

Diagnostic Guide to Alternative Fuels

Or:

Everything you wanted to know about making your vehicle run on Propane but were afraid to ask!

By

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About the Author:

The author has over 38 years experience in the automobile service industry and almost 18 years with Alternative Fuel vehicles. The author is currently a senior lecturer for the alternative fuels industry and provides onsite training and project technical liaison assistance.

The author is also a current and past ASE certificate holder as a Master Automobile Technician, Master HD Truck Technician, Advanced Drivability, and Alternative Fuels, and possess other licenses and certifications referencing alternative fuels and automotive service.

Product disclaimer:

Any references to manufacturer or manufacturer's material or product names or descriptions is designed as a point of identification and does not imply any specific endorsement or criticism about a product or manufacturer.

For the repair technician:

This diagnostic guide is designed to assist the automotive technician in a manner that many may find consistent with conventional automotive diagnostic steps. In other words, follow the progressive flow of questions. If any shortcuts are taken, an important answer or diagnostic informative step may be missed. Do not "bottom line" the diagnostic flow pattern!

It is assumed that the diagnostic technician has an overall knowledge of general automotive skills in addition to a working knowledge with the behavior and properties of alternative gaseous fuels.

The author assumes no liability for any mis-interpretation of any information presented here. The reader of this guide assumes the sole responsibility of performing any repairs suggested here. It is the reader's sole responsibility to ensure compliance with local, regional and national laws, codes, restrictions, and product compliance.

The following material is an excerpt from the book, which is currently in editing, peer review, and updating. It may differ from the final product but not significantly.

My vehicle doesn't run on propane, what diagnostic steps can I perform?

Is this a new conversion?

If it is, please review installation procedure and equipment. If not, let's proceed.

Is this a previously running vehicle with new drivability complaints?

(YES = Proceed.)

(NO = Review installation procedure and equipment.)

Does the vehicle typically start on the alternative fuel?

Some vehicles will start on gasoline and then switch over automatically within a few seconds of operation.

- On the positive side, it eases the starting of some vehicles, which may be problematic with propane. This process also helps keep fuel injectors flushed and the fuel system clean. If the vehicle were driven almost solely on propane, the gasoline system will eventually go stale. If the gasoline is allowed to sit for more than a couple of weeks, the gasoline will lose approximately 20% of its octane.
- On the negative side, you may occasionally forget to refill with gasoline, making starting more difficult, especially if the fuel system was initially calibrated to start with gasoline.

Does the vehicle start easily?

What we are looking for is a starting sequence similar to operation on gasoline. One thing many people forget to do is to verify basic engine electrical, mechanical and tune-up specifications. Remember that an alternative fuel vehicle must still have all of the tune up specifications in proper working and operational order.

Don't forget to check the fuel level and refill if necessary. You would be surprised how many vehicles are towed into a service facility when they are simply out of fuel!

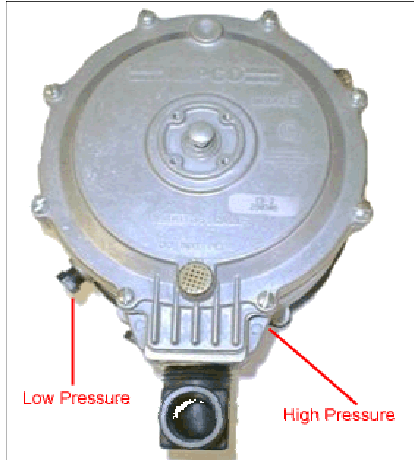
Check the manual fuel supply valve, open slowly if necessary. If the tank mounted manual liquid or vapor service valve is opened quickly, the excess flow valve will seat.

Also, verify the operation of the fuel lock-off. The lock-off should be energized in the crank and run position (electrical) or if equipped with a vacuum lock off, it typically opens with .2" WC. If the vacuum bleeds off or the unit does not open, repair or replace vacuum lock-off after confirmation of fault. A pin may be inserted in the rear of the lock-off to depress the diaphragm to test the integrity of the vacuum supply and diaphragm.

If the vehicle now starts, check the vacuum hoses, hose orientation, and diaphragm. The vacuum lockoff is designed to operate on air-valve vacuum, and if it is connected to manifold vacuum, the diaphragm may be damaged due to the relative "higher" vacuum (inches of mercury versus inches of water column).



Performing a Vaporizer Pressure Test



Performing a vaporizer pressure test can quickly pinpoint a drivability and performance problem. Proceed with this procedure to continue diagnostics tips. Many equipment manufacturers **require** a vaporizer pressure test as the first diagnostic step.

To pressure test the vaporizer:

1. Locate and remove the two pressure port plugs.
2. Install the appropriate pressure gauges and compare with the list below.

Remove the 1/8" NPT plug from the upper body. (One exception is the Model J/Cobra, which is accessed through the unused vapor outlet. Remove one of the 1/2" plugs from the vapor chamber. Install the necessary fittings to adapt the gauge fitting properly.) With Impco models "E", "L", and "J", expect to see about -1.5" WC at the vapor chamber (secondary pressure plug) with the engine running.



To test the vacuum (air valve vacuum), remove one of the 1/4" -20 screws at the mixer base and attach a F4-2 vacuum fitting. Connect a WC gauge and measure the engine cranking vacuum with the throttle held open. The vacuum should be between 4" and 8" WC. If the reading is less than 4" WC, check engine cranking speed, engine condition, or mixer mounting integrity. Repair as necessary before proceeding. (Hint: If there is no or minimal vacuum reading, the diaphragm or mixer cone may be stuck in the open position!)

The photo at left shows the location of the primary pressure port for the Impco and similar Model J and Cobra; the photo above shows the location of the secondary port.



Inspect vaporizer pressure balance spring.

(General rules of thumb.)

It is recommended that the BLUE spring be used for IMPCO mixers and other air valve type mixers requiring -1.5" WC, and ORANGE spring for OHG mixer applications with -.7" WC. (OHG X-1 vaporizers built after November '96 all are equipped with a BLUE spring.) Spring choices are not available on OHG with Natural Gas applications.

Also, tests have shown that there is not very much difference in the performance with the two springs. I recommend the use of the BLUE spring in all applications.¹

For Impco Model E, Model J, and Model L vaporizers, use the BLUE spring for -1.5" H2O, and ORANGE spring for -.5" H2O. As in OHG above, I recommend the BLUE spring for all applications. The springs are not interchangeable between Impco and OHG vaporizers.

¹ Note that it is possible to fine tune the fuel mixture by selecting different balance springs. The use of a stronger spring will tend to shift the entire fuel mixture slightly leaner since "more" vacuum is required to open the vaporizer diaphragm. The use of a softer spring will provide a richer fuel mixture for the opposite reason.

Impco "P" series natural gas regulators have different colored springs indicating different delivery pressures. The "P" indicates that it is a pressurized system, and will most frequently be used on Natural Gas applications. Some specialized LP applications may use the "P" series regulator. Impco "P" series vaporizers are adjustable, but typically operate in the 1.5" H₂O, +/- .5" but some specific applications will use up to 5" H₂O +.

Will the vehicle idle normally?

Ideally, the propane powered vehicle should have an idle quality similar to gasoline in operation. In some cases, the vehicle may actually idle smoother and at a lower speed more easily than gasoline.

The next sequence of diagnostic questions center around abnormalities in idle quality.

What is the idle quality?

Is the idle speed oscillating high and low, surging or hunting? The assumption is that the vehicle has an automatic fuel mixture control device installed. The following tips are based on that assumption.

One of the first things to inspect is a probable incorrect idle mixture. Older non electronic fuel mixture systems require constant mixture adjustments, three or four times a year or even more frequently if needed! With the introduction of the electronic fuel mixture control, the control of the mixture is automatic and systems may not require any adjustments for several years.

If an improper fuel mixture is diagnosed, you should identify the cause. Start by identifying the specific mixture control. Since there are several different types of fuel control manufacturers, specific systems will not be demonstrated here; however, later in this book the basic concept of vacuum controlled fuel mixtures will be discussed along with some unique variations.

- Check the EGR action at idle (verify while on gasoline.) For many propane systems, the EGR system is not altered from gasoline, so any problems existing with the EGR will be evident on both fuels. Vehicles running on propane tend to produce less combustion chamber carbon than with gasoline, thus the EGR valve may be less prone to develop carbon buildup which may hinder smooth operation.
- Test the O₂ sensor for cool-off, especially after extended idling, verify with scan tool for variable O₂ voltage swings or cross-counts at idle. Tap into the O₂ sensor lead prior to the connection for the alternative fuels connection to enable a correct O₂ sensor output. If the O₂ sensor has cooled off, the reading will typically be below 300 mv. Since most O₂ sensors require exhaust temperatures over 600° F, an engine at idle for relatively long periods can lose O₂ voltage control. The addition of a heated O₂ sensor will greatly help this problem. If you are installing a heated O₂ sensor where a non-heated sensor originally existed, a useful location for the power supply is the electric fuel pump circuit. The sensor requires less current than the fuel pump so there is little chance of overloading the electrical system.
- The TPS voltage should be checked, and if in doubt, verify while on gasoline. On some systems, improved off-idle performance may be improved if the base idle TPS voltage is slightly increased. Many vehicles do not have an adjustable TPS module.
- The CTS may be out of range, verify while operating on gasoline. Some propane fuel system computerized engine supports intercept the CTS signal to prevent engine adaptive learning while operating on propane.

- As with the CTS sensor, on many systems the MAP sensor signal is also tailored for a specific application. While on gasoline, verify the output signal and compare with OEM specifications. The sensor may be out of range or vacuum hose leak.

Install meter to test duty cycle of the mixture control solenoid (s). The dwell or duty cycle should read in the middle of the scale, (50 counts on the Impco meter), between 4 and 8 volts using an analog meter, or an average duty cycle of 50% average using an averaging function digital volt-ohm meter.

Just because the vehicle is operating on propane does NOT mean that any sensors, solenoids, valve cover gaskets, spark plugs and wires, timing chains, oil pan gaskets, rear main bearing seals, headlamps, transmission gaskets, and universal joints are impervious to failure! All of these items have been blamed on using propane since they failed during a period after vehicle conversion!

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