Ethanol Blending: How to Prevent Vapour Lock

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GRABNER INSTRUMENTS vapour Pressure Testers allow versatile ramp measurements for gasoline-ethanol blends

Imagine you are driving your car and the motor suddenly stops. You are lucky if this doesn´t happen on a crossing. When you try to restart the car, the hot motor stalls again. You call the breakdown service, but they cannot detect any problem with the engine, after they connected your car to their computer. You get your car towed away and contact the manufacturer, who gives a lot of advises and sends you spare parts. Possibly he sends them free of charge, as he is anxious to solve the problem with their car. But they, too, cannot find the problem. You might end up with a completely new motor, but the problem still might not be solved. The only solution seems to buy a new car.

Every year several thousand cars experience similar problems worldwide. The reason is that gasoline vapour lock causes engines to stall, mostly when the car is in traffic and temperature is rising high. Similarly when a car is parked for a short period of time the heated motor won´t start. The higher the temperature, the higher the altitude, the more likely it is that gasoline vapors build a vapour lock, preventing the fuel in the line from moving to the engine.

Regulations to prevent vapour lock

As gasoline vapour pressure is also essential to assess fuel performance and risk of outgassing, the US Environmental Protection Agency (US EPA) forces strict regulations for vapour pressure on petroleum manufacturers. To prevent vapour lock and environmental issues, automotive fuel specification ASTM D4814 requires that gasoline is tested according to ASTM D5188. This standard is governing the assessment of vapour-liquid ratio temperatures. In automotive fuel speculations, the temperature, at which a ratio of 20 (vapour) to 1 (liquid) is reached (commonly referred to as $T_{(V/L)} = 20$), indicates the risk of the fuel to form a vapour lock. This tendency is higher in hotter climate and in higher altitude.

How is ethanol blending affecting vapour lock tendency?

With petroleum refineries adding more and more ethanol to gasoline, and as longer and longer periods of hit weather are experienced worldwide, testing fuels for the risk of forming a vapour Lock is of renewed interest. Many older engines simply have not been built to be prepared to match modern fuels. In the USA more and more states are adopting the E10 rule, which allows for 10% ethanol (EtOH) added to the fuel. The US EPA frequently has to adapt gasoline volatility regulations for the petroleum industry, to prevent emissions becoming too high and to guarantee driveability. Further down in the text we will also show that also new cars are affected. The main reason, why testing fuels for their V/L ratio temperature is essential, is because ethanol blending affects the vapour pressure. The vapour pressure of ethanol is much lower than the vapour pressure of gasoline. The addition of ethanol changes the temperatures, at which various V/L ratios occur. Adding 10% of ethanol to gasoline – as is currently done in the USA - drastically reduces the V/L ratio temperature. Therefore a critical vapour liquid ratio, which can cause vapour lock, will be reached at lower temperatures with gasoline-ethanol blends than with regular gasoline. Figure 1 shows the temperature dependent V/L behaviour, when different amounts of ethanol are blended into gasoline.

Interestingly there is no linear solution on how ethanol blends affect the vapour pressure. Figure 1 shows surprising behaviour of gasoline-ethanol blends: Depending on the V/L ratio, the temperature curve unexpectedly changes its direction and moves up instead of down. This "S" curve phenomenon can be seen for E5 and E10 blends, but not for E15 blends. Another phenomenon shows in Figure 1: For low V/L ratios the E15 $T_{(V/L)}$ is higher than for the E10 blend. Around a V/L ratio of 35:1 both curves intersect, caused by the "S" curve phenomenon for E10.

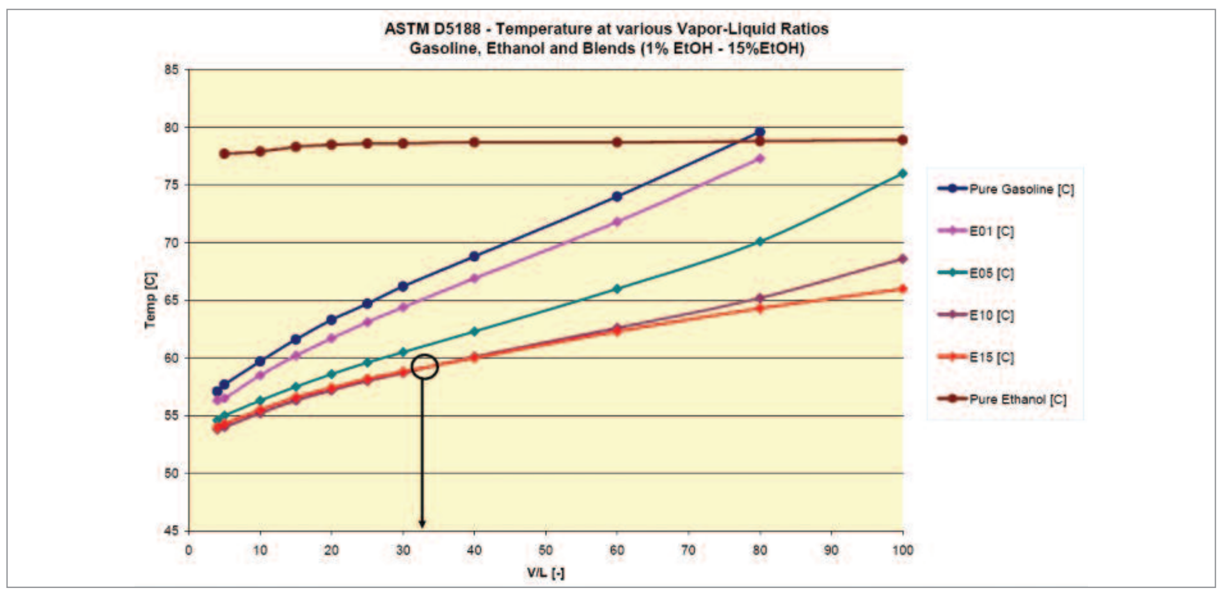

Figure 1: Temperature changes at various V/L ratio for 1%, 5%,10% and 15% gasoline-ethanol blends. Highlighted is $T_{(V/L)}$ = ~35.

As surprising as these results are, there is no need to worry about blending ethanol into gasoline. But this example shows how essential it is to measure fuels not only at a V/L ratio of 20, but to measure over the FULL $T_{(V/L)}$ range – as required by ASTM D5188 - to find out about vapour pressure behaviour of modern blended fuels. Testing at $T_{(V/L)} = 20$, as currently done for ASTM D4814 automotive fuel specifications, simply is not giving enough information about fuel vapour behaviour. This example also indicates, that blending higher ratios of ethanol into gasoline as currently being done might result in more predictable behaviour of blended fuels.

How about modern injection motors and vapour lock tendency?

vapour lock is also a growing challenge for car manufacturers, who are developing new engines, which have to run on different fuels. When modern injection motors are stopped after long travelling, some might not be able to restart immediately. The reason is that those new motors reach temperatures up to 120-140°C, and vapour lock is prone to happen at high temperatures. Especially with modern fuel blends vapour lock issues show more frequently. Recent feedback from car manufacturers indicates that they have a specific need to detect vapour pressures up to 5-6 bar and to closely watch vapour pressure when developing their new generation engines.

How to test vapour lock tendency

Known worldwide as "The vapour pressure specialist", GRABNER INSTRUMENTS has developed the MINIVAP VPXpert, a new extremely versatile analyser to assess temperature at different V/L ratios for ASTM D5188 tests. The MINIVAP VPXpert also is the optimum solution for testing vapour pressure of gasoline-ethanol blends at high temperatures. It allows for ramp measurements up to 120°C, providing the highest temperature range of vapour pressure testers on the market. Incorporating the world famous GRABNER vapour pressure test method, the analyser complies with all industry vapour pressure testing standards, thus enabling safe development of the new generation automotive engines for ethanol blended fuels.

MINIVAP VPXpert – Expert vapour pressure testing at highest temperatures.