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Low Speed Pre-Ignition – a new menace.

If you haven't come across low speed pre-ignition or LSPI, then you can consider yourself to be lucky. It's becoming a significant problem impeding the development of small, fuel efficient petrol power units and one that can cause very real damage to such engines.

LSPI is the phenomenon when the fuel air mixture ignites sooner than the engine designer intended - ignition occurs before the plug sparks. This pre-ignition causes an excessive pressure to build up inside the cylinder which, if mild, can simply cause abnormal engine noise, but if severe, will cause damage. The peak pressure observed during LSPI may be three times that encountered when the engine fires normally.

In some ways, it is similar to engine knocking or "pinking" that has been around for some time and is more familiar with workshop technicians.

Engine knocking had some very clear causes such as the use of a low octane fuel, dirty interior surfaces of the cylinders and overly advanced ignition timing and therefore the solutions were equally well understood. LSPI on the other hand has proved to be more of a mystery both in terms of its causes and prevention.

Two examples of piston damage due to LSPI (Source: www.infineuminsight.com)

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So, what do we know about LSPI?

LSPI has become of interest lately because it tends to affect smaller, highly stressed, turbocharged direct-injection petrol engines. Just the sort of power units that are finding favour as people look for greater fuel efficiency and (in some cases) are falling out-of-love with diesel as a fuel for passenger cars.

Annoyingly, LSPI tends to come and go within a particular set-up. An engine may be operating quite normally and then LSPI will develop for a few cycles before mysteriously vanishing again. Very frustrating if you are trying to diagnose the problem.

All of the following factors are likely to have an impact on LSPI.

Hardware design – LSPI simply seems to be more prevalent in some engines than others.

Engine set-up – as engineers adjust settings to obtain better fuel economy from their hardware these very changes seem to make LSPI more likely.

Engine loading – LSPI occurs more readily under conditions of high-loading and low-speed.

Fuel quality & lubricant composition- Fuels with a higher-octane number tend to decrease the frequency of LSPI but this only reduces, not eliminates pre-ignition and relies on the consumer using premium fuel.

It probably comes as no surprise that two of the OEMs that have been very active in the study of LSPI, namely Ford and GM have both launched down-sized 3-cylinder 1.0 litre turbocharged engines, which have roughly the same power output as somewhat older 4-cylinder 1.6 litre units. The reduction in number of cylinders means that friction and heat losses are reduced so the engines are more efficient, but to achieve the same power, boost pressures have to be increased.

These new engines are designed to operate at low speeds and are capable of delivering high levels of torque. However, all these factors taken together become a perfect storm for the initiation of LSPI.

What causes LSPI?

An early view was that LSPI was likely to be caused by hot spots or soot accumulation of the cylinder walls. Such mechanisms are quite likely to be at play but are not the whole story.

Viewing the combustion process as the engine is fired, it seems that the sources of pre-ignition are not confined to the cylinder surfaces but can occur anywhere within the volume of the combustion chamber.

One theory is that oil droplets or other deposits floating in the combustion chamber can auto-ignite prior to the spark ignition and thus ignite the fuel too early.

It appears that the fuel injected as a mist under high pressure into the cylinder can dilute the oil film on the cylinder walls. Then, as the piston rises up the cylinder during the compression cycle, some of this oil/fuel mixture gets physically displaced in the form of small droplets which travel away from the walls into the combustion space where they can pre-ignite. This ignition then spreads to the rest of the fuel air-mixture causing LSPI.

What can be done to prevent LSPI?

Though changes in the way engines are set-up could significantly reduce the problem of LSPI, this would involve sacrificing engine power or fuel efficiency so such changes are unlikely to be welcomed. For example, if some excess fuel is injected into the cylinder towards the end of the compression cycle, this has a cooling effect which in turn makes LSPI significantly less likely. But obviously, excess fuel will not only increase emissions, it will have a detrimental effect on fuel economy so this can't be seen as a long-term fix.

Much can be achieved by changing the composition of the engine lubricating oils.

It has been shown that one of the metals used in engine oils, calcium can be a "bad actor" when it comes to LSPI. However, calcium does lots of good in other areas, so it can't just be removed without giving problems elsewhere in the engine. Clearly, LSPI is a critical issue as engines can be seriously damaged in just a few seconds, but there are other, equally important factors such as wear prevention and engine cleanliness which cannot be sacrificed just to fix this one problem.

By skilful formulation, the level of calcium can be replaced with other elements such as magnesium, which can bring about a much improved LSPI performance together with equally good performance in all other areas.

Changes on the horizon

OEMs are getting increasingly concerned of this issue and while some take steps behind the scenes, others are making more obvious moves.

For example, Vauxhall Opel had been recommending an oil meeting their Dexos 2 specification pretty much across the board in Europe. However now, for certain petrol engines, particularly some smaller 1.0 and 1.4 litre units, they are recommending oils meeting their Dexos 1 Generation 2 specification. It will come as no surprise that the chemical limits for this new Dexos 1 Generation 2 specification have lower levels of calcium to assist LSPI, while still keeping the performance around much the same in every other respect.

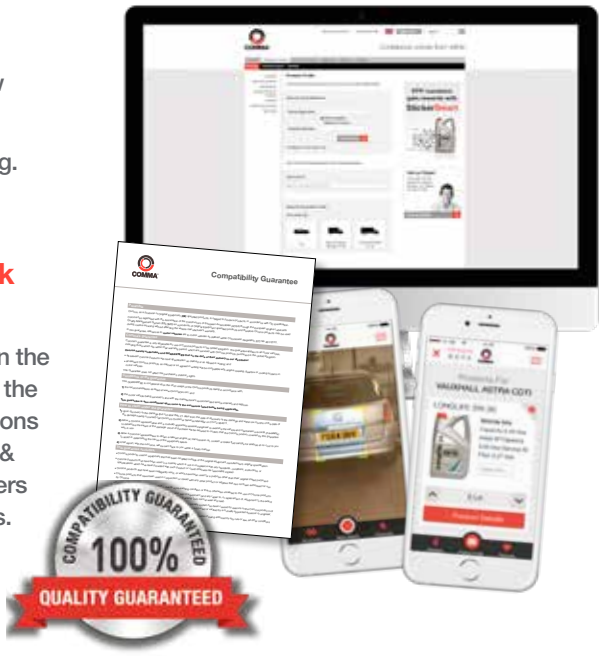
So what can you do?

As a workshop owner/technician, you can be aware of the issue. Awareness is always the first and most important step with any new challenge.

The issue of LSPI is very complex and, at the moment, fast changing. Rather than trying as individuals to keep up with the myriad of developments it is probably better to let Comma do that for you.

If the car is experiencing LSPI problems, double check that the correct oil is being used.

As long as you use the Comma's application tools you will be shown the right oil for these vehicles based on the very latest information from the OEMs. At www.CommaOil.com you will find product recommendations with our 100% compatibility guarantee for engine oil and antifreeze & coolant for European vehicles going back over 30 years. It also covers brake fluid, transmission and power steering fluid recommendations.



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