twist the rubber boot during assembly.

Working with what you know

Sometimes you encounter a problem on a car that doesn't seem to have a clear solution. Sometimes the only thing you can do is fix what you can, and then see what effect that has on the rest of the situation. Using this method, eXponentia's Steve Carter encounters a seemingly un-fixable Volvo, and fixes it.

Steve Carter, eXponentia

A 2008 Volvo V70 with a D5 turbocharged diesel engine was towed to a garage after breaking down on the road. The car would not crank, there were some warning lamps illuminated on the dash and the brake lamps were on. The garage set about checking the battery, to make certain it had enough power to crank the engine and then plugged in their diagnostic scanner to read the Diagnostic Trouble Codes (DTC).

Much to the mechanic's surprise, only airbag trouble codes were displayed. The ABS and Engine Management fault lamps were both illuminated on the dashboard, but his scanner could not display any DTCs from these systems. A quick check of the physical connection between the car and the scanner, and a check to see that the scanner was indeed switched on and was connected to the car, did not sort the problem.

Faced with these two sets of contradicting facts, it was time to start at an even more fundamental level. The scanner came under suspicion, but when connected to another car it worked as expected. The thought that the scanner might be incompatible with that car prompted the mechanic to try another brand of scanner. This garage was located in a business park that had two other garages close by, so another scanner was handy, but the results were the same - no DTCs from either the Engine Management or ABS systems could be seen. When a third brand of scanner was connected to the Volvo the result was the same. No Engine Management or ABS DTCs could be seen when he knew that they had to be in there, but he didn't know why.

Now the mechanic had three heads working on the problem, but no solution was in sight. Anything they tried or checked did not get them any closer to a solution. And of course the owner of the Volvo wanted to know what was wrong, how much was it going to cost to fix it and when would it be ready. Even more unknowns to worry about. It's a tough spot to be in with a customer that has put their faith in your abilities, but it seemed as if towing the car to a Volvo dealer would be the only solution. It seemed time to surrender the car to a Volvo dealer.

As luck would have it, I had come round to the garage to collect a car for a training course being held the next day. I was pressed for time, but offered to have a quick look to see what could be done. A one minute recounting of the details was provided, and I set about seeing what could be done. This car was equipped with CAN-Bus, so there was no direct wiring between the components, all communications between components is over a network.

Because multiple scanners alone had been unsuccessful on their own, I attached a breakout box to the data port of the car. The breakout box allowed me to see what activity there was, at any pin in the connector. On this Volvo, with the key on and engine off, there should have been network activity at 6 and 14 and also on 3 and 8. There was activity on 3 and 8, which was the network that controlled the airbags. There was no activity on 6 and 14, which is the network that controlled not only Engine Management, but also the ABS. That explained why the scanners had all failed, the network that was supposed to report the DTCs was not working.

A scanner alone could have sorted this problem

A breakout box provided a clue, but it was not essential

Given that there was only one network active, the next step was obvious: you do what you can do and see where that gets you. A quick scan of the airbag network showed a total of at least 15 faults, all CAN-Bus related. Once these faults were cleared, there was network activity between 6 and 14. The Engine Management and ABS could now be scanned. There were also at least 15 DTC on each of these systems, and as would be expected now, all but one were CAN-Bus related. The remaining fault code related to the brake light switch, and it was the only fault code that was not CAN-Bus related.

Do you remember that the brake lights were on at all times? When the brake light switch was unplugged, the car started and ran perfectly. The source of the problem had been identified in less than 15 minutes, with the proper tools and knowledge of how the control network on this car really works. While the breakout box was not essential in solving this problem, it did provide a bit more information, and it confirmed the nature of the problem. The problem could have been sorted without a breakout box, by using the scan tool to look at the airbag system, clear those codes and then checking the other networks as they would have come back to life.

Now the question you should also be asking is: How could a faulty brake light switch bring the entire car to a stand still? The initial fault was reported and caused a cascading series of discrepancies in the network that created more faults, relating to the CAN-Bus network. These new faults caused even more faults. The faults accumulated in the system until it became paralyzed and simply switched itself off, either incapable of resolving too many conflicting messages, or believing that some serious problem existed that might cause damage to the car.

The mechanics who had been stumped by this were a bit shocked that a solution had been so simple, and the lesson so clear: Do what you can do and see where that gets you.

eXponentia™ The Automotive Training Experts

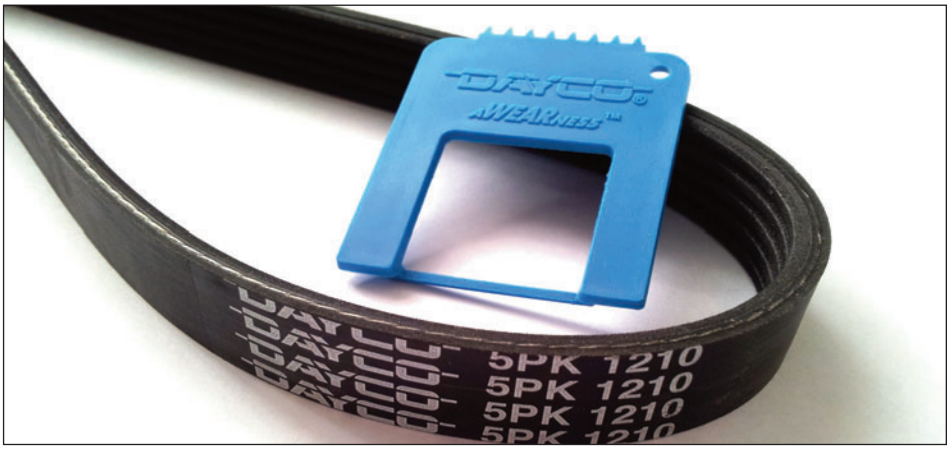
Is that belt really worn out?

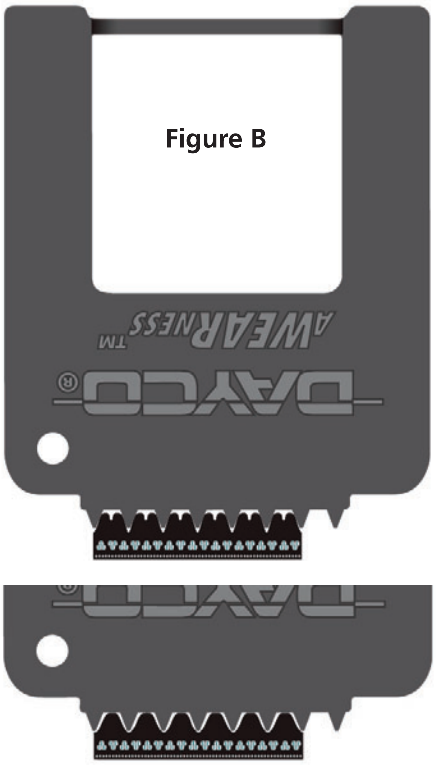
With advances in drive belt technology, the service life has been extended and the materials and their characteristics have changed significantly. Dayco has developed a tool to help mechanics quickly and easily determine when a belt is worn out.

To provide the motorist with a high standard of service and repair, a mechanic must make sure that they regularly check the condition of all multi-rib auxiliary belts and replace them when the signs of wear become visible.

However, what are the signs of a worn out belt and how can the degree of wear be judged accurately, to ensure that a worn belt is replaced, but a serviceable belt is not replaced unnecessarily?

Historically, multi-rib belts were made from neoprene compound, had a service life of between 50,000 to 80,000 miles and the signs of wear were generally obvious in the form of cracking, chunking (small sections of the belt broken off), glazing or splitting. Today's belts, in contrast, are made of extended-life rubber compound (EPDM), have a service life of around 100,000 miles and the wear signs are more difficult to detect, as these belts tend to wear through material loss, in the same way a tyre would.





A new or serviceable belt, top, and a worn belt that needs replacement, bottom.

As a result, the 'V' profiles of the ribs on the belt begin to wear down and start to resemble a 'U' and not a 'V'. As the profile changes, the contact area of the belt on the pulley is reduced, and the efficiency of the belt drops. This wear can lead to slippage and affect the performance of the belt, as well as make it very noisy.

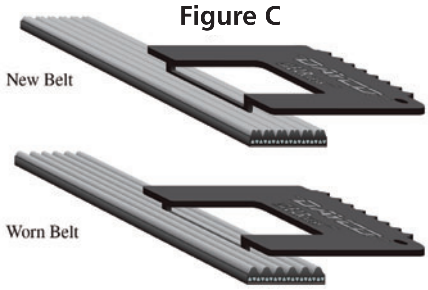
In order for workshops to quickly and accurately measure the wear of these belts, Dayco has produced an easy-to-use tool that makes the process extremely straightforward. The Dayco 'a-WEAR-ness gauge' is a small but robust plastic tool, that allows the technician to perform three visual checks, that will clearly reveal the condition of the belt.

First, the profile of the ribs can be measured using the 'comb' end of the tool which, when held against the ribs, will show whether there is any side clearance between the teeth of the 'comb' and the side of the ribs. A new (or still serviceable) belt will show no side clearance, as shown in Figure A. On a worn belt, the base of the teeth will bottom out on the top to the ribs and reveal a gap between the sides of the ribs and the teeth of the tool, as shown in Figure B.

The second check will show the wear on the ribs themselves. An indicator 'bar', on the opposite end of the tool to the comb, will sit above the tops of the ribs when placed lengthways along the groove on a new or serviceable belt. On a worn belt, the bar will sit below the top of the ribs. This shows that material has worn away and the gap between the ribs has increased. (Fig C)

A final check, for cracks, allows the technician to view the ribs through a 25mm square 'window'. If four or more cracks are visible through the window, then the belt must be replaced before failure occurs.

Figure C



A new or serviceable belt, on top, and a worn belt that needs replacement, on bottom.

The condition of the auxiliary belt should not be overlooked, particularly as they tend to drive more components on a modern vehicle and the environment in which they operate is very hot and can contain harmful contaminates. Although auxiliary belt failure is not usually as catastrophic as the failure of a timing belt, it will nonetheless stop the vehicle and necessitate its recovery. Dayco recommends that a thorough inspection of all drive belts be undertaken after the vehicle has reached 75,000 miles. It is also good practice to thoroughly inspect all drive belts whenever the timing belt is replaced.

The Dayco aWearness gauge is available from Team PR Reilly on 01-832-0006.

DAYCO

Getting a closer look with a borescope

A borescope is a flexible, bendy inspection camera with an integrated screen. Ring Automotive explains the advantages, and just some of the jobs a hand held borescopes can help you with.

Scan this QR Code or go to tinyurl.com/5stm58m to see a borescope in use.

Attachments allow the borescope probe to retrieve objects and see at an angle

A borescope is an ideal tool for inspecting areas or parts which are difficult to reach. The flexible camera probe is able to look inside narrow gaps and pipes, making it easy to inspect, diagnose and fix potential faults on engine, gearbox and wiring systems.

A borescope will have a screen for real time viewing. With some borescopes, it is possible to capture images or video. Images or video can be saved to show or email your customer, to help you sell the repair. Some borescopes are also able to output the screen via USB for display on a larger screen, such as a laptop or tablet computer.

The benefit of using a borescope is the speed in which some faults can be diagnosed.
A good example is a suspected fault within a turbocharger. Without a borescope, on some makes you would have to physically remove the turbocharger, to properly see the turbine blades or see the part number to order the proper replacement.

Another use for borescopes is inspecting the condition of components inside the engine such as pistons, valves and bores. This kind of inspection would typically involve removal of the cylinder head, however, a borescope removes this hassle. The camera probe of the borescope can be inserted down into the combustion chamber via the spark/glow plug hole.

A waterproof camera probe, with integral LED illumination, provides a clear view in this sort of poorly lit area. By using a mirror attachment on the borescope probe, a view of the valve condition can then be observed and recorded. Any pitting, carbon deposits or damage can be identified, allowing for a quick diagnoses of what work is needed.

Another use is the easy inspection of brake pad thickness, without the need to take a wheel off. The borescope can be put through under the wheel arch to take a close look.

Suspected damage to turbines can be easily verified within a few minutes

Valves can be examined by inserting the probe in the spark/glow plug hole

The uses of a borescope are extensive, and with a bit of thought more will come to mind. Inspection time can be greatly reduced, allowing significant savings in labour costs. Problems can clearly be identified to the customer, helping speed up the sale and completion of the repair. A borescope will pay for itself in a short matter of time.

There are a variety of attachments that can be used with a borescope. A magnet and hook can be fitted on the probe to retrieve objects. Another handy attachment is a mirror, for viewing different angles. Probe extensions of up to 3 metres are also available, that put almost any area of a vehicle into the range of a borescope.

Scan the QR code above to see demonstrations of the borescope in use, or visit tinyurl.com/5stm58m.

For further information on borescopes, contact Henry Bisson at Ring Automotive on 0044-113 213 7338 or email henry.bisson@ringautomotive.co.uk.

RING

Combustion and EGR

In this first part of a series, the Institute of the Motor Industry (IMI) looks at the combustion process and emissions in petrol and diesel engines, the reasons behind the need for exhaust gas recirculation (EGR), EGR operation and what happens when things go wrong.

Petrol engine combustion

A four-stroke petrol engine, running on ordinary petrol, will operate at its most efficient with an air/fuel ratio of 14.7:1 (14.7 kgs of air for every 1 kg of fuel). At this precise ratio, all of the fuel will be burnt and all of the oxygen in the air will be burnt, leaving nothing left to form unwanted emissions. This ratio is referred to as stoichiometric, a term borrowed from chemistry. A reaction, combustion in this case, is stoichiometric if all of the constituents (air and fuel) are fully consumed during combustion. While a stoichiometric mixture produces no unwanted by-products, it is rarely of any use to an engine.

Inefficiency

The average 4-stroke petrol engine is less than 25% efficient. This means that for every four litres of fuel that you put in, less than one litre turns the flywheel! This inefficiency is mainly due to heat loss. A petrol engine is a heat engine – it converts heat energy through the burning of the fuel and air into kinetic energy (the rotation of the flywheel). The great majority, more than 75% of this energy escapes through the exhaust pipe, into the cooling system, heating the engine etc. The theoretical maximum effeciency that a combustion engine could ever acheive, in a completly useless laboratory configuration, is only 37%.

Another area of inefficiency is in the mixing of the fuel and air. Oxygen is the only constituent gas in air that supports combustion, and it accounts for only 21% of air. So only one fifth of all the air drawn into the engine during the induction stroke is of any use.

The ideal is to ensure that the particles of fuel are mixed thouroughly with the air, to make best possible use of all of the oxygen. If some of the oxygen doesn't burn, the effeciency of the engine drops. There are numerous ways to ensure that thorough mixing does take place, but they can all be related to two techniques: creating turbulence (or swirl) in the induced air or introducing the fuel as a finely atomised (a very fine mist of microscopic droplets) state as possible.

Emission gasses

Under perfect conditions, when petrol is burnt in air at a mixture strength of 14.7:1, nitrogen (N2), carbon dioxide (CO2) and water (H2O) are the only gasses produced.

In reality, an engine also produces the following gases, most of which are undesirable for many reasons:

- carbon monoxide (CO)

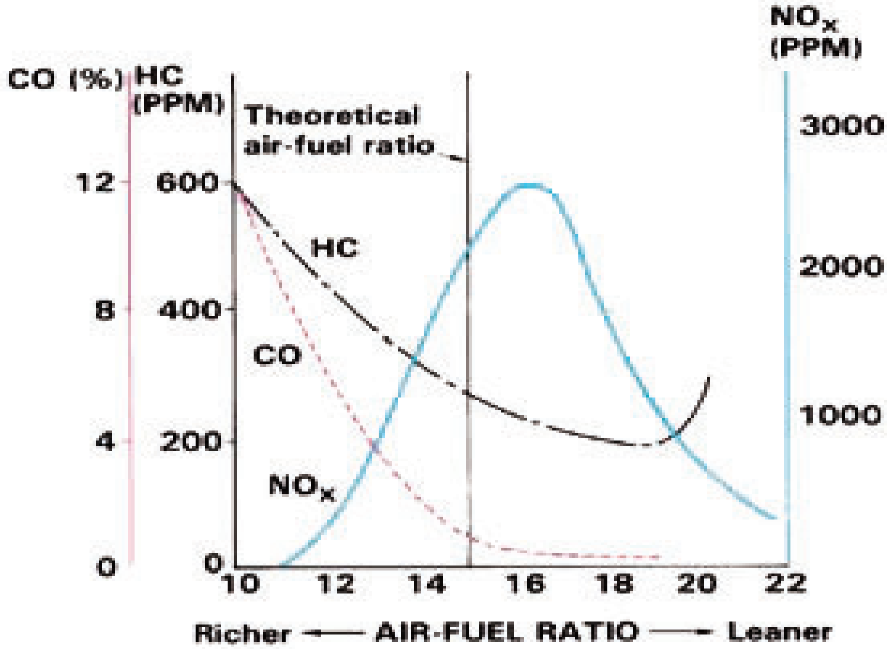


Figure 2 The effect of air-fuel ratio and CO (red line), HC (black line) and NOx (blue line)

- hydrocarbons (HC)
- oxygen (O2)
- carbon dioxide (CO2)
- Oxides of nitrogen (Nox).

CO is produced by incomplete combustion of the fuel, which can be caused by poor mixing of the fuel and air at the time of combustion. This is a particular problem when the engine is cold and temperatures around the cylinder walls are low, which leads to "quenching" (figure 3). Quenching occurs when the relatively colder surfaces in the combustion chamber allows fuel to condense on the cylinder walls, just as steam will condense on a cooler surface. Fuel left unburnt in these quenching zones is then exhausted during the exhaust cycle as HC.

A rich mixture (excessive fuel or insufficient air) can also contribute to the production of CO. This happens when there is not enough oxygen to combine with the fuel during the combustion process.

A lean mixture (excessive air or insufficient fuel) burns slowly and the metal in the combustion chamber is exposed to the burning gas for longer and will absorb more heat, which can cause the engine to overheat. Excessively lean mixtures will extinguish as the piston moves down, causing a rise in HCs.

Carbon dioxide is the byproduct of complete combustion and peaks at or near stoichiometric ratios. (See figure 2).

Hydrocarbons

HC is raw, unburnt petrol emitted from the engine. It comes from the following sources:

- raw blow-by of gas caused by overlapping of intake and exhaust valve timing (figure 5).
- raw gas remaining near the walls of the cylinder after burning, and exhausted during the exhaust cycle quenching zones (see figure 3).
- Low compression during coasting or deceleration which casues incomplete combustion of fuel, resulting in raw HC gas in the exhaust.

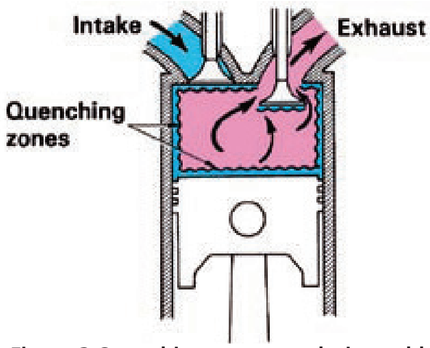


Figure 3 Quenching can occur during cold engine start-ups. Some of the air-fuel mixture may condense on surfaces inside the combustion chamber.

Oxides of nitrogen (NOx)

Oxides of nitrogen, NOx, are gases formed by Nitrogen and Oxygen during combustion if the combustion temperatures become excessive. They are NO nitric oxide, NO2 nitrogen dioxide, 2NO nitrous oxide, and so on. In general terms, the higher the temperatures during combustion, the higher the levels of NOx. A figure of around 1,800 degrees Celsius is often quoted as a temperature above which excessive levels of NOx are formed. The type of NOx depends on the length of time the high temperature prevails.

The NOx effect

NOx is a colourless gas, which can cause paralysis if it enters the bloodstream. NO2 can cause respiratory irritation and can damage lungs. Additionally, oxides of nitrogen, combined with hydrocarbons, can form photochemical smog. Hence legislation requiring vehicle manufacturers to fit additional equipment to aid NOx reduction.

NOx formation reduces engine efficiency

The reaction between oxygen and nitrogen is endothermic, it takes an external heat source to make it happen. This takes energy out of the expanding gas, robbing the engine of power. NOx formation also steals oxygen away from the fuel, producing incomplete combustion, lower combustion pressures and higher CO and HC output, so it's all round pretty undesirable.

The basic problem in an internal combustion engine is that high combustion temperatures cause an increase in NOx production. Any aspect of the engine design or operation that increases combustion temperature is then going to result in higher NOx emissions. Many modern engines run fairly high compression ratios, with ignition timing hovering just around the point of detonation. This creates high combustion temperatures which increases NOx emissions.

EGR to the rescue

Inventors of EGR were looking for a way to reduce temperatures in the combustion chamber so NOx would never form. A compromise was reached where the EGR system allows a percentage of the exhaust gas to be fed back into the intake system. Exhaust gas is mostly non-combustible; therefore, if a small amount of exhaust gas is mixed with the fresh fuel/air mixture, it occupies a portion of the mixture that would otherwise be combustible and less heat will be produced.

The recirculated exhaust gas absorbs some of the heat produced during combustion, by increasing the heat capacity of the mixture in the cylinder. Exhaust gas has a higher heat capacity than the fresh air fuel mixture, so diluting the intake charge with exhaust gas causes the heat energy from combustion to have less effect in raising the in-cylinder temperature.The combustion temperatures are reduced, thus reducing the formation of NOx.

EGR does not make it so cool that no NOx forms at all, but it is a compromise that does enough to keep NOx formation below limits specified in government pollution regulations.

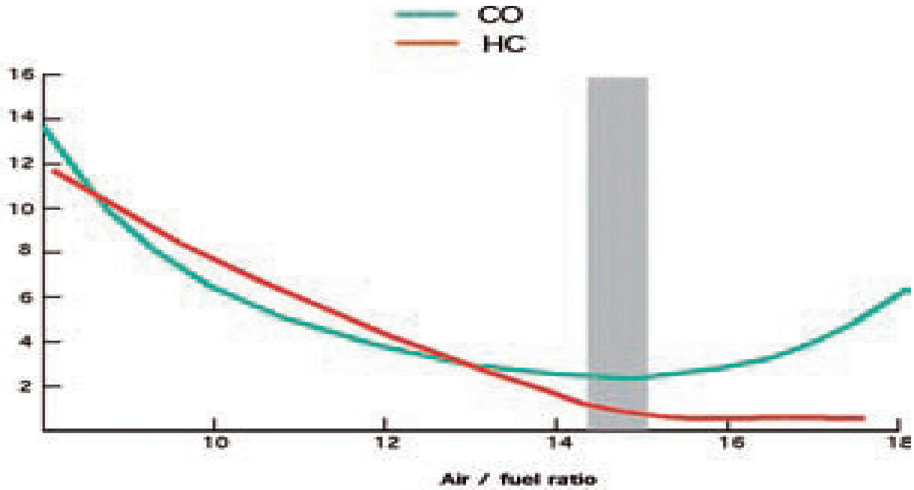


Figure 6 The effect of air-fuel ratio and HC (red line) and HC (red line)

EGR and performance?

It is an ongoing myth that EGR reduces performance when operating correctly, it actually marginally improves fuel economy. The fuel economy benefits of EGR are made through a small reduction in pumping losses. With each rotation, the engine consumes a certain volume of air. This volume can be calculated based on the engine's displacement, RPM, and volumetric efficiency. Without EGR, the volume is filled with just intake air. This air has to be travel past the throttle valve, which is obviously a huge restriction when it is partly open. But with EGR active, some of that volume is filled with exhaust gas. This makes the engine more efficient through slightly increasing the pressure in the intake manifold, as if it had an increase in throttle opening, thus a reduction in pumping losses. The benefit to engine efficiency is that the engine wastes less torque drawing air into itself. This shows up as a small increase in fuel economy.

There is a fine line as to the efficiency improvement EGR offers, because once the optimum point has been passed, further increases in EGR result in poor combustion, increasing emissions of hydrocarbons (HC) and therefore excess fuel consumption. About 5% to10% per cent EGR appears to be the current maximum in spark ignition engines.

Internal EGR

This method was realised once variable valve timing became a common application. At light loads, increasing valve overlap to retain or reintroduce exhaust gasses back through the exhaust valve that remains open longer, becomes an effective EGR system. As mentioned before, slight pumping losses are reduced through a diluted mixture. Secondly, internal EGR will reduce HC emissions by burning the unburnt hydrocarbons that appear towards the end of the exhaust stroke. The downside of internal EGR arise when precise temperature control is required to reduce combustion temperatures. The systems are often very complex and so cost becomes high.

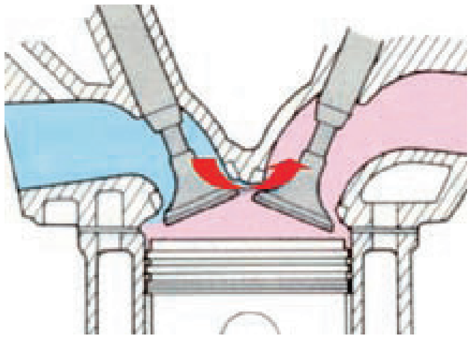


Figure 5 Blow-by of the air-fuel mixture, red arrow, occurs when both the intake and exhaust valves are open

External EGR

This system has largely become the industry standard. It takes exhaust gas and reintroduces it into the intake manifold. The major benefit of this system is increased efficiency in temperature reduction as the gas flows externally or through part of a cooling system heat exchanger, resulting in a further reduction in NOx.

The limits of EGR

Like all systems on vehicles, EGR has limits on its operation. During idle speed, the EGR system is disabled - after all, EGR is a controlled leak into the intake. Idle speed conditions become unstable because the engine is very sensitive to air fuel ratios and swirl conditions. Diluted mixture will have adverse effects on combustion.

During wide open throttle, the EGR system is also disabled, as maximum power and torque are required and need the engine's full volumetric efficiency.

Combustion and EGR Part 2

In this second part of the series, the Institute of the Motor Industry (IMI) continues looking at the combustion process, stoichiometry and emissions in petrol and diesel engines, concentrating on diesel exhaust gas recirculation (EGR), and the differences between them.

The first thing that should be known is that petrol and diesel combustion ingredients are identical: Air (78% nitrogen, 21% oxygen and 1% other gasses) and fuel, a refined blend of 16% hydrogen and 85% carbon. It is the way they are mixed and the different characteristics of the larger diesel fuel molecules that make them different.

Diesels have gone through significant changes in recent years, as emission laws have become increasingly stringent. The common rail system is now the industry standard, due to its higher efficiency and greater emission control. The common rail system injects fuel in stages at very high pressures (approx 1500 Bar) into the cylinder.

The combustion process is broken down into various stages (up to 7) but consists of 2 main stages:

Pilot injection: pilot injection reduces knock caused by the delay between the injection and the ignition of the fuel. It does this by injecting a small amount of fuel into the compressed air before top dead centre (TDC). This gives time for this small amount of fuel to ignite. Knock is traditionally caused by the delay as fuel heats up to its ignition point. The longer the delay, the more fuel that will be in the cylinder, causing a large uncontrolled pressure rise around TDC which is what can be heard as knock.

Main injection: As the piston nears TDC, and while the pilot injection is still burning, the ECU injects fuel into the cylinder. This provides a rapid, smooth rise in pressure and allows torque control via the amount of fuel injected. This method of injection maximises efficiency by burning all the fuel evenly, thus minimising undesirable emissions.

The emissions from diesel combustion are almost identical to those of a petrol engine:

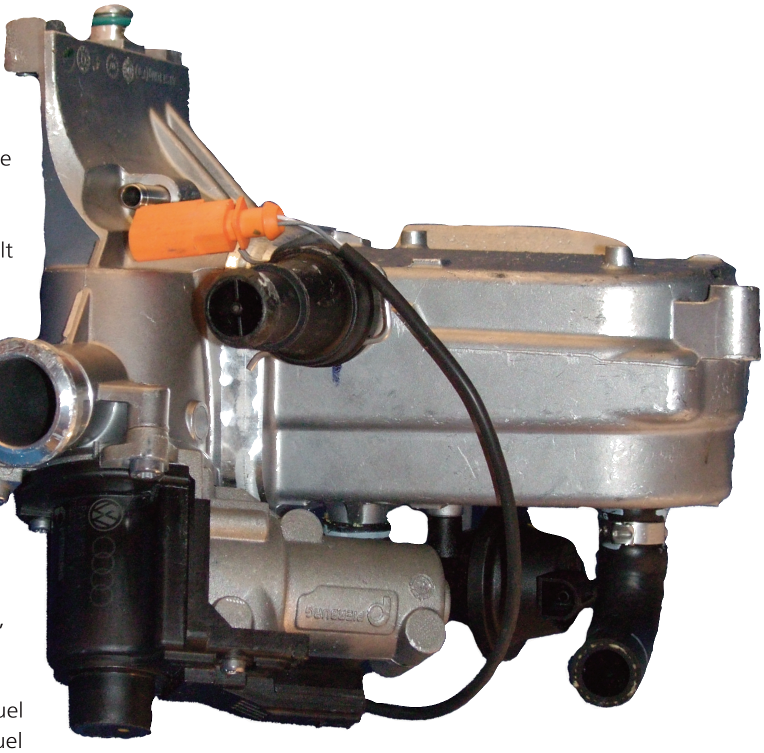
Carbon monoxide (CO): a by-product of incomplete mixing of the carbon and oxygen. With direct injection, the epicentre of combustion occurs at the centre point of the injector. The flame spreads from the centre outwards, resulting in poor mixing at the furthermost points.

Carbon dioxide (C02): the normal result of combustion resulting from carbon mixing with oxygen correctly.

Hydrocarbons: raw, un-burnt fuel exiting through the exhaust. They are an undesirable emission and are completely wasted energy. This is the result of poor mixing of the air and fuel and the time it takes for the flame to spread. Unburnt fuel is usually the result of poor atomisation and penetration into the combustion chamber. The bigger the droplet, the lower its velocity and liklihood of clumping. When the fuel is clumped together, fuel on the outside of the clump combusts and forms a barrier between the fuel in the centre of the clump and the available oxygen. Poor air movement and bad injectors are the most common causes of incomplete combustion

Particulate matter (soot): created when carbon is starved of oxygen. This causes the carbon to become baked during the large temperature increase and it is then exhausted into the atmosphere.

Oxides of nitrogen (NOx) Unlike a petrol engine, intake air is not restricted on a diesel engine. They take in a cylinder full or more with every stroke.



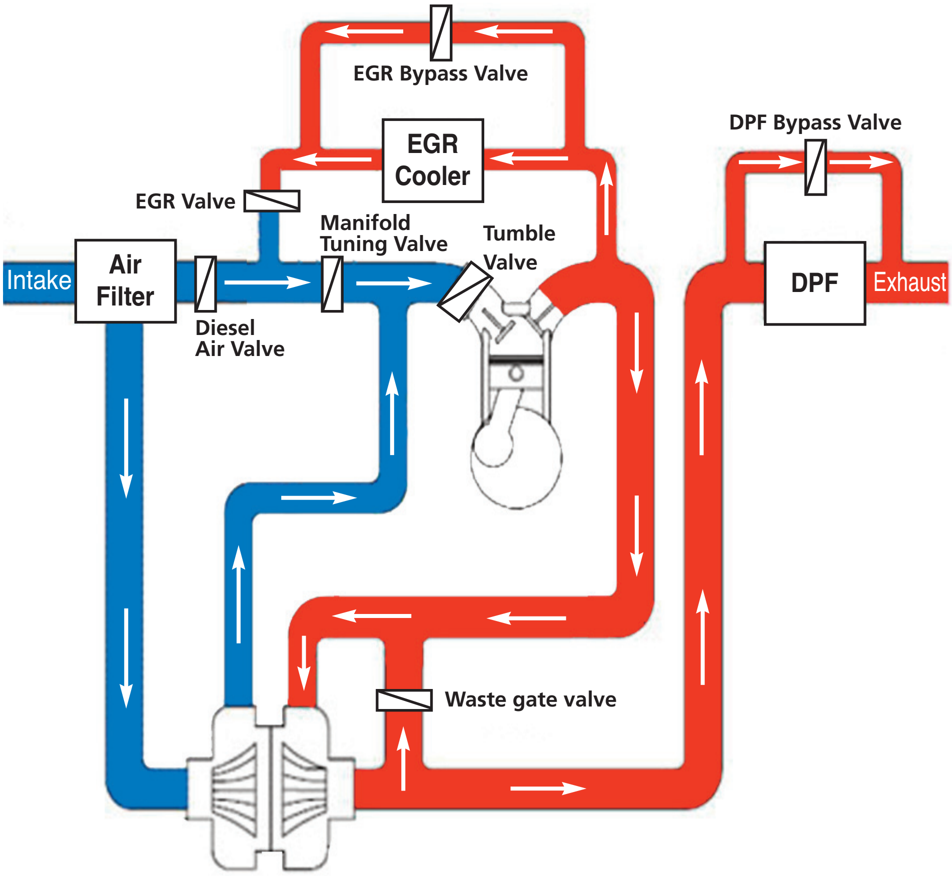
An EGR Intercooler from a late model 1.6l Diesel VAG

New technology brings new types of failure

As you might imagine, every new technology or design brings a new type of possible failure. In the case of EGR intercoolers, there are ways that they can fail and cause you to suspect something else entirely. What is required to avoid this costly and time-consuming trap, is knowledge of what the new technology does, what it doesn't do and how to test it for proper operation.

An EGR intercooler brings engine coolant and exhaust gasses into close proximity, and provides another path for coolant to leak into the exhaust. If an EGR intercooler has an internal leak, you might not be able to see it directly.

If you have a car that is losing coolant, white steam is coming out of the exhaust and exhaust gasses can be detected at the radiator cap, you might suspect a bad head gasket or a cracked head. With an EGR intercooler present, you have to consider that the intercooler may be leaking before tearing the head off. Bypass or stop the coolant flow through the intercooler and see if the leak is still present. A simple step that will save you time, money and your customer's faith.



An example of a more complex diesel EGR design with a turbocharger

The engine torque is controlled by the amount of fuel injected. The air/fuel ratio varies from 17:1 to 29:1 under load, and 50:1 to 145:1 at idle or no load. This means that a diesel engine only ever runs close to stoichiometric proportions at full throttle and load, unless there is a fault. Unfortunately, very high localised temperatures within the combustion chamber lead to the production of NOx. There are a number of strategies to control NOx emissions and the most common is exhaust gas recirculation (EGR). Exhaust gas is a mixture of CO_2, H_2O (water vapour), nitrogen, and oxygen. Two effects of EGR are: CO_2 and H_2O thin out the oxygen in the inlet air and slow the rate of combustion. H_2O, water vapour, has a high specific heat capacity (SHC) and causes a reduction in peak combustion temperatures, and therefore NOx production. SHC describes the amount of heat energy it takes to raise the temperature of a substance. Air has an SHC of around 1kJ/kg/°C whereas steam has an SHC of 2.25kJ/kg /°C

Differences between petrol and diesel

Diesel is distinctly different to petrol in relation to manifold pressure. Diesel engines use throttle pedal angle as a demand for increasing or reducing fuel supply. This means that the pressure drop associated with conventional throttles is not used for restricting air flow. Instead, the engine ECU controls the amount of throttle opening for alternative gains. These benefits come in the form of reducing noise during idling and deceleration, as well as noise and vibration that are generated when the engine is stopped. During EGR operation, the throttle valve moves towards the closed position to increase manifold vacuum. This means that a greater amount of EGR can be introduced into the inlet air.

EGR operation

While the modern diesel has been refined to be very efficient, it has still not completely eliminated emissions of NOx. The strategies used to control NOx emissions have become very advanced and complex, due to the variety of operating strategies used.

Just like in petrol engines, the same goal exists of cooling the exhaust gasses once they have left the cylinder. The recirculated exhaust gas will then absorb some of the heat produced during combustion by increasing the heat capacity of the mixture in the cylinder.

EGR can be controlled by various methods such as a control solenoid or an electro valve operation. The solenoid can be powered by the ECU to open and close, dependent on engine load. The electro valve operation uses the brake servo pump to actuate the pressure differential at the EGR diaphragm.

While petrol engines use EGR at light load and high engine speed, diesel engines use their EGR systems throughout their operating range, and can provide as much as 60% of the total intake air at idle. This aids warm up of a cold engine and also reduces idling noise significantly. Because of the constant use and harsh conditions, EGR coolers are commonly used. This involves exhaust gasses travelling through a heat exchanger, depending on operating conditions, such as during warm up or full throttle. This ensures sufficient cooling of the recirculated gas before entry back into the cylinder. Some coolers feature an oxidation catalyst to minimise clogging in the cooling fins caused by HCs and particulate matter.

EGR feedback

Due to the amount of EGR that is introduced into a diesel engine, the engine management system requires some form of feedback to monitor operation. EGR feedback can be measured in various ways. Measurements of manifold pressure and air flow on some systems is enough to calculate EGR. Some systems use actual EGR valve opening values, measured via the actuator solenoid, to provide the engine management ECU with a real time value.

Wide or broad band oxygen sensors are becoming more popular. These sensors are the most accurate way to monitor oxygen content in the exhaust gas. This data can then be used in a similar way to that of a petrol engine management system, as a closed loop control to monitor and control EGR actuation against the pre programmed map value in the ECU. If the sensor detects a lean situation, EGR is increased causing the mixture to enrich. When the sensor detects a rich mixture, EGR is reduced causing a leaner mixture.

The values detected are also used in conjunction with corrective injection duration. This has a significant difference to the overall drivability and the emission output of the modern diesel vehicle. In addition to EGR control, other factors, such as particulate filters and NOx reducing catalysts, are used to further reduce emissions.

CV Joint inspection

Recognising that a CV boot is worn and needs to be replaced is easy, but what about the CV joint? GKN gives some tips on when a CV joint is still fit for service, if it needs to be replaced and also provides some general guidelines to follow when replacing CV Joints and boots.

Whenever possible use boots specifically developed for the joint in question. During assembly do not distort or overstretch the boot. Pay attention to the correct tightening force of any clamps and always follow the manufacturer's instructions. Always comply with the indicated tightening torques of any bolts or fasteners, de-aerate boots and use suitable tools. A quality CV boot repair kit provides you with all parts needed for the correct repair. When mounting the joint, always examine all of the parts. Always replace the circlip and use new screws/bolts for fixing. For outboard joints, always replace the retaining nut.

Different joint lubricants are available for ball and tri-pod joints, as well as for standard and high-performance applications. The ingredients are adjusted to the steel of the joint and the boots for the respective application. This enables the components to act smoothly. High-performance greases can withstand temperatures of up to 160° Celsius for short periods of time, while standard joint lubricants are designed to withstand short-term exposure to temperatures of up to 110° Celsius. Using a standard lubricant in a high-performance application may result in the out-gassing of the grease, and ultimately to the total failure of the joint. The amount of grease in a quality CV boot repair kit is sufficient to completely fill the corresponding joint and boot.

CV removal - inboard joint

- Cut off retaining clips and turn boot inside out over the driveshaft.
- Expand and take off circlip.
- Knock the joint from the shaft using a plastic or rubber hammer. Always make sure to knock on the hub. Knocking on the ball guide ring or joint will damage the joint.
- Pull off boot. Remove waste grease and thoroughly clean the joint and all of its components.

Deformation of the surfaces on this bearing cage would require the CV to be replaced

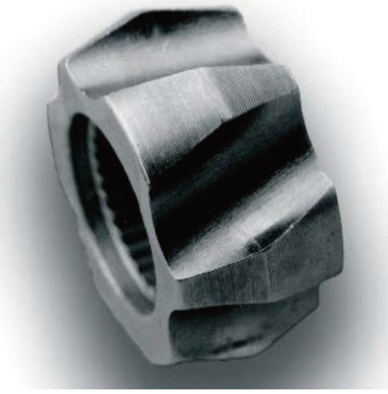
CV removal - outboard joint

- Cut off both retaining clips.
- Turn boot inside out over driveshaft.
- Expand circlip. Joints fitted with inside-positioned circlip (invisible) have to be pulled off the shaft by tapping with a plastic or rubber hammer on the joint's face.
- Pull joint from shaft.
- Pull off boot. Remove waste grease and thoroughly clean the joint and all of its components.

Examine the interior of the CV joint for any wear, beyond polishing

CV Joint Inspection

After thoroughly dis-assembling and cleaning all of the interior components of the CV joint, carefully examine the parts for any indication of wear or damage. Some examples of abnormal wear are shown on this page. Slight polishing of the bearing surface of the inner or outer races is normal, but any wear, even slight wear, that can be detected by touch is a clear sign that the CV joint should be replaced. Any damage should also cause you to replace the CV joint.



Examine the hub inside the CV joint for any wear, beyond polishing

CV Assembly

- Apply retaining clip to the shaft. Place boot in correct position between ridges of the shaft.
- Fill half the grease supplied into the joint.
- Plug the joint on the shaft until the splines of the shaft and the ball hub are in line.
- Using a plastic or rubber hammer, drive the joint carefully on the shaft until the circlip expands to fit its function position. The circlip should snap into the groove of the connecting shaft or respectively expand behind the ball hub.
- Apply gear-sided joints with disc connection using a plastic or rubber hammer. WARNING: Use a tube or pipe to make sure you only hit the hub of the joint. This way, you can avoid the ball cage or the joint being damaged. The joint must be firmly fixed onto the shaft.
- Fill in the remaining grease.
- Lock retaining clip with pliers. Place circlip in the groove of the ball hub. Both shanks of the circlip should lie in the outer recess. If the circlip has to be positioned inside, place it in the groove of the shaft. Joints fitted with disc spring and thrust washer: Take care that these parts are installed in their right positions.
- Pull boot onto joint in correct position and de-aerate boot.
- Apply second retaining clip by hand as tight as possible.
- Lock retaining clips with pliers and check close fit. The boot rim must be in full contact with the joint and driveshaft.

Equalisation charge for a Hybrid

Hybrids are here to stay, and they are going to thrive under a combination of more stringent emission requirements and rising fuel costs. eXponentia's Steve Carter recounts a problem encountered on a Prius that refused to start and then required an equalisation charge to clear a fault code.

Steve Carter, eXponentia

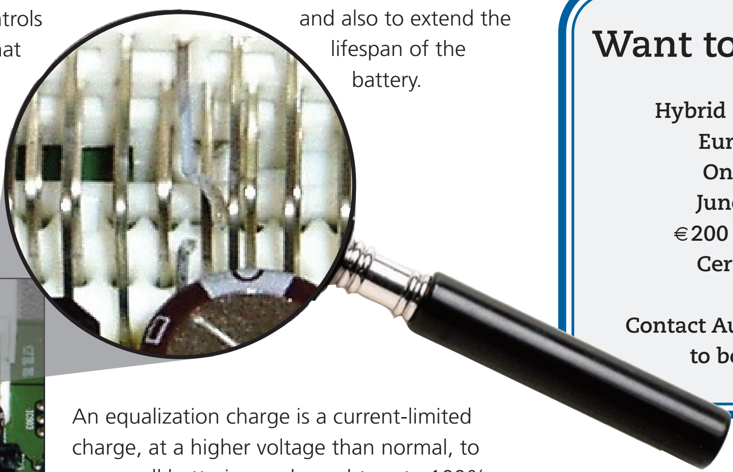
In this month's trouble-shooting guide, we will be looking at a particular vehicle that many of you may have not had the opportunity to work on; a Toyota Prius hybrid. It is quite fortunate that the opportunity to work on this particular car has arisen, at a time when fuel costs and environmental issues are at the forefront of most of our customers' minds.

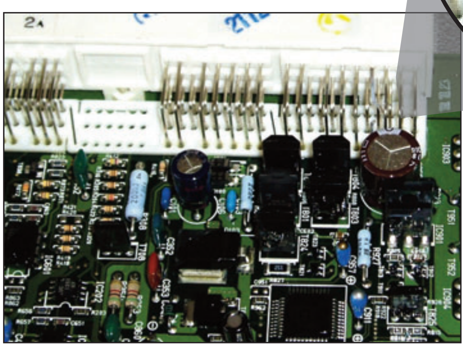
This Prius was an older model, a 1999, with just 35,000 miles on the clock. Although newer models of hybrids are more advanced, the fault in this case still illustrates an important, and still relevant, point. The Prius had been totally reliable until one morning, when it refused to start. It is worth noting that these vehicles do suffer with a very poor 12V ancillary battery. A breakdown services had been called and were unsuccessful in jump starting the vehicle, meaning it had to be transported to a local garage for further investigations. This garage had the car for over four weeks with no success in starting the vehicle.

It was then forwarded on to another garage, where one of the technicians had some training by Toyota on this particular vehicle. However, he had no diagnostic equipment suitable for this car. With the car still not starting, our first task was to obtain any fault codes from the vehicle ECM's. With the complexity of this car, there were a couple of ECM's you will not see anywhere else. The first is the ECM that controls the hybrid function and the second ECM, that manages the vehicle's traction battery operation.

After scanning, we discovered two particular fault codes; the first relating to an internal malfunction with the engine control module and the second indicating a problem with the vehicle's traction battery. After gaining access to the engine ECM, located in the passenger foot well, some scorch marks on the ECM loom connector were detected. We took the decision to open the module and from the picture below, you can clearly see the fault. We were fairly confident this fault was caused by incorrect jumpstarting of this vehicle. On repairing this connection, and with a fully charged 12V supply, the vehicle started promptly.

With the engine running, we directed our attention on the traction battery ECM, which gave a fault requesting an equalisation charge. First, we need to understand what this fault is and what can cause it. Initially, we need to understand that the traction battery pack in this vehicle is made up of 240 individual cells, each with a terminal output of 1.2V, making the total output from the battery pack 288V. This output can provide sufficient current for 35 KW of power (a four-bedroom house wouldn't use that much power). Over time, the battery pack performance will degrade, as differences between each cell become more pronounced. It is also worth noting that the Prius never actually charges its traction battery fully during normal operation, only somewhere between 40 and 60%. This is to allow room for storage of any regenerated braking charge and also to extend the lifespan of the battery.





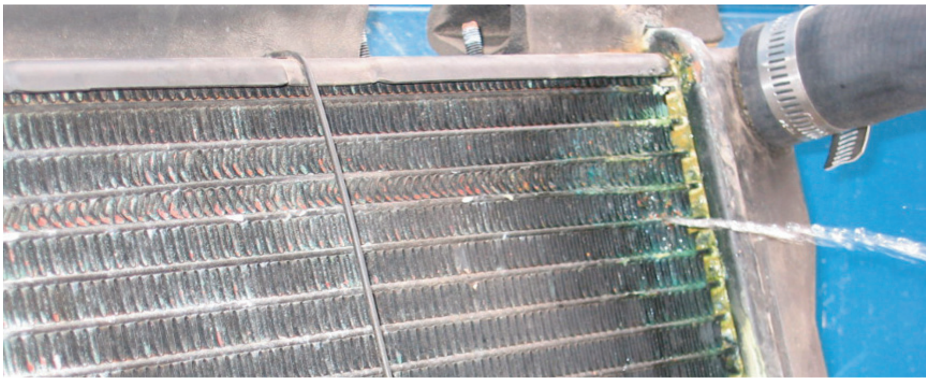
An equalization charge is a current-limited charge, at a higher voltage than normal, to ensure all batteries are brought up to 100% charge. During this process, the battery pack can become quite warm. Not knowing the entire history of this vehicle, it was only sensible to make sure there was sufficient airflow around the battery. Before we attempted to remove the covers, we killed the battery with the break switch located in the boot. With the battery now completely disconnected from the rest of the vehicle, we were able to remove the covers to the battery safely and to confirm that the internal cooling fan to the battery was working correctly.

With the covers removed, we replaced the break switch and started the vehicle. To allow for an equalisation charge to take place you must, of course, have the engine running continually. The only way for the engine to run continuously on this vehicle, is to engage the air-conditioning . During the equilisation charge, we carefully monitored the voltage of the traction battery and its internal temperatures. After 17 minutes of continuously running the engine, the voltage had risen to 365V. This is the threshold for equalisation charge, and at this point the voltage started to decrease. The internal battery temperature reached 35 Celsius, which is well within safety limits, and the battery pack cooling fan was operating normally at all times. With this process completed, the two fault codes were erased. The Prius was taken on a 12 mile journey through heavy stop-start traffic and was functioning perfectly.

When good radiators go bad

It can happen very quickly, even in a matter of weeks or even days. A perfectly good radiator can develop pin-hole leaks that are an indicator of possible electrolysis. Harbour Radiator's Garry O'Brien, explains what to look for and how to prevent it from happening again.

Electrolysis can be very damaging to any aluminium component that comes into contact with the coolant in any vehicle. If you have a radiator, heater core, or even a thermostat housing or cylinder head that is leaking coolant from tiny holes, electrolysis is usually the cause. If you only replace the failed part, you may see the same car back again in a matter of weeks, or even days, with the same problem. Knowing when and how to look for electrolysis and how to eliminate it, will steer you clear of what can end up being an expensive and reputation ruining experience.



Electrolysis is caused by electrical current travelling through the coolant, turning the cooling/heating system into an unintended circuit. Once this stray electrical current occurs, any metal that the coolant touches can be dissolved into the coolant. Electrolysis has a preference for different metals, and will attack zinc or magnesium before it attacks any other metal. If you are familiar with boats, you probably already know that zinc is often attached to the hull, to protect the electrical system from electrolysis. The zinc is a sacrificial anode and must be replaced when it is consumed. Aluminium is the second metal that will be consumed by electrolysis. As there is no zinc or magnesium anywhere in the cooling system of an engine, anything made from aluminium will be the first victim. The increasing amount of electronics on a modern car, also raises the potential for electrolysis, making it a problem that is more likely to occur now.

The first step in successfully curing electrolysis is recognising it when it occurs. The most obvious indication of an electrolysis problem is leaks from the radiator, heater or other aluminium component from very small pin-holes. The pin-holes are the result of aluminium being stripped away at a microscopic level, until a very small hole is created. Electrolysis can cause leaks anywhere in the cooling system, but they are more commonly found at the edges of the radiator or heater core, near seams or around an electric cooling fan mounted to the radiator. Pin holes are usually found first in the radiator or heater core, because the walls here are thinner and are the first to leak, even though aluminium throughout the entire system is being consumed. A pinhole leak anywhere in the cooling system should immediately alert you to check for electrolysis.

Chemical Electrolysis

One type of electrolysis is caused by the coolant itself. This type of electrolysis is a chemical reaction between the coolant and the aluminium, that is basically like a battery. When the coolant is "worn out", it acts like acid in a battery, allowing dissimilar metals to create voltage and a current. The cure for this type of electrolysis is simple: replace the damaged parts, flush the cooling system and refill with the proper coolant.

Stray Current Electrolysis

The second type of electrolysis is caused by stray current entering the cooling system. This is usually caused by a poor or missing ground on some electrical circuit. The most common problems used to be caused by aftermarket accessories added to the car, such as fog lights, radios, cruise controls, phone kits, etc. While it is not common to find accessories that are not factory installed, they do still exist and so it should be the first thing to check for. The most common circuits to cause stray current in modern cars, are probably electric cooling fans and starters.

No matter what the source of the stray current, it can be methodically hunted for, and you will be confident that you have cured the problem.

Testing Procedure and Repair

To determine what type of electrolysis you are facing, turn the key to the on position, attach the negative probe of a multimeter to the engine block or other proven earth, and dip the positive test probe into the coolant at the radiator or reservoir cap, being careful to make certain that this probe is not contacting anything but the coolant. If the voltage reading is less than 0.1 volts, there is not any significant electrolysis.

If there is more than 0.3 Volts, remove the positive battery cable from the battery and repeat the test. If you are still measuring the same voltage, the vehicle is suffering from chemical electrolysis caused by 'worn out' coolant. After replacing the damaged parts, flush and refill the cooling system and repeat the voltage test.

If the voltage reading drops with the battery disconnected, the electrolysis is from stray current. Methodically check all suspected circuits, including heater fan motors, air con compressors, etc. Be suspicious of recent additions or repairs made to te vehicle. A check can be done by either turning on some items, or removing fuses or power to individual parts (such as a fan motor), or by providing a temporary ground to the suspected component. When the voltage drops, you have identified a circuit that is causing stray current. Identify and repair the fault in the circuit, usually a poor or missing earth connection. Be sure to test for intermittent electrical loads, such as thermostatically controlled cooling fans or the starter. A poor ground on a starter may cause a heavy current flow through the coolant, but you have to be looking for it when the engine is cranking over. A poor earth on the starter can destroy a radiator in days.

Another problem to look for is a faulty earthing strap between the engine, chassis and battery. Visually examine these connections and test with the multimeter. Also remember that it is always possible to have multiple faults.

Once all of the faults have been repaired, replace the faulty parts, flush the cooling system and refill with new coolant. Then you can be confident that the replacement radiator or heater will have a normal service life.

A fouled Astra and a hot & cold Mondeo

In this month's troubleshooting guide, we are going to be looking at a 2004 Opel Astra and a Ford Mondeo of a similar age. The Astra was worked on, but not repaired by, a garage that overlooked the fundemental basics. The Mondeo had a fault that was easy to diagnose using a clear, simple diagnostic process.

Steve Carter, eXponentia

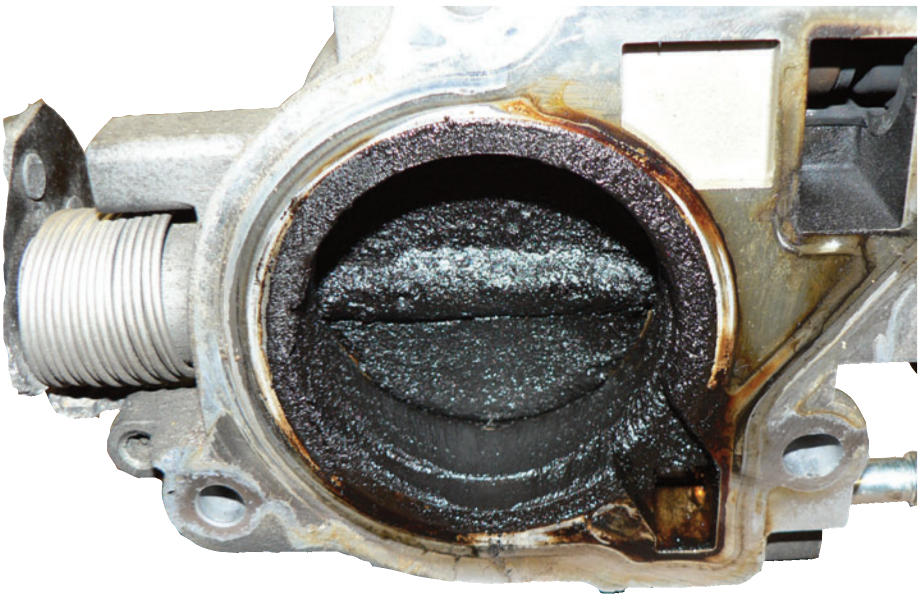
A rough idling Astra

The Astra was presented to the garage with an inconsistent idle speed and a tendency to stall on a regular basis. A previous garage had replaced one or two parts, but the customer could not be certain as to what they were.

Our first task was to check for any ECM fault codes; upon this we did discover one code, the airflow meter was below the minimum value. Prudence tells us we should check the actual value of the airflow meter with our known target value and this confirmed our first thoughts- that the airflow meter was perfectly okay (I am sure you will recognize that this fault code is often recorded, due to the fact the engine has stalled at some point in time).

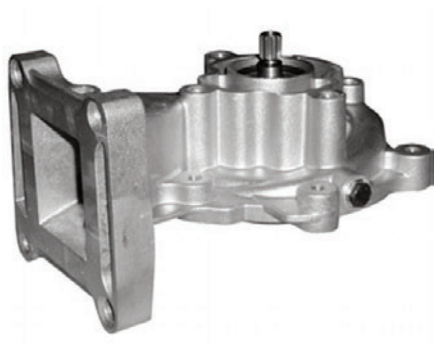
Whilst our diagnostics were connected, we checked validity of the throttle potentiometer, which gave us a full clean sweep from 9% to 100%. At the same time, we were able to confirm that the engine ECM was receiving the command: "idle, part load, and full load". Remember most ECM's have different engine mappings for each of the three conditions mentioned, meaning that a different set of control conditions will be applied during these very different engine operating conditions. Like most modern vehicles, the system employed on this Astra was drive-by wire, where the engines idle is controlled by the throttle butterfly, which receives commands by the engine to the ECM to vary the degree of opening, thereby increasing or decreasing idle speed as appropriate.

Once the intake air ducting pipework had been removed, the problem was plain to see. The inlet manifold and throttle body were very contaminated and sooted up. Although this was a low mileage vehicle, most of those miles had been done around town and on the school run. Whilst most competent garages may consider this inlet and throttle body fouling fault very routine, it is worth noting that this car had been to a previous independent garage that had indeed changed the airflow meter. More worrying than this was the fact that they had diagnostic equipment and software, that was able to change the engine's idle speed. They probably changed the idle speed in some misguided belief that this would cure the car's idling problem. This was discovered after the throttle body and inlet manifold were cleaned and the engine idle came close to 1100 rpm. This was obviously corrected before the vehicle left the workshop.



A hot & cold Mondeo

The next vehicle in question is our 2004 Ford Mondeo TDCI. It was presented to the garage with inadequate vehicle heating. After checking all the engine and dashboard information, it became apparent that although it was not overheating whilst driving at moderate speed, the temperature would rise dangerously high if held stationery at high idle, whilst no heating was available to the interior of the vehicle.



As I'm sure you're aware, for some particular reason, a splined shaft drives the water pump on this vehicle from the power steering pump. It would appear that as the miles pile on, the male splined shaft of the water pump is manufactured from material less durable than the female output shaft of the power steering pump. As a result, the splines on the water pump shaft are eventually rounded off, with the inevitable result that the impeller does not rotate. On contacting the local Ford dealer, they confirmed that they are now moving significant numbers of the pumps for this very reason.

exponentia™ The Automotive Training Experts

Battery chargers for professionals

With winter approaching, garages can expect an increase in the number of battery faults and repair jobs. Ring say their SmartChargePro range of battery chargers is the ideal tool to maximise customer service and profit during the winter season.

Having a battery charger is not always seen as a vital tool for a garage or workshop to have. Instead it is more likely that they will have a battery powerpack to jumpstart any battery that needs a boost.

Plus, when a motorist takes a car into a garage with a battery fault, the easy solution is to replace the battery.
However, with environmental concerns and motorists wanting to spend less on car maintenance, garages have the opportunity to provide an additional service with the SmartChargePro range of battery chargers from Ring Automotive.

With the SmartChargePro, mechanics can offer a battery service when used in conjunction with a battery analyser. So when the vehicle comes in for a service, a quick check of the batteries health with the battery analyser will tell if the battery needs to be charged. If it does, the SmartCharge Pro can be attached providing the needed charge to get the battery back to its optimum level. Once the charge cycle has been completed the battery analyser can be reattached to indicate the improvement made. A printout can be taken to show the customer what work has been done.

For motorists the SmartChargePro reduces the cost of battery replacement and the hassle of claims for the battery warranty.
Motorists will also see an improvement in battery performance, to deal with the constant drain from the ever increasing on board electronic equipment and in-car gadgets.

Garages benefit by enhancing their reputation and standing with the customer, but also providing a fast, easy, and efficient service that has minimal effect on resources and time.

The SmartChargePro range with its 8 stage charging cycle is a comprehensive and accurate charging technique, giving batteries prolonged life and better performance, compared to using standard chargers. For mechanics it is a specialist tool to diagnose, recondition and service a customer's battery.

The Ring Automotive SmartChargePro range includes 6, 12v models; 7A, 10A, 15A, 25A, 35A, 50A and a 24v 8A model.

As more vehicles are fitted with different types of battery, the SmartChargePro has a unique Programmable Multi-Chemistry feature. Multi-Chemistry allows mechanics to set the charging profile to suit the battery chemistry type (AGM, Calcium, GEL or Lead). This will ensure correct and optimum charging for each battery type, maximising battery performance.

It is easy and intuitive to use, simply plug into the mains, connect to the battery and set the battery type. The SmartChargePro will do the rest.

If needed, there is a manual recondition function to recover batteries from a deeply discharged state to improve performance allowing the battery to operate at full capacity. The SmartChargePro range will also adjust its charge rate to compensate for any increase in battery temperature to fully protect the battery.

The other real benefit to garages for having the SmartChargePro is the battery support function, that will sustain a vehicle's electrical system during diagnostic work. Diagnostic work places a large draw on the battery; especially when it runs tests that actuate the motors. It is important that when such work is being done the voltage does not drop as this can interrupt the data upload and possibly corrupt the ECU. It is imperative that the voltage is maintained. The constant and stable 13.8 voltage provided by the SmartChargePro when used in the battery support mode, prevents loss of power, ensuring a smooth diagnostic upload and no damage to the on-board ECU.

So for mechanics the SmartChargePro not only provides the most sophisticated tool for accurately charging a battery, but it can be used to generate an additional revenue stream with a battery care service for customers.

The built in function of battery support also ensures accurate and safe diagnostic servicing. Offering two tools for the price of one!

With winter just around the corner, the cold temperatures often make motorists notice the state of their battery as more energy is needed to start a vehicle. Garages can expect an increase in the number of battery faults and repair jobs. The SmartChargePro range of battery chargers is the ideal tool to maximise customer service and profit during the winter season.

Testing for a brake pressure switch fault

A fault code retreived from a car starts you on the journey to find out what caused the fault, but it does not tell you that some part is faulty. Ken Geer, Bosch Technical trainer and programme developer, explains an easy way to determine if an integrated brake pressure sensor is actually faulty.

Ken Geer, Bosch Technical trainer and programme developer

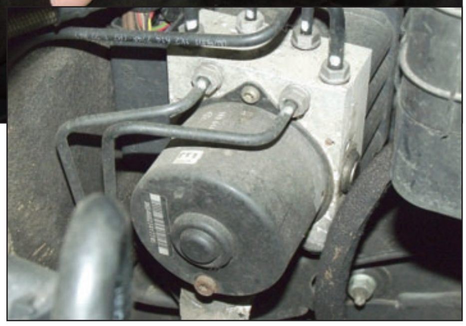
It is not unheard of for a mechanic to retrieve a code from a diagnostic scanner, locate the sensor in that circuit and then simply replace the sensor. The mechanic might just get lucky and that will solve the problem, but what if it doesn't? And what if it is an expensive sensor? How much are you willing to gamble as far as your time and the customer's money s concerned? Not fully understanding a problem can lead to digging a deeper hole, that can leave you lost and the car still not repaired.

After the fault code has been retrieved, the next step is to consider what could have caused the fault and examine all of the possibilities. It is the careful consideration and proper diagnostics that will get the repair done in the quickest time possible and with the least amount of problems.

A customer recently reported to the Bosch technical helpline, that they had a 2004 Audi A3 with the ABS/ESP light on. After connecting their Bosch KTS diagnostic equipment to the car, they retrieved the following fault code:

059B – Brake pressure sensor

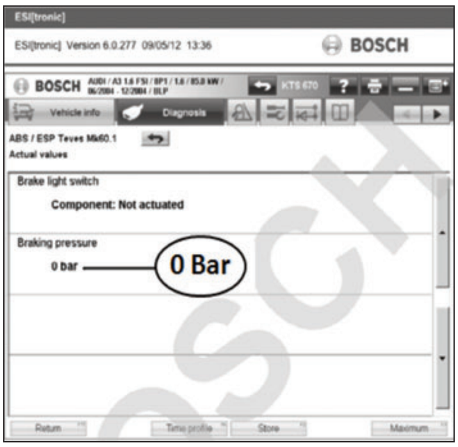
This fault code may indicate a faulty brake pressure sensor, but it can also be triggered by other faults such as a signal or wiring problem. To ensure that the problem is properly diagnosed,



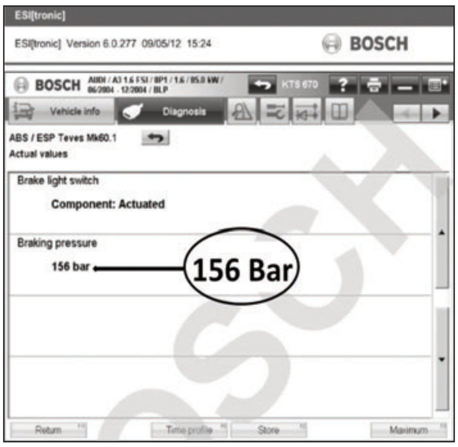
Ken Geer checking live data with the Bosch KTS, above. The brake pressure switch was an integral part of the hydraulic modulator control unit, at right.

the sensor should be tested to confirm if it is working correctly or not. The Teves Mk 60 ABS/ESP control unit on this particular vehicle uses the signal from the pressure sensor, to calculate the current brake pressure in the master cylinder; the pressure sensor is supplied with 5 volts and outputs a signal voltage of less than 1 volt with the brakes off. As the brake pedal is applied and brake fluid pressure rises, the signal voltage will increase.

Because the brake pressure sensor is integrated into the hydraulic modulator control unit, the only real means of testing the sensor is to use a diagnostic tester, such as the KTS, to determine what the actual values that are being reported to the ECU for brake pressure. The brake light switch and related wiring should also be checked for proper operation at the same time.



Without brakes applied, the brake pressure is zero and the brake light switch is not actuated



Any brake application will change the status of the brake light switch and will raise the braking pressure accordingly

Testing actual values has been made even easier with Bosch's new ESI[tronic] 2.0 workshop software. After selecting the correct vehicle in the diagnostic scanner, set the KTS to look at brake pressure and brake switch actual values, and then progressively press the brake pedal. The brake switch should immediately switch from "component not actuated" to "component actuated" as soon as the pedal moves. As increasing pressure is applied to the brake pedal, the brake pressure should increase proportionally. Be certain to determine that there are no problems with the wiring or connectors in the sensor circuit, as a loose or missing connection could definitely trigger a fault code.

BOSCH

Turbocharger troubleshooting

When Bernard Clarke of Clarke's Garage, Co. Cavan, was confronted with a suspected faulty Variable Nozzle Turbine (VNT), he eliminated all other possibilities before deciding to replace this costly item. Here is what he did and learned along the way.

Bernard Clarke

Bernard Clarke of Clarke's Garage, Annagharnet, Co. Cavan was presented with a 2000 Mercedes E220 CDI (diesel) that was running poorly and bogging down on acceleration. A check of the basics and a scan of the trouble codes gave only one realistic fault: Implausible Air Flow. (There was a fault code for the auxiliary heater, which the car did not have, so this code was ignored.) After checking the voltage and signal from the air flow sensor, Bernard could see that the sensor signal was out of its expected range slightly, so he replaced the sensor. After clearing the trouble codes and test driving the car, the car drove much better, but was still bogging down on acceleration.

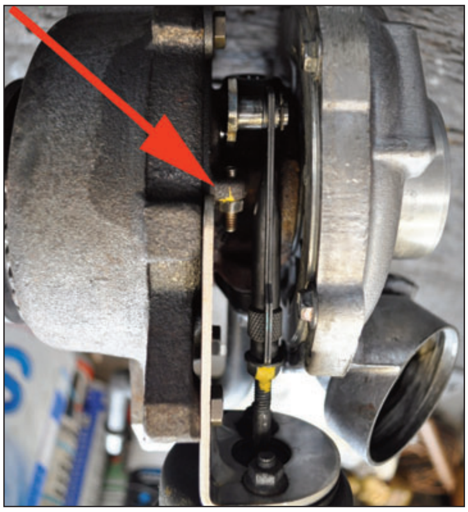
This problem was only present during the first few seconds of acceleration, and then the boost from the turbo would kick in. Live data from a Bosch KTS showed that the turbo boost was about 1.8 bars.

The EGR system was examined and found to be generally OK, but it was cleaned out anyway. The exhaust was examined for any blockages or restrictions. If the exhaust was partially plugged, it could have been causing the initial lack of acceleration.

The next step in checking for any exhaust restrictions, involved installing a pressure port on the upstream side of the particulate trap, just behind the turbo. Bernard has a handy kit that allows him to drill a 9.5mm (3/8") hole in any part of the exhaust, insert a threaded fitting and use a custom tool that crimps a port firmly into position. The port is permanent and threaded for either a pressure gage or a stainless steel plug and washer. The pressure at the upstream side of the particulate trap was 0 psi at idle and 2.5 psi at wide open throttle. These readings showed that the exhaust was not resricted at any point. If a high reading was found, Bernard could have installed more pressure ports along the exhaust until the pressure dropped. The restriction would then be upstream of the first normal reading. After testing, the port is sealed with a stainless steel bolt and washer, which can be removed for future testing.

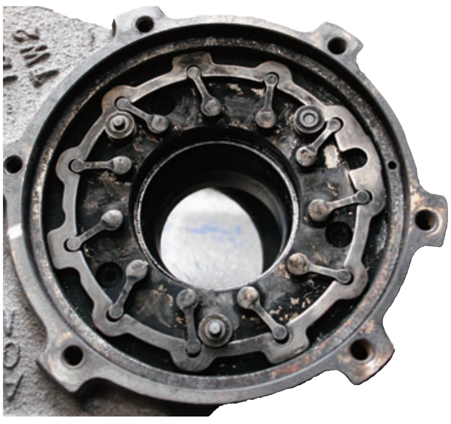
At this point, the nature and source of the acceleration problem became more complex. Other than the interior of the turbo, everything was known to be in good working order, and the car should have been running normally. But it wasn't, and the diagnosing of the problem went deeper.

The turbo on this particular engine is a variable nozzle turbine (VNT) and operates slightly different than an ordinary turbo. A VNT has a set of vanes that controls the angle at which the exhaust gasses hit the impeller to spin it. The impeller on the exhaust side of the turbo is connected by a shaft to the impeller on



The old VNT turbo and the adjustment for the vanes, at arrow

the intake side. The faster the exhaust impeller turns, the more inlet air is sucked into the intake side and forced into the combustion chamber, boosting power. The position of the vanes on this turbo are controlled by a vacuum solenoid. At idle, the vanes are positioned to provide maximum boost, in anticipation of acceleration demand by the driver. On acceleration, manifold pressure drops, releasing the turbo vacuum solenoid, and moves the vanes so that turbo boost drops. The vanes change the direction of the exhaust gasses as they hit the impeller. The further away from the centre that exhaust gasses strike the impeller, the faster the impeller spins, and the more boost is created. Maximum boost occurs when the air is striking the impeller at an angle almost perpendicular to its radius and at the outer radius. The vanes continually adjust the amount of boost to meet demand, and eliminate the need for a waste gate.



A view of the ring that controls the postion of the vanes, which change the boost provided by the turbo

To get a better understanding for how this works, think of a water hose spraying on a paddle wheel. A water stream applied near the centre might cause the wheel to spin slowly or not at all, at some angles of application. When the stream hits the very outer edge of the paddles, the wheel spins faster. It will spin fastest when applied to the outer edge of the paddles, and at an angle perpendicular to the radius.

There is a way to adjust the vanes on this turbo, but it was only intended for adjustment at the time of manufacture, not during service or repair. Bernard suspected that the turbo was faulty, but wanted to make sure he was on the right track, so he adjusted the vanes to see the effect it would have. Adjusting the vanes is not a way to fix a turbo problem, it was used as a test method only. He initially installed a 2mm thick metal bar that prevented the vanes from going all the way back to the idle position, and then took the car for a test drive. The acceleration problem was gone and the car ran perfectly. Bernard had the evidence he needed to make the correct decision and he replaced the turbo. The car ran perfectly with a new turbo installed.

The old turbo was taken apart to see what was going on to cause the fault. The vanes are controlled by a single ring that is rotated by the vacuum solenoid and moves all of the vanes in unison. All of the vanes and the ring looked fine, but if comparing them to a turbo in good condition, you would see that there was a bit of slop in every connection from the solenoid to each vane. The accumulated wear was causing the turbo to raise the exhaust pressure, causing a restriction, rather than a boost.

Seen anything strange?

If you have come across a strange, puzzling or odd fault or repair, your experiences can be shared and help others facing the same or similar problems. All you need to do is give us a call, and we'll do all the rest.

Contact Autobiz on 091-523 292 and ask for John.

Tech Tips

Getting correct belt tension

The Opel evergreen 1.7-litre diesel engine has been a regular fixture in a number of configurations in many Opels for more than a decade. The design of the timing belt tensioner has gone from fully fixed, to a spring-loaded version, requiring a different tightening procedure, as explained by Dayco.

During installation, the function of the new, spring loaded timing belt tensioner, is to provide the correct tension to the timing belt. But once the engine's adjustment revolutions have been made and the retaining bolt secured, the tensioner, in reality, becomes a fixed tensioner and will not modulate belt tension like an automatic tensioner does.

Naturally, this change was made in a bid to make the tensioning of the belt, which is particularly important on this unit, an easier and more accurate task. However, while this may be the case on the production line during the engine's manufacture, it has proven to be a far more challenging operation for the workshop undertaking a timing belt replacement.

The result of the problem is revealed by a premature failure of the replacement spring-loaded tensioner and the subsequent need to install another timing belt kit. The cause of the failure is excessive tension on the belt, which puts an unacceptable load on every component in the timing system, but particularly the tensioner, which can become distorted, and the timing belt, which can wear unevenly.

The reason that the belt can become over tight, is because although it is straightforward to install the new spring loaded tensioner, it is very easy for it to move while it is being secured. Even a small movement can make a big difference to the tension on the belt.

To prevent this costly problem, Dayco recommends technicians use the following procedure when fitting a timing belt kit to this unit, to ensure that the job is completed correctly and without the risk of subsequent failure.

To set an accurate tension of the belt, the engine must be cold, at rest for at least four hours.

Install the new tensioner, engage the spring 'hook' and preload the tensioner, by turning it anti-clockwise with an Allen key and lock it in this position, so that it is out of the way while the belt is fitted.

Lock the camshaft and injection pump sprockets in place with locking bolts and ensure that the notch in the crankshaft is aligned with the lug on the oil pump cover and the timing mark on the timing belt.

Install the timing belt following the direction of its rotation, starting with the crankshaft pulley, followed by the oil pump pulley, injector pump pulley and finally the camshaft pulley. While carrying out the installation, it is very important to make sure that the belt is taught between the oil pump and injection pulleys.

With the belt in place, slacken the tensioner-retaining bolt and allow the spring to apply tension to the belt. Remove the locking bolts from the camshaft and injection pump sprockets.

Rotate the crankshaft against the direction of the engine rotation, in accordance to the requirements of the specific engine code, which are stated in the Technical Bulletin accompanying the Dayco timing belt kit. Tighten the retaining bolt on the tensioner to the torque setting, also stated in the Technical Bulletin.

It is during the action of tightening the retaining bolt that the belt can inadvertently be over tensioned, so a handy hint to ensure that the tensioner doesn't move during this process, is to scratch a mark on the tensioner and a fixed point on the engine, before the finally tightening is done. If the marks remain in line, the belt will be at the correct tension, if not, the tension will be wrong.

Finally, rotate the crankshaft in the direction of the engine rotation, in accordance with the requirements of the specific engine code. Make sure that the crankshaft notch is still in line with the lug on the oil pump and the timing mark on the belt, and that the locking bolts can easily be re-inserted into the camshaft and injection pump pulleys.

If any of these final checks do not match, the installation process must be carried out again from the beginning.

The newer design, spring loaded timing belt tensioner for Opel evergreen 1.7l diesel engines

To simplify the process further, technicians can use a Dayco Tensiometer, which will ensure the correct tension is achieved. The tool is easy to use and only needs the relevant test code for the belt application to be entered and the belt vibrated. If the test reading is 'OK' the belt is fine, but if the result reads + or – 3, the belt will need to be reset.

Depending on the variant, Dayco provides either timing belt kit KTB414 or KTB468 for the GM 1.7 diesel engine, but both options contain a High Tenacity (HT) or 'white' belt.

Full technical information is available on the Dayco website, www.dayco.com. Or for more information regarding the OEM quality power transmission products in the Dayco range, please email: info.uk@dayco.com or call Team P R Reilly on: 01-832-0006.

DAYCO

Bearing replacement made easy

Changing a wheel bearing that contains an integral wheel speed sensor can be a challenge. A direct impact or pressure on the sensor could render it useless, forcing you back to square one, after you discover it doesn't work anymore. NTN/SNR provides a clear, step-by-step process to make the job easier.

These instructions are for the removal and fitting of a front wheel bearing with wheel speed sensor on the following models:

Audi A2, SEAT Cordoba and Ibiza, Skoda Fabia and Roomster and VW Fox and Polo. The NTN/SNR Wheel Bearing kit numbers are XMGB40889 R01 and XMGB 40899R01.

REMOVAL

1 Removal tools that will be required. (Fig. 1)

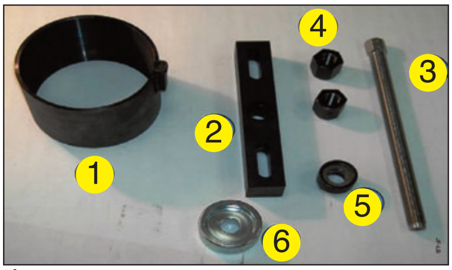


Figure 1

2 Remove the steering knuckle and position tool 1 on the knuckle. (Fig 2)

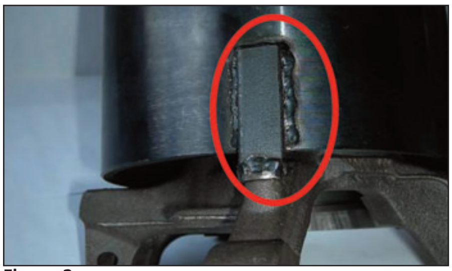


Figure 2

3 Assemble removal tools 2, 3, 4 and 5. (Fig 3)

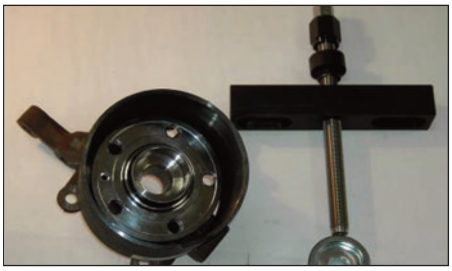


Figure 3

4 Insert the removal tool above through the hub and steering knuckle. Position tool 6 (extracting washer) and check that the outer diameter of the washer is at or below the outer diameter of the hub support on the inside of the steering knuckle. Fit the remaining nut, and tighten it to extract the old bearing. (Fig. 4)

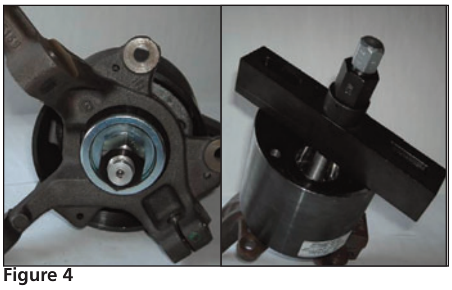


Figure 4

FITTING

5 Fitting tools that will be required. (Fig. 5)

Figure 5

6 Remove the protective cover from the replacement bearing. Check that the coded seal is working correctly, with an NTN-SNR ASB® tester card. (Fig 6)

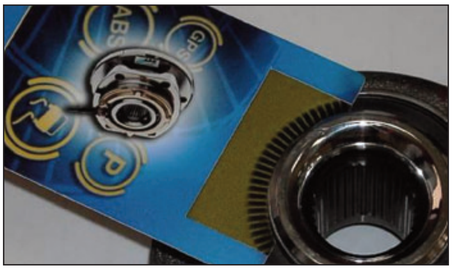


Figure 6

7 Position one of the half moon tools in place, then the second. Use the wheel mounting bolts to fix the two half moons in place. (Fig 7)

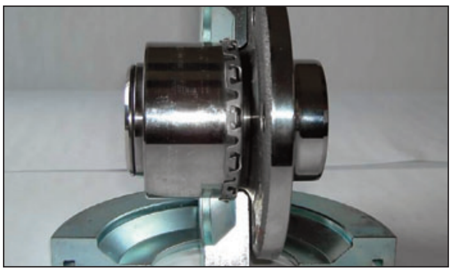


Figure 7

8 Position tool 3 in the groove provided and assemble tool 4. (Fig 8)


Figure 8

9 Position the hub on the steering knuckle. (Fig 9)

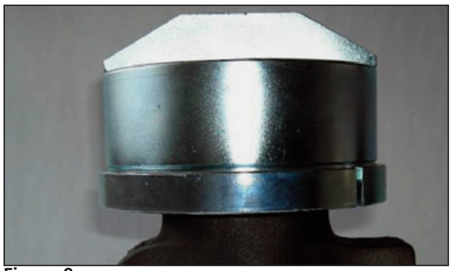


Figure 9

10 Insert tool 5 into tool 4 and then through the hub bearing and steering knuckle. Position tool 6 (locking washer) and add tool 7 (nut). Tighten the nut to insert the bearing inside the hub until the bearing lock ring is inside the steering knuckle. (Fig 10)

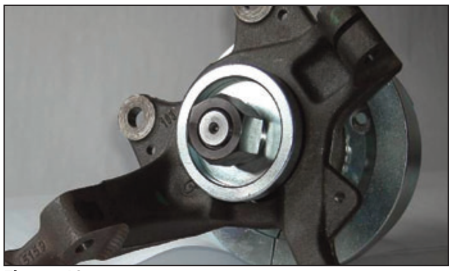


Figure 10

11 Remove the tools, the fitting is complete. (Fig 11)

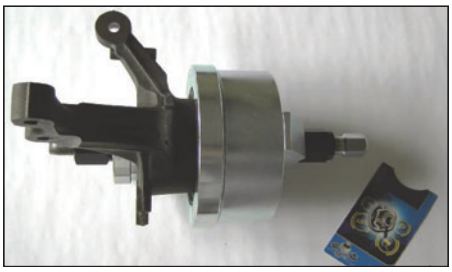


Figure 11

NTN® SNR®

Basics of Lambda Sensors

Without a lambda sensor monitoring oxygen in the exhaust of an engine, controlling the fuel delivery would be impossible, to the exacting standards required by a modern engine. Denso provides details of lambda sensor function and their importance and maintenance.

A lambda sensor, sometimes known as an O2 or oxygen sensor, provides real-time critical information to the ECU, that allows for precise control of fuel delivery. Low emissions, smooth running and maximum power/efficiency all rely on the precise ratio of air to fuel. An air/fuel mass ratio of 14.7/1 is the ideal, and any deviation creates a loss of power and fuel economy, while also creating an increase of noxious emissions. Carburetors were never able to accurately deliver fuel over a wide range of engine operation, but the introduction of fuel injection, brought precision into fuel delivery. The problem then became how to adjust injectors to always provide proper air/fuel ratios.

Lambda sensors provide information on whether the engine was running lean or rich, and in real time. Lambda sensors are made from ceramic materials that interact with the exhaust gasses and inlet air. The sensor, inserted into the engine's exhaust, does not actually measure oxygen concentration, but rather the difference between the amount of oxygen in the exhaust gas and the amount of oxygen in the inlet air. By monitoring the voltage signal from the lambda sensor, the ECU knows if the engine is running rich or lean, and can then adust fuel delivery accordingly. High frequency monitoring means that the injectors can be adjusted in micro-seconds, resulting in very precise fuel delivery control and near perfect air/fuel ratios, at nearly all times and all conditions.
Early Lambda sensor designs only knew if the mixture was rich or lean, and by what amount. Newer designs also tell the ECU how fast the mixture is changing, allowing an even more accurate control of fuel during changes in power demands and operation. Some advanced engines have more than one lambda sensor, allowing the ECU to control fuel delivery on a more localised basis, rather than making changes to all injectors at any given moment.

Only use the thread sealant provided with the replacement lambda sensor

Need for Lambda sensor replacement
Due to the hostile environment in which they operate, sensors are subject to a high degree of wear and tear and ageing. It would be difficult to accurately state the expected service life of a lambda sensor, as they will be subject to very different conditions, such as vehicle application, usage and driver behaviour. It would be reasonable to expect, that the service life of a lambda sensor, fitted to a vehicle used mostly for short in-town journeys, would be shorter than one used for steady motorway use. It is recommended that the function of the sensor be checked every 30,000 kilometres or annually. The emissions check (as part of the current NCT) samples the exhaust gases to monitor the efficiency of the engine, exhaust system and engine control systems. A lambda sensor is a vital part of this system, and any fault should be noticeable during an emission check.

A worn, faulty or failed sensor might make itself apparent by causing the engine to run poorly, increasing fuel consumption, increasing unwanted exhaust emissions or illuminating a malfunction indicator lamp on the dashboard or instrument panel. Newer vehicles have the ability to store fault codes in the processor; some of which will relate to the lambda sensor and associated systems. Defective sensors can also cause irreparable damage to the catalyst.

On removal, examine the sensor tip for contamination/disclolouration. If it is light grey in colour, then there is a coolant leak. A fault that caused the sensor to fail needs to be fixed before a new sensor is fitted. Oil/grease contamination on the exterior of the sensor also has to be cleaned and the source eliminated.

Sensors, and their wiring harness and connectors, that have sustained physical damage, will most likely have their life shortened or performance affected and should also be replaced. DENSO lambda sensors are made with a stainless steel housing for durability, but careful handling is still required during installation. Grease, dust or any other material blocking air from entering the sensor, will also interfere with proper operation and service life. Be sure to use only the thread sealant compound provided when replacing a worn or damaged sensor, and be certain to clean the port.

DENSO

Steering and suspension basics

Many Irish roads present a serious challenge for cars. For many drivers, wear and tear on steering and suspension components is greater than what the car was built for. Meyle's Heavy Duty (HD) range offers a longer life that will keep your customer's cars going strong, as they are keeping their cars longer.

The trend of holding on to cars for longer has resulted in more attention being given to suspension and steering parts. Combined with poorly maintained roads, these components generally wear out and need to be replaced more frequently. When they are replaced, it is critical to replace them with quality components, as anything less will not last and will reflect badly on your reputation as a mechanic. Add to this that these parts are critical to safety and any savings made in using dubious quality parts makes the choice clear: don't scrimp when it comes to steering and suspension parts.

Recognising worn steering and suspension parts is generally straight forward. An inspection of the steering and suspension components should start with a test drive. If the car is pulling to one side, wandering when it should be going straight, making unusual noises, or is rough then there is a problem that needs to be repaired. The test drive will lead you to look for the particular type of repair that needs to be done.

Next, put the vehicle up on the lift and rigorously examine all of the steering and suspension parts. Is the suspension level from side to side? Grab the wheels and check for any play. Grab the top and bottom to see if you can move the wheel, then grab the wheel at the left and right to check for play in the steering. Any movement. other than a slight in/out movement on some axles that are designed to allow this motion, is a clear sign of a worn part. Check the tyres for unusual wear patterns. While incorrect pressure will cause abnormal wear, it can also be caused by worn shocks, springs or worn/mis-adjusted suspension parts. thoroughly examine all of the steering and suspension parts. Any play in a joint or bushing means that part is worn and should be replaced.

Look for any signs of wear or physical damage. Carefully examine the rubber at all bushings and mounts. Any cracked or deformed rubber bushings or components should be replaced as they are only going to get worse, and most likely very quickly. A worn or deformed bushing, can allow the metal parts it separates to come into contact, resulting in tapping or banging noises. Some components are made with rubber bonded to metal. Any signs that the rubber is separating from the metal, however small, should be seen as a failure of that part. A minor separation will extend and then the part will fail completely.

Once you have identified all of the parts that need to be replaced, you can start the repairs. Unless there is a very strong reason to believe that the part failed as a result of an unusual event, such as impact damage, it is be best to replace the parts in pairs. Wear and tear that damaged a part on one side also damaged the other side, it just isn't noticeable yet. Do you want your customer to return in a year's time with the same complaints, because the parts on the other side are now worn enough to cause problems? Maybe they won't take the car back to you, but try another garage because they think you didn't do a proper job the first time.

Also, consider installing parts that have been made to be stronger or better than those that came off the car, such as Meyle HD. Meyle identify O.E. parts that fail early in service. They use recall statistics and info from German technical inspection organization, TÜV, as well as workshops, to find wear-prone OE components. Then their engineers analyse the weak points and develop technically sophisticated solutions that are designed to be longer lasting, and back it up with a 4 year warranty. An example of this is Meyle's zinc-nickel alloy replacement bolt, for a 1995 or newer VAG upper control arm. The bolt also has a corrosion resistant film and cataphoretic coating. The original bolt is usually difficult to remove due to extensive corrosion. One reason for the corrosion, is that the original bolt was made with a steel that reacts to the aluminium of the control arm. Meyle's replacement bolt reduces this corrosion by using a different metal, and by providing a corrosion resistant coating on the bolt. As these parts are all critical to safety and require a high level of reliability, this is not the time to look for savings.

Meyle's zinc-nickel coated VAG replacement suspension bolt, at left, after a 480 hour salt spray edurance test. The other bolt is an OE suspension bolt, after the same test.

Always follow the vehicle manufacturers instructions, and always use all of the new replacement parts provided. Some bolts, lock nuts and other parts are designed to be installed only once. Re-using them will only result in premature failure.

The final step in any repairs on steering and suspension, should be to check the tracking and adjust according to the manufacturer's specifications. Even if you think that the tracking was correctly set before any part was replaced, you have no guarantee that it will be correct after new parts are installed. This check will also guarantee that the car is back in good working order, driven by a satisfied customer who will appreciate your work.

Some things are best replaced in pairs, steering and suspension parts are one of them.

Don't get tangled up in chains

Timing chains have made a come back and are now common on new vehicles. While they are very strong and fit for purpose, they do require proper oil lubrication, as FAI Autoparts points out.

Timing chains have become the preferred choice for engine manufactures over timing belts, as they offer greater strength and reduced friction. Both of these factors enable engine designers to squeeze more power from smaller capacity engines, along with lower friction coefficients, resulting in more power, less heat and therefore less pollution.

However, as with any new technology, there is always a steep learning curve. Modern timing chain kits are no exception and it is vital to ensure the timing chain kit you are fitting works perfectly, for as long as possible.

The correct oil is vital

Modern timing chain kits are far more sophisticated than the ones used a few years ago, using powder metal gears, high velocity chains and thermo plastic tensioners (housing). They are subjected to far greater loads, whilst weighing much less.

For any engine to operate correctly, it must use the correct grade of oil, as modern oils are very complex structures, which are critical to an engine's performance and long life.

Replacing the old oil with an incorrect grade will most certainly cause failure. A timing chain relies on two things to keep working: first, lubrication, so that the metal parts do not make contact (at a molecular level) preventing seizure and incorrect tension, which in a modern engine is produced 99% of the time by a hydraulic tensioner applying pressure directly or via a tensioner rail onto one or more contact points on the chain. If this pressure is lost or reduced in any way, the chain will start to oscillate, creating fatigue in each metal link and pin of the chain, which will eventually cause the chain to break in one or more places. Before this stage, it is likely that you will get the customer back complaining of a rattling chain.

It is vital that the tensioner gets the correct volume and oil pressure from the engine's oil gallery. Without this, the tensioner will be unable to load the chain and failure will occur. If the engine manufacturer specified oil is not used, then the tensioner will not be able to maintain the correct pressure as the engine RPM increases. Secondly, all hydraulic tensioners receive their oil feed via an inlet port or valve, the diameters of which range from 1.5mm to 0.50mm, so if there is contamination in the oil (carbon, metal swarf etc.) the feed holes can become blocked very easily, starving the tensioner, which in turn will fail to load the timing chain. It is also important to change the oil filter, so that any contamination is not carried over into the new, clean oil.

FAI Timing Chain Kits provide everything you need to make a full repair, which saves you time, trouble and money. The precise specification for the oil to be used is right on the box.

To enable today's chain kit to survive, it must be fitted to a clean and uncontaminated environment. FAI also recommends that the engine lubrication system is flushed just before work is started to remove the old timing chain kit. This will remove the majority of contaminants that will have built up over the life of the engine and during installation the sump should be removed and inspected/cleaned, along with the oil pump and pick up pipe. Spending a little more time cleaning, in conjunction with using the correct oil and new oil filter, will ensure that the timing chain kit will perform optimally, as long as recommended servicing and oil changes are adhered to.

FAI is rolling out a program of technical information labels, specific to each popular timing chain kit offered in the FAI range. The label will give the exact oil specification needed for the kit, including grade e.g. 0W-30, composition e.g. synthetic/mineral, etc. and any relevant additional important information such as "low ash" for engines using DPF's.

FAI Timing Chain Kits

FAI Timing Chain Kits always supply every part you need to carry out a full repair, including gaskets, oil feed pipes, seals and special sealant where specified. The range includes money, time and space saving solutions, such as Kit TCK 47, which replaces 8 competitor part numbers for Ford Duratorq engines.

The FAI range covers all modern engine applications and is fully catalogued with a buyer's guide and pictorial references. A technical helpline is available to give you on the spot advice, should you need it.

For more information on the FAI timing Chain Kit range please visit www.faiauto.com.

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