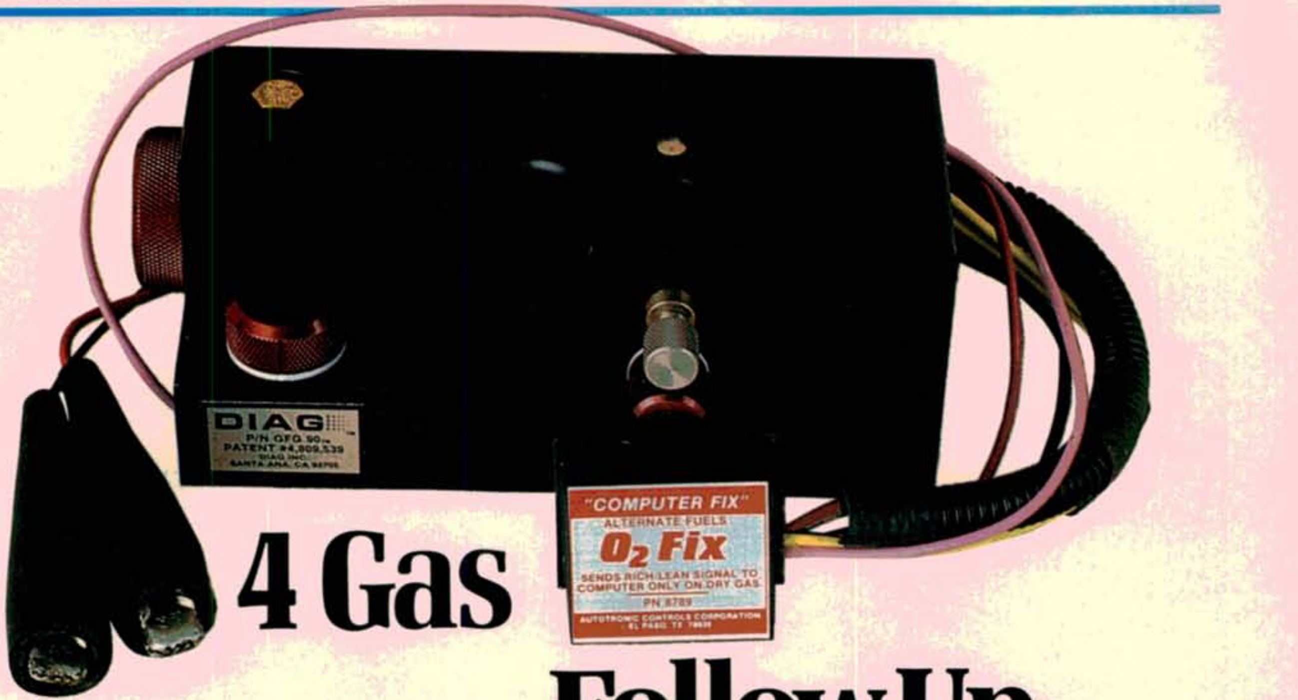

4 Gas Follow Up

Last month we looked at ways to interpret different 4 gas analyzer readings as an aid to diagnosing various fuel and emission problems. Now we'd like to introduce you to two little known tools which can make 4 gas analysis even more efficient. Hope you don't mind 4 gas two months in a row, but the tools mentioned here seemed to be a good follow up.

The iron was still hot.

Tool Number One

First, we'd like to introduce the DIAG GFG 90. Perhaps the best way to describe the GFG 90 is to call it a square, hand held, remote carburetor.

Before we hook up the GFG 90, let's imagine that 4 gas readings on a given car in our shop show that it's running below peak fuel/air efficiency. Too much fuel for available oxygen, or too little. So how do we know rich from lean, especially in borderline cases?

This is where the GFG 90 comes in. The GFG allows us to eliminate guesswork by introducing an atomized fuel/air mix directly into the intake manifold to richen a lean mixture. Or it'll let us add more oxygen to an overly rich mixture. The GFG can act both as a single circuit carburetor, or as a remote vacuum leak.

Tool Two

Our second tool is called the O_2 Fix. The O_2 Fix sends a rapid, fluctuating millivolt signal to the ECU. Ranging back and forth between about 200 to 700 mv, the O_2 Fix allows us to disconnect the car's O_2 sensor during testing without having the ECU scream "Whoa" and setting a code.

With the O_2 Fix connected in place of the O_2 sensor, the ECU thinks it's in closed loop. The midrange millivolt signals from the O_2 Fix keep the ECU happy, and it doesn't respond to the changes we're making in the fuel/air ratio.

Sneaky, huh?

Advantages

The main advantages of this approach are as follows:

- **If we can "fix" the car by altering the fuel/air ratio, then we know for sure that we have a fuel/ air problem somewhere. Then we can concentrate on fuel and air. Plain and simple.**
- **If we can dial in a peak non-catalyzed CO_2 in the 13.5 to 14.3% range, we know that the engine is mechanically capable of running that efficiently. We also know that the ignition system is working well enough to properly fire a good fuel to air mix.**
- **If we can dial in an acceptably high CO_2 level without the catalyst lit, and then increase CO_2 to a range of about 14.7 to 16.0% after lighting the catalyst, we know the catalyst is working.**
- **By the same token, if CO_2 won't go up with the catalyst lit, and if we have a lot of O_2 and CO left over, we know the catalyst isn't oxidizing as it should.**

Once again, we'd like to thank Lynn Goodman of Colorado State University for his help in preparing this article.

Let's look at our two new friends.

O_2 Fix—Autotronic Controls Corporation
Circle No. 200

Diag Inc.
Circle No. 201

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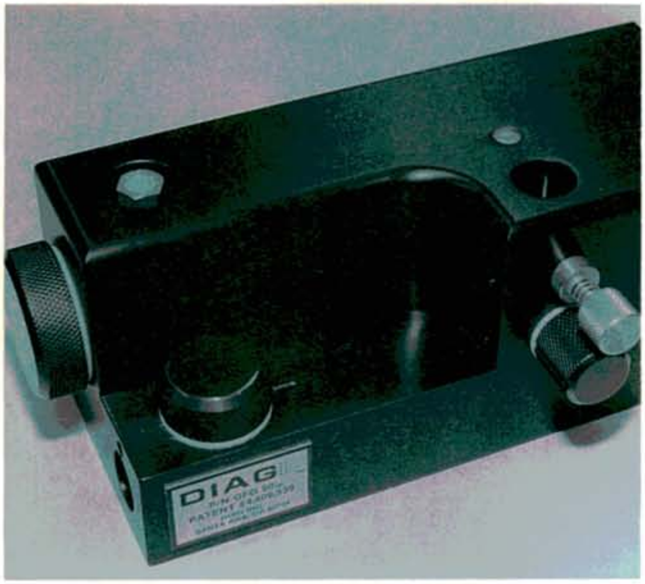
Mini Carburetor

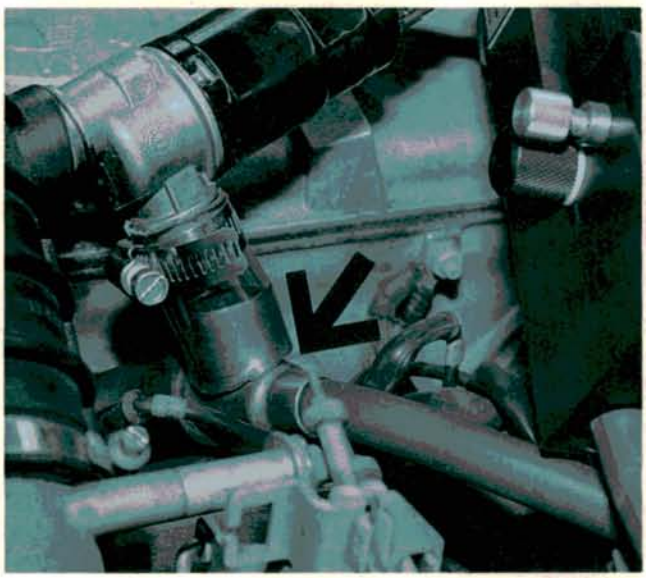


With the GFG, we have everything needed to supply fuel and air to the engine. It holds its own supply of fuel in a reservoir, and has its own venturi complete with a valve for controlling venturi vacuum and a needle valve to control fuel delivery based on vacuum.

Connecting to Vacuum

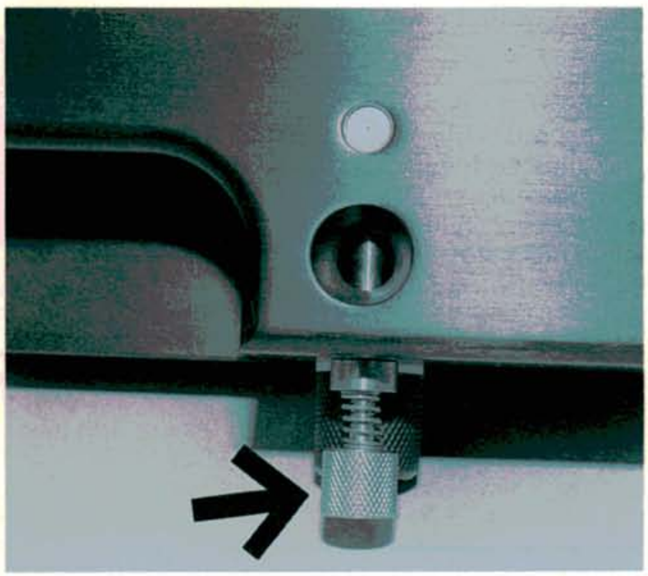
We want a good centralized vacuum port at the intake manifold. Normally a brake booster or PCV line is a good hook up spot. Before starting the engine, we'll completely close the large air bleed drilling connected to the vacuum port. Later we can open the valve to introduce more oxygen if the mixture is too rich.

Improvising



We had to improvise a hook up on our Motronic equipped BMW. A quick trip to the local hardware store produced a copper plumbing tee and a short length of flexible tubing. We installed the tee between the air stabilizer and the large hose running to the manifold. Then we ran a hose from the tee to the GFG's feed port (arrow).

Richening the Mix



Original 4 gas readings suggest that this car is running too lean. With the GFG connected, we richen the mixture by adjusting the fuel mixture needle, and watch to see if O_2 and HC go down. CO_2 should also go higher, above 13.5% and idle RPM should go up slightly. If the engine speed shoots up dramatically, we probably have a major vacuum leak.

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Leaning the Mix

If the car had been too rich, we would simply shut down the GFG fuel/air mix, and dial in additional oxygen, looking for HC, CO to drop, and for O_2 to increase. Once again we would dial in peak CO_2. If we can get CO_2 above 14% by adding air, we should start looking at the air filter first, a faulty purge valve, or other unwanted enrichments.

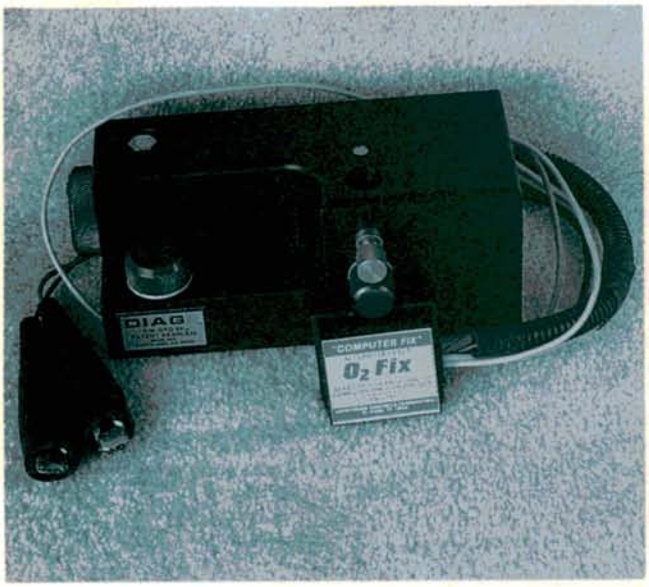
Checking the Oxygen Sensor

We can also check the O_2 sensor voltage response and range. Measure millivolt readings at the connector between the O_2 sensor and the ECU (O_2 sensor connected, engine running). Using the GFG 90, drive the fuel mix full rich (10% CO) and look for 900 mv. Then drive it full lean (0% CO or as close as possible) and look for 100 mv or less.

The Importance of O_2 Sensor Range

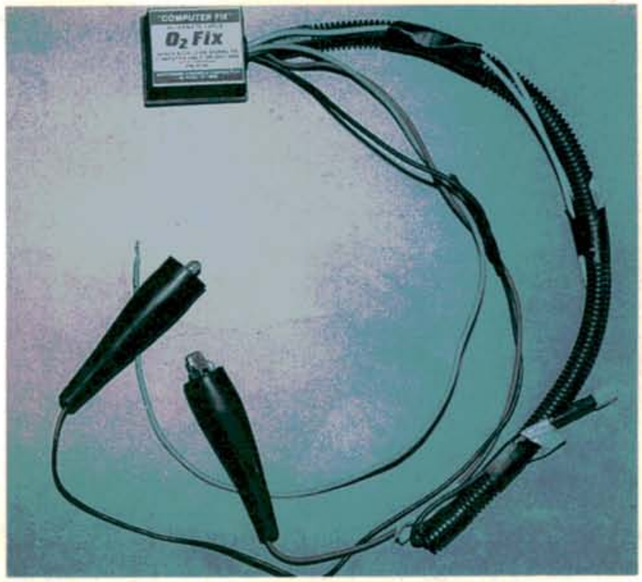
A tired O_2 sensor can "step down" causing problems. If an aging O_2 sensor can't get all the way to 900 mv or more, no matter how rich the mixture gets, the whole system gets biased towards a lean mixture. Some sensors will operate in a maximum range of 50-700 mv, meaning that the system's whole range of adjustment "steps down" a notch.

Fooling the ECU



Designed originally for use in setting up alternate fuel systems, the O_2 Fix sends a fluctuating millivolt reading similar to the O_2 sensor signal. The signal keeps the ECU from responding to changes in air and fuel, and also prevents the ECU from setting a fault code.

Preparing to Test the Catalyst



Using the procedures outlined in last month's article we prepare the catalyst for testing (exhaust inspection, disabling any air injection, and running the engine at 2500 RPM for two minutes). But instead of disconnecting the O_2 sensor and running the risk of setting a code, substitute the O_2 Fix.

Combining the Tests

We can test both the fuel/air mix and O_2 sensor at the same time. We'll disconnect the O_2 sensor and connect the O_2 Fix to the ECU's O_2 input wire. Then we'll connect our DVOM between the O_2 sensor and ground. That way we can drive the mix rich or lean without having the ECU respond. The sensor should respond without affecting the system.

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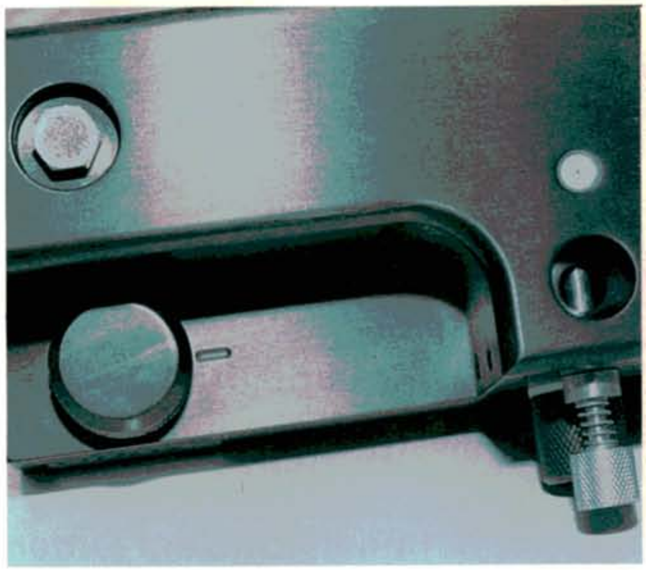
Testing the Catalyst

Warm the engine. Disconnect the air injection (if so equipped). Run the engine at 2500 RPM for two minutes, then let it idle. Use the GFG to maximize CO_2 readings. Try to adjust CO_2 to 14.7 to 16.0% (or more). If O_2 is above 0.9% and is also greater than CO (with CO above 0.5%), you'll know the catalyst is not oxidizing the exhaust as it should.

How Do We Know That?

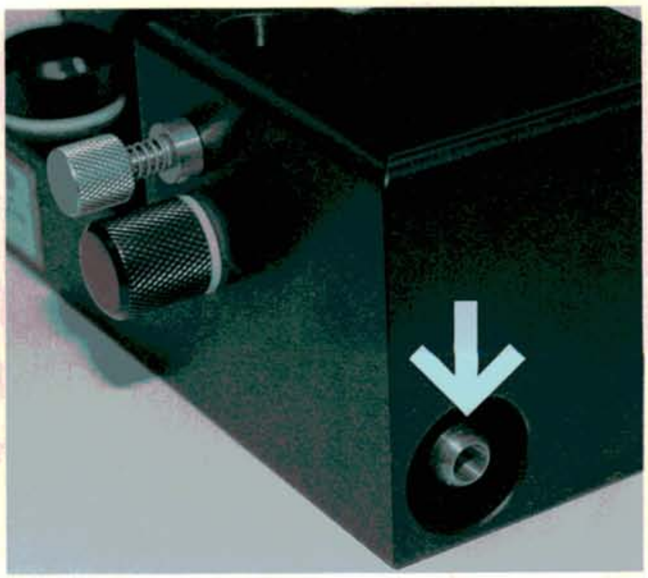


By artificially dialing in the most efficient fuel/air mix, we should reduce the amount of O_2 and CO as the catalyst makes CO_2. We know we have enough O_2 for oxidation (0.9) and left over CO. If the catalyst were oxidizing, however, O_2 and CO would be even lower, and CO_2 would go even higher.

Carbon Cleaning

Occasionally you'll see a car with so much combustion chamber carbon, that EGR and premium fuel combined can't eliminate engine ping. In this case, fill the GFG 90 with water. Run the engine at about 2000 RPM until the reservoir is empty. The atomized water will remove carbon without damaging the catalyst.

Diagnosing a Bad Exhaust



If water alone won't clean out all the carbon, a catalyst approved cleaner may be used. But what if the engine vacuum isn't high enough to draw fluid from the GFG outlet port? In this case, you may also be diagnosing a plugged vacuum port, PCV hose, or brake booster hose, depending on where you hooked up. If the hoses are clear, suspect a plugged exhaust.