TECH TALK WHAT IS HAPPENING DURING A COLD START?

According to one study, 70 percent of the harmful emissions from a vehicle occur in the first 30 seconds of operation. Engineers are always trying new ways to reduce these emissions by using different strategies to warm up the engine and sensors faster. As technicians, many drivability problems start with saying, “It only does it when it is cold.” Understanding what happens when the engine is cold is essential to solving many problems.

Back in the day.

In the days of carburetors and distributors, a cold start required the driver to set the choke by pressing the accelerator to the floor. The choke plate would close off part of the horn of the carburetor to reduce the air entering the carburetor and richen up the mixture. At the same time, a quick idle cam would raise the idle speed, and a small door in the snorkel of the air cleaner would close to pull air from an inlet around the exhaust manifold. Some systems even bypassed the ballast resistor for the ignition coil for a hotter spark while cranking. This was not an exact science. As for warmup times, it depended on the ambient temperature. Also, the choke might take up to five minutes to disengage and give decent drivability.

Until oxygen sensors are heated through.

What happens when a modern engine with port or direct injection starts on a cold day? The first thing to remember is that the oxygen sensors must achieve their operating temperature to detect oxygen levels in the exhaust stream. To get the oxygen sensor working faster, the sensor has a heater. Air fuel ratio sensors have larger heaters that can heat the sensing elements to higher temperatures than that compared to an oxygen sensor. The heater circuit uses a pulse width modulated signal with a duty cycle. When the engine is first started, the heater circuit might be at 90 - 100% duty cycle to warm up the sensor. After the engine is warmed up, some heater circuits will continue to operate at a lower duty cycle to keep the sensor at optimal temperatures.

When the oxygen sensors are cold, the engine management system goes into open-loop operation. This mode uses preset parameters to determine how fuel is injected into the engine to get it started and keep it running with a smooth idle. Some systems will use the coolant, air and ambient temperature sensors until the oxygen sensors warm up. Some strategies will manage the amount of oxygen and fuel available to the catalytic converters so they can warm up faster. Once the operating temperature is reached, the system will go into closed-loop operation. In this mode, the oxygen sensors primarily determine the fuel trim.

Modern improvements.

Modern systems are very sophisticated when it comes to cold starts. Some systems will regulate the flow of coolant in the block and head to reduce cold start emissions. Other systems might use coolant stored in a thermos-style container to reduce the warmup times further. In the case of hybrids, the internal combustion engine might not be used until the motor, battery and inverter have created enough heat to warm the engine.

Another cold start improvement has been the ignition system. With control over the individual coils, it is possible to control the timing and even the number of sparks to improve the combustibility of the cold air/fuel mixture. Even spark plugs have evolved with high ignitability designs that expose more of the electrodes to the combustion chamber.

Where do you start?

So where do you start when a repair order says, “when the vehicle is first started in the morning,” or “it only does it when it is cold?” The first step is to document the complaint or condition. For some cases, it might help to know the ambient temperature when the condition occurs. Another great piece of information is the freeze frame information. This data can include the coolant temperature, closed/open loop operation and engine speed. This data is captured when a code is set and is often saved even if a code is not currently active.

The next is to do some research. Often, some monitors are linked to specific temperatures for coolant during open loop operation. This can be found in the theory and operation section of the service information. Also, check for TSBs. Often, the remedy for the condition is just software. If you are still stumped, you will have to replicate the condition at your shop. This might require the vehicle to be left overnight for a good cold soak. However, note that the ambient temperature is not under your control. **For further information, please call NGK Technical Support at 1-877-473-6767 ext. #2, or visit us at ngksparkplugs.com.**