System Overview

VP44 Fuel System

Diagnosing this fuel system requires a unique approach and a sense of humor as you can't just plug in scan tool for all the right answers. You can't get what you need from a shop manual either as it was probably written before the author had the experience necessary to diagnose this unique fuel system. The best news is that the mechanically inclined back-yarder can diagnose this fuel system accurately, without a scan tool, with only a few simple tools and a cheap analog voltmeter. The codes that are in the ECM are a help, but in most cases mean nothing unless accompanied by a certain symptom.

You only need to read the codes in the ECM as that is the only computer that runs the fuel system. The PCM is for all other systems in the truck. In some cases the codes we don't get are the most important part of determining an accurate diagnosis. If you follow these diagnostic procedures below you will get accurate answers, but not necessarily the answers you like.

There are seven components in the fuel system in a VP44 fueled truck.

1. The ECM (Engine Control Module)
2. Fuel Injectors
3. APPS (Accelerator Pedal Position Sensor, also known as a TPS or Throttle Position Sensor)
4. Manifold Air Pressure Sensor or MAP Sensor (also known as a Boost Sensor)
5. Fuel Filter
6. Lift Pump
7. VP44 Injection Pump

The ECM and OEM Injectors rarely experience issues. In fact up until 2009 we had never heard of a bad ECM, even at crazy high mileages, but now that these trucks are getting older we have to change our tune. The APPS and MAP Sensor rarely are a problem, and can be diagnosed with the info below. The Fuel Filter and the Lift Pump have their own diagnostic pages for your review. The VP44 Injection Pump is almost always the cause of a drivability issue and or symptom, and can be accurately diagnosed by reading below.

How this fuel system works in simple terms:
You will likely understand the following diagnostics with ease if you have a solid understanding of how the fuel system works. Now that you know what components exist, and which ones are generally trouble free and which are not, here is how and when they do their thing.

Cranking or starting the injection pump is operating in what is called "Open Loop" electrically. That means the injection pump is only using 12 volt power and ground. It does not pay any attention to, or require any other component, including the electric lift pump, in the VP44 fuel system to only start and idle. (More info on this phenomenon is explained in the Lift Pump Diagnostic page.)

When the ECM sees idle RPM, then it runs the injection pump in "Closed Loop" and turns on the electric lift pump to run continuously, and pays attention to all the sensors, computers, etcetera to meet desired parameters preset in the ECM, like fueling rates and emissions.

To get more RPM or power you step on the throttle which is connected via a cable to the TPS, which Chrysler calls an APPS. When you press the throttle down the APPS sends an increased analog voltage to the ECM which commands the VP44 to deliver more fuel. The more you move the pedal the more voltage is seen by the ECM and the more fuel is commanded. The VP44 takes all of its commands, other than starting, from the ECM, which monitors a bunch of signals from inside the VP44 too, like pump timing and a pulse width signal from the fuel solenoid inside the VP44, to compare with the pulsed signals from the Crankshaft and or Cam Sensors.

The signal from the MAP or Boost Sensor is used by the ECM to control fueling rate. It tells the ECM how much boost pressure is being made by the turbocharger, and the ECM determines how much fuel is actually being burned compared to load or command, and how much smoke or emissions are likely present. This is how the ECM controls performance and or emission standards. If the analog signal voltage from the MAP Sensor seen by the ECM is within appropriate voltage parameters, then more fuel will be added until the command from the APPS is met. If the appropriate MAP signal voltage parameters are exceeded or too low, then the ECM tells the injection pump to adjust and limit fuel volume. This is what some call “Limp Mode”. We don’t consider the IAT or Intake Air Temperature sender a part of the fuel system, as it only tells the ECM whether or not to turn on the intake heating ribbons, for a cold start.

Now for the fun part, the VP44. It is a rotary style medium high pressure injection pump that is mostly mechanical with two electronically controlled components in it. One is the timing solenoid, which is pulse width modulated by the ECM to control timing piston travel against a spring in the housing of the VP44. This piston moves the wavy ring inside the pump which is what forces the pistons in the rotor inward as it turns and creates high pressure to pop off, or open, the injector that the rotor is pointed to, to get fuel to flow.

Fuel only flows through the injector as long as its pop off pressure is exceeded. If the high spot on the wavy ring is moved one way to the point where pop off pressure is exceeded and fuel flows sooner, the injection event is advanced. If it moves the other way it makes pop off pressure come later and therefore retards the injection event timing. The distributor portion of an injection pump is basically the same as a distributor cap in a gas scenario except that it has holes in it going to each delivery valve and injector line in the correct firing order in direction of rotation.

The rotor in this pump does the same job as a rotor in a distributor in a gas car application. Instead of directing electricity to the contact in the distributor cap and spark plug wire, in an injection pump it is hydraulic and the rotor turns past a round hole in the so called distributor so fuel flows to the individual injector. The hole in the rotor, that mates up to the round distributor hole, is slotted so fuel can flow for a period of time as the rotor turns.

The other electronically controlled part in the VP44 is the fuel solenoid that is both the fuel fill valve and the pressure relief valve for the rotor. The rotor is hollow with three pistons mounted radially in it, that mate up with and run over the highs and lows of the wavy ring on the inside of the pump housing. The solenoid is actually a valve on the end of the rotor. When it is open, low fuel pressure fills the hollow part of the rotor with fuel as centrifugal force and fuel pressure push the pistons outward to the lowest spot on the wavy ring allowing the rotor to completely fill with fuel.

At a computer determined magic moment, the solenoid closes the fill point or fuel solenoid, and then as the rotor turns, the wavy ring makes the pistons compress as they go over the high spots. When the pistons are compressed, pressure builds up in the rotor and when it exceeds injector pop off pressure, fuel flows through the injector until the computer on the top of the injection pump shuts off the solenoid valve, allowing it to open, which relieves the pressure in the rotor to below pop off pressure and fuel stops flowing. As the solenoid is now open, the rotor is refilled for the next injection event. The longer the fuel solenoid is kept closed during each injection event, the more fuel is injected into the cylinder. This is how you make more or less fuel come out of this pump.

A fueling style performance box like our Fuel Management System works on this principle. The performance box holds the solenoid closed longer than the computer on the pump tells it to, and fuel continues to flow, making more power until the rotor is empty or the solenoid is shut off by the box and the fill valve is opened.

Why you should check fuel supply first:
You may think that low fuel supply pressure will cause many or all drivability problems, but that is not so with this fuel system. Human nature also makes us want to take the path of least resistance, by replacing the less expensive components first, before diagnosing this fuel system correctly. Please know that Lift Pumps have their own problems, but are rarely the cause of a catastrophic Injection Pump failure, or a drivability complaint, contrary to what a lot of people want you to believe.

A weak or failed Lift Pump or a restricted Fuel Filter will not give any other drivability issues other than a skip, miss or buck at high load/high RPM operation. If you only experience these symptoms, replace the Fuel Filter and if you can't bleed the system, or if changing the filter doesn't fix the problem, go to our Lift Pump Diagnostics for more answers.

You may have to do a Lift Pump diagnosis and or replace the Fuel Filter after you put on a rebuilt Injection Pump because it may make more power than the old one, therefore using more fuel, and therefore lowering the fuel delivery pressure to the point that you then have a skip or miss at high rpm/load. Be sure that you have at least 5 PSI Lift Pump pressure, under load to be sure it isn't preventing full power or timing advance, and or causing any harm to an old style diaphragm in your VP44.

We strongly suggest installing our Low Fuel Pressure Warning Kit to monitor fuel pressure as a diagnostic tool and a future money saver. It will tell you when restriction in the filter necessitates replacement, which means you will change your filter by restriction, rather than the seat of your pants, and save replacement filter costs! It will also tell you if the Lift Pump fails mechanically or electrically.

Visit our Products page for more info about this money saving product.

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