Foreign Service

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A smoke machine can be one of the most effective diagnostic tools you can buy. Make sure it has features that will assure safe operation and protect your shop from the risk of fire or explosion.

This month, I'll update you on smoke machines that are used for evap system leak tests. It's a timely topic for several reasons. First, the vast majority of OEMs that approve the smoke technique for diagnosing evap leaks are foreign automakers, and the repair of their vehicles is the focus of this column. Second, there's much to tell you since our last smoke machine story appeared in July 2003. Third, I continually meet shop owners and technicians who are completely clueless about OEM safety criteria for evap-style smoke machines.

I'm not here to preach like I'm the saint of safety. I'm not here to pitch equipment to you. What's more, I'm not saying that ignoring safety criteria will definitely cause a catastrophe at your shop. But I will cite the old adage that ignorance never resolves an issue. If a fire or explosion did occur at your shop, I doubt that local authorities or attorneys for the injured will care that you didn't know industry safety standards and trends. As I stated four years ago, forewarned is forearmed!

Let's review the key facts and trends in OEM evap-style smoke machines. First of all, 22 OEMs presently endorse smoke technology for diagnosing evap leaks—Acura, Aston Martin, Audi, BMW, Chrysler, Ford, General Motors, Honda, Hyundai, Jaguar, Kia, Land Rover, Lexus, Mazda, Mercedes-Benz, Nissan, Saab, Saturn, Suzuki, Toyota, Volkswagen and Volvo.

Seven aftermarket companies also offer OEM-equivalent smoke machines—Cornwell Tools, Mac Tools, Matco Tools, MotorVac Technologies, SPX/OTC, Snap-on and Vacutec.

A typical OEM-style smoke machine heats a specially formulated, highly refined mineral-oil-based fluid. This creates a nontoxic, smoky vapor that won't harm the evap system.

Photo: Dan Marinucci

The vast majority of automakers that endorse smoke machines require or strongly recommend using an inert gas such as nitrogen.

Driver Gas Choices

A propellant or "driver gas" is needed to push the smoke through the evap system. These same OEMs and aftermarket companies either *require or strongly recommend* using an inert driver gas. (As of press time, Chrysler is the only exception.) Nitrogen is the most commonly used inert gas but carbon dioxide (CO_2) or argon (Ar) are also suitable. So if you're doing the math, 95% of the OEMs and 100% of the aftermarket suppliers cited above require or prefer nitrogen as the driver gas.

Fires can't start without fuel, adequate oxygen and an ignition source. Using an inert gas such as nitrogen to push the smoke prevents a fire from occurring inside the evap system. It does this by displacing the oxygen—eliminating it from the equation. Of course, nitrogen can't prevent gasoline vapors from being ignit-

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ed outside the evap system, but at least it prevents the worst-case scenario of fire and/or explosion inside it. So common-sense fire precautions are still important in the shop whenever evap leak tests are performed.

Nitrogen is newsworthy for other reasons, too. First, General Motors recommended leak-testing evap systems with nitrogen as far back as the late 1990s, before it endorsed smoke. Its service literature told you to pressurize the system with a regulated source of dry nitrogen and then snoop for leaks with an ultrasonic leak detector. Here at MOTOR, we discussed nitrogen use in feature articles in May 2002 and July 2003. As far back as the summer of 2004, I cited in my own evap seminar workbook eight OEMs that required nitrogen. So at least a few of us recognized the trend toward nitrogen.

Second, a closer look at some OEM-approved smoke machines clearly reinforces the importance of an inert driver gas such as nitrogen. For example, the same smoke machine is approved by all GM divisions as well as Aston Martin, Land Rover, Saab, Saturn and Suzuki. Another smoke machine is endorsed by Audi, Kia, Mazda and VW. The nitrogen tanks on both of these OEM-approved smoke machines are plumbed *directly* into the machine so there's no provision whatsoever for using compressed air. On top of that, the latest smoke machines approved by BMW, Ford, Jaguar, Land Rover and Mercedes all have internal nitrogen generators. Therefore, 66% of OEMs listed here have chosen nitrogen over compressed air *by design*. So it appears that nitrogen use today is more the standard than the trend.

Understandably, some techs wonder about the operation of the leak detection pump (LDP). This little pump, which is most commonly found on Chrysler products and European vehicles, creates a slightly *positive* pressure inside the system when the evap monitor runs. The LDP does push air into the evap system. But it's designed to run for a very short time and doesn't pump anywhere near the volume of air required to make the evap system flammable.

Fail-Safe Features

Fail-safe features are another important but overlooked characteristic of OEM-style smoke machines. A typical smoke machine is powered by the vehicle's battery. Every OEM-approved smoke machine and OEM-equivalent aftermarket unit shuts off the flow of driver gas the moment it loses electrical power. So if someone accidentally knocks a smoke machine lead off the battery, the machine won't continue pushing gasoline vapors from the evap system out into the bays. Furthermore, all OEM-approved and equivalent aftermarket smoke machines cited have a timer-out capability. If you're distracted and walk away from the smoke machine, it shuts off the flow of driver gas within anywhere from five to 15 minutes. Five minutes is the more common shut-down time.

Of all the equipment cited here, only one first-generation OEM-approved smoke machine lacks these two fail-safe features. However, this smoke machine is either nitrogen- or argon-specific by design.

The overwhelming majority of evap systems have a canister vent solenoid valve. This vent valve, which is the back door of the entire evap system, is normally open mechanically. Suppose you're distracted from your evap leak test and forget to shut off the smoke machine. In that case, the driver gas will continue pushing fuel vapor out the canister vent valve and into the bays until you do shut off the machine.

Some techs insist on using compressed air *and* using it on low-dollar smoke machines that lack OEM-style safety features. For example, there's at least one machine that won't shut off the driver gas even if you disconnect it from the battery! To shut it off, you must remember to disconnect the air hose from it or turn off a manual flow control valve every time you finish working with it. (If that's okay with you, fine. But to say the least, it flies in the face of *all* safety trends in OEM-approved smoke machines.) Suppose a tech leaves this type of smoke machine connected to the evap system, leaves the air hose connected to it and then leaves the compressor on overnight. Anyone care to document why this scenario isn't risky?

Other Voices Speak Caution

You needn't be a veteran trail scout to read signs. The focus of these safety features on OEM-approved smoke machines has been to eliminate or minimize operator errors and safety-related mistakes. The goal is to prevent fires inside the evap system as well as to minimize fire risk outside the system.

At least one source outside our immediate automotive circle also voiced caution about evap testing. For instance, several avid MOTOR readers referred me to Dr. David Checkel after hearing his presentation on fuel safety issues last summer at the annual conference of the North American Council of Automotive Teachers (NACAT). Dr. Checkel, a professor of mechanical engineering at the University of Alberta in Canada, is internationally known for his research work in oil field safety, fuel behavior and safety, combustion analysis and alternative fuel research. Among other projects, he has built and tested several prototype alternative-fuel vehicles for OEMs. (The truly cool part is that he's been active in motorsports for years, competing in everything from ice racing, hill climbs and rallyes to driving down-and-dirty shifter karts.)

Anyway, I learned some startling things from this man's work. For instance, suppose you use compressed air as the driver gas for your smoke machine during evap testing. With typical gasoline and typical smoke machine flow rates, this compressed air can make the vapor mixture inside the evap system flammable within one to five minutes. So if you're bent on using compressed air, you had better make sure you work quickly!

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Also, most MOTOR readers know that the air we breathe is about 21% oxygen. But did you know that an evap system containing as little as *11%* oxygen (by volume) can still sustain combustion?

Did you know that a leak as small as .070 in. could allow a flame to enter the evap system? A flame isn't nearly as likely to enter this tiny hole as it is to enter a disconnected, .250-in. vapor hose, but it's possible.

Did you know that "weathered" E85 ethanol flex fuel becomes flammable more readily than common gasoline does?

The bottom line is that evap system flammability varies according to a variety of factors, Dr. Checkel said. Out in the workshop, we can't easily predict or control factors such as vehicle history, type of fuel, age of the fuel, fuel level or temperature, ambient temperature, the number and size of evap system leaks, etc. What's more, we can't always control human variables such as ignorance, carelessness or apathy. Just think of the techs you know who can't be bothered reading a trade journal or getting update training. (By the way, Dr. Checkel reminded me that when an oil field worker misses questions on a safety procedures test, he's escorted off the work site!) High employee turnover in some shops may make it difficult to keep everyone adequately trained.

However, we can try to control such evap safety factors as test time, the choice of driver gas, the potential ignition sources within our work area, etc. Regardless of the driver gas we choose, the less time we spend leak-testing, the less fuel vapor we push out into the bays. The less fuel vapors in the bays, the lower the overall risk of fire.

When I asked Dr. Checkel for some closing words of wisdom, he paused and said, "It's *conceivable* that someone could manage the risks of using compressed air as a driver gas in an auto repair shop. But then, he would always have to worry that he or a tech that learned in his shop will cause an accident while using the wrong technique. On the other hand, he could play it safe—just use nitrogen and charge the going rate for doing the job right."

Wrapping Up

Let's put this whole discussion into perspective. There are 21 OEMs and seven major aftermarket suppliers that strongly recommend or prefer nitrogen as a driver gas for smoke machines used for evaporative system testing. By design, a majority of OEM-approved machines prevent you from using compressed air as the driver gas. Nearly all of their approved smoke machines

have two fail-safe/shut-off features.

According to the National Fire Protection Association, an average of 4550 fires occur annually in auto repair facilities nationwide. How many of these fires actually were evap-related is uncertain.

If you use compressed air as a driver gas, you *may* get by *if* you work quickly and *if* you somehow control all the variables.

I entered the trade in 1967 and have reported on the auto repair industry since 1976. I sold automotive equipment for three years. I've been presenting seminars nationwide for 14 years. That field experience taught me that we've got some of the brightest, most resourceful and most capable technicians you could find in any skilled-trade industry. But there are also a number of, shall we say, rambunctious and undisciplined characters among our ranks. I've watched them firsthand countless times over the years. And at classes, I hear endless accounts of bonehead maneuvers that started fires—especially when least expected. I guess that's why many bosses have told me that they organize their shop and its procedures on the philosophy of "expect the unexpected."

Now suppose you use a smoke machine that lacks the key OEM-style safety features discussed in detail earlier. You use compressed air as the driver gas. The unexpected happens and there's a fire and/or explosion. Trust me, fires and explosions generate untold scrutiny from the local government, police and fire departments, insurance companies and attorneys. In lieu of any other standards, they'll look to the OEMs for safety requirements, guidelines and trends. With relatively little research, they'll turn up the same information I've presented here. And your rebuttal would be...?

Last but not least, I'll repeat a point I made back in July 2003: Experience shows that a smoke machine is one of the most effective tools you can buy. It's beyond me why a shop can't afford one—especially one with all the OEM-type safety features. The better shops I know easily charge in the range of 25 to 50 bucks every time they use it. I've used smoke machines for 12 years and learn something new almost every time I do. So when someone tells me it's the most profitable piece in the shop, I believe him.

Yes, there's a small price spread between equipment with OEM-type safety features and those without. Show the price difference to the local fire marshal and your insurance carrier. Let me know which kind of equipment they prefer. Whatever your course, good luck. Just be careful out there. M