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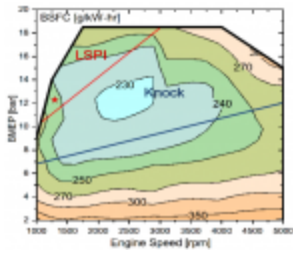


I know that Trailboss mentioned this in one of his posts and after a really good discussion with Dewserb I decided to do some research. I have been having some really weird knock readings while cruising in a high gear at a constant speed. These were happening with a tune and without a tune. At first I was thinking false knock but then LSPI was mentioned. A lot of the info is what we already knew, but it would attribute to a lot of the failures and why they may have been missed even while datalogging. Anyways feel free to discuss away. Here is an exert of what LSPI is:

Some GDI engines also have an unwelcome tendency toward pre-ignition, or spontaneous combustion before normal spark ignition, especially at lower speeds coupled with higher loads and high cylinder pressures. This unwanted phenomenon is called low speed pre-ignition (LSPI). Combustion events occurring before they are wanted or expected can hammer the mechanical internals of gasoline engines (evident with severe knocking), because pistons and connecting rods are rising when this downward combustion “bang” occurs. In the worst case, ongoing pre-ignition can lead to broken piston rings, damaged ring lands, and/or bent connecting rods. The mechanism of GDI pre-ignition is not yet fully understood. Multiple parallel strategies to mitigate GDI pre-ignition involve lube oil/lube additives, engine mapping (spark ignition and fuel injection event timing), and mechanical changes.

**Low speed pre-ignition (LSPI) can in severe cases lead to engine damage such as a broken piston as shown above.**

The engine operating area where LSPI occurs is very close to where fuel economy, performance, and drivability are optimally balanced. Operating at relatively low RPM and constant load such as highway cruising the engine can slip into the LSPI zone where potential engine damage may occur.



Possible prevention from the FocusST site (so not all of it will relate to us):

- Here is a list of things you can do to minimize LSPI conditions:
  01. Reduce carbon buildup mechanically - Use **baffled** catch cans; GrimmSpeed-type air/oil separators are sketchy
  02. Reduce carbon buildup chemically - Apply CERMA engine treatment
  03. Use cooler [spark plugs](#) than OEM
  04. Use a PAO-based (Group IV) or ester-based (Group V) synthetic oil - There are exceptions, such as Pennzoil Ultra Platinum, which is a Group III (natural gas) base oil
  05. Avoid using an extended service interval oil - longer intervals mean higher concentration of additives; use oils low in calcium-based (detergent) additives which are the worst offenders for producing LSPI events; high zinc additives require higher phosphorus content to neutralize the LSPI-inducing effects of zinc; high amounts of molybdenum additives are ok
  06. Change your oil & filter every 3000-3500 miles - fuel dilution (fuel/oil mixture) from piston ring blowby is another significant contributor to LSPI events
  07. Use the highest octane fuel possible - 93 (AKI); optional - add E-85 to create a higher ethanol blend (further increases octane); no more than E-40 (~99 AKI)
  08. Use a periodic (every 3000 miles) fuel treatment if your fuel is not top-tier (i.e., containing additives) - Techroline, CERMA fuel treatment, Red Line fuel treatment, AMSOIL fuel treatment, etc.
  09. (Optional but highly recommended) Use a methanol/water injection system
  10. (Optional) Get aftermarket pistons with ceramic-coated crowns plus gapless piston top rings

**No longer recommended:**

**Update (per @TheRock): Ford has stated that no current chemical induction service is approved, as the chemicals involved may also cause LSPI events and blown head gaskets! Use this method at your own risk.**

**More info:**

**Notes:**

Above all else, avoid going wide-open throttle at low RPM (1500-3000 (LSPI zone)) in too high of a gear, which lugs the engine. Downshift and then accelerate (more important on manual transmission VTs) when in the LSPI zone. Also, avoid doing the RCV solenoid bypass (boost hack) mod, as it causes boost spikes (overshooting) on moderate/heavy throttle that are also a major factor (leads to high Brake Mean Effective Pressure (BMEP) values; i.e., high cylinder pressures) in producing LSPI events.

To reiterate, avoid calcium-based (detergent) oil additives and only use PAO-based or ester-based oils with just enough zinc/phosphorus (anti-wear) and molybdenum (friction modifier) additives to get you to your next oil change with a positive total base number (TBN) value (get your oil tested by BlackStone or similar labs). If your TBN value drops to 0, LSPI event probability increases substantially.

Exhaust gas can also cause carbon deposits in the combustion chamber when GDI scavenging is done. This is why top tier fuels and routine fuel treatments are Hyundai-recommended. Increased ethanol content in fuel (however unpopular) will result in more thorough combustion, reduced exhaust emissions and less carbon deposits as a result. Ethanol also increases octane which lowers the chance of LSPI events.

**Anti-LSPI oil recommendation:**

Pennzoil Ultra Platinum 5W-30 (Group III stock, derived from natural gas, will be GF6-compliant)

**Other oil recommendations:**

RedLine 5W-40 or 5W-30 (Ester-based)

AMSOIL Euro Formula Mid-SAPS 5W-30 (non-PAO; they have a high-SAPS formula, but could cause [catalytic converters](#) to clog)

Cerma 5W-40 or 5W-30 (PAO)

Cerma X 5W-40 or 5W-30 (PAO)

AMSOIL Signature 5W-30 (PAO)

Motul 8100 X-cess 5W-40 or 5W-30 (PAO)

\*Shell Rotella T6 5W-40 (non-PAO, designed for diesel engines, but low levels of calcium and very good test reports) - per WhiteBoy, this oil is prone to foaming under race conditions, so avoid if you run your engine to redline for extended sessions.

Pennzoil Platinum 5W-30 (non-PAO) - can be used in a pinch and can be found in nearly all [auto parts](#) chains; do not run for more than 3000 miles.

Another post from the focus ST forum.

- Knock sensors DO pickup PI in Ford ECUs, and its used to set a Pre-Ignition Detection Level. Preignition from a cylinder pressure and noise viewpoint looks the same as knock, but it happens earlier. (Like before the ECU fires the spark ).

Ford uses windowing strategies on the two knock sensors to detect when individual cylinders knock during their combustion phase. If it happens early enough (like before it triggered the spark event), it triggers pre-ignition detection.

The stock tune upon pre-ignition detection lowers the load limit by blending together a mix of 3 LSPI tables.

Misfires are different events entirely, and are detected due to lack of power from a cylinder causing an irregular crankshaft acceleration. By definition a misfire means the cylinder didn't light off, and thus the torque produced is not near the expected value, so there is a sudden lack of crankshaft acceleration.

The thing about LSPI, is turbo GDI engines are the first spark ignition engines that have really been able to operate in that range of BMEP vs RPM.

We don't understand enough of its causes, and its still an active area of research.

All of the things listed in the PDF are just applying normal reasons PI and knock happen to LSPI, and no one knows if that's entirely true yet. To work around it, engineers have been given DI engines stronger compression capable rods, and using the ECU to prevent operating in that region.

On a complete side note:

Your use of a catch can and breather might be great for keeping blow-by out of the engine, but I doubt its efficacy at preventing LSPI.

We don't have a full understanding of the combustion processes involved in LSPI from a scientific standpoint yet.

Here are a couple links and I will also paste some of it below.

[http://pceo.com/GDI\\_and\\_Turbocharging\\_Rinek](http://pceo.com/GDI_and_Turbocharging_Rinek)

[Low Speed Pre-Ignition \(LSPI\)](#)

[LSPI Risk Minimization Tips and Research](#)

[This is why motors keep blowing up!](#)

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2013 F150 FX4 Appearance Loaded Eco. w/Max Tow. Level lift with 305/55r20 Open Country ATII Extremes. Rear Raptor Shocks. 5 Star Tuned/X4. Wagner Intercooler. AFE Stage 2 Intake. RX Catch Can/UPR CSS. Boost-Bars Raptoid