

WHAT ARE YOU SMOKIN'?

Keep a clear head about smoke oil

BY ROGER MOLA



"With the buyouts and mergers of the petroleum companies, our tried-and-true smoke oils like Corvus and Canopus have changed their names," says Steve Oliver, of the Pepsi Aerial Entertainers. In some markets, consolidation has brought a spike in cost, leading users to seek options. "Suddenly, 'new' smoke oils have reared an ugly head," says Oliver. "They're lower in price, but high cost in that they give us a headache."

Like most performers, Oliver specifies a brand and grade of smoke oil proven for health and safety, and for his type of display. Yet Oliver is continually asked to swap for other oils, most often the military specification that show organizers buy in bulk to pump for the jet team. "Even with the cross-references manufacturers claim on the label, some oils are not acceptable, especially for civilian aerobatics," says Oliver.

Performers can refuse to make substitutions, but the argument is hardly suitable on arrival day, particularly since needs have been established for months. And no pilot should need to choose between basic

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safety and a reputation for being difficult.

Jim LeRoy of Bulldog Air Shows notes, "Most performers specify Canopus 13, however, shows rarely buy this; instead they purchase an equivalent. Usually this equivalent is acceptable, but sometimes it is not." LeRoy once agreed to use Handy 15; its label warned of brain damage from its vapor. "I was concerned so I called the oil distributor, and he said that the label was just for liability purposes and that it was the same as Canopus. So I tried it and it stoned me. I didn't know how bad it was till I got out of the aircraft and had trouble walking a straight line."

LeRoy acknowledges the push to buy a 55-gallon drum, and perhaps qualify for a discount. "But the jet pilots don't have to breathe this stuff as it is injected into the exhaust behind the

airplane. The prop guys breathe it, so it is absolutely an infringement on crowd safety to provide the wrong stuff." LeRoy adds that alternate oil simply may not smoke as promised. "There's no excuse for bad smoke at an air show."

Dennis Dunbar, a show organizer for the Terre Haute International Airport Authority, is himself an aerobatic pilot. "I understand that at 1,500 feet above the ground you have to have your head in the game all the time. Some of the cheaper smoke oil leaks into the airplanes; some can be so noxious as to affect a pilot's judgment, depth perception and decision-making, and it can be fatal. The last thing I want to do is to save a dime per gallon of smoke oil for something that's bad for my friends and bad for the industry."

Still, costs are rising. Oil in

55-gallon drums that once sold for \$300 have in some markets spiked to \$500. Though safety prevails, like many organizers, Dunbar is tempted by newer oils costing half as much.

"One of my complaints would be that all of these performers request a different type of product. The types and brands vary across the country and you may find them, but then the manufacturers change. There's no national standard, so it would be helpful if the performers were on the same page."

Last season, Dunbar put a volunteer full-time on smoke oil research, hoping for consensus to help him standardize the logistics, and to purchase safely in bulk. The solution at Terre Haute was Aeroshell Vitrea 13; the latest designation and maker of the former Texaco Canopus. "Shell is now making the product that virtually everyone can use," says Dunbar. "The only problem with the Vitrea is that it's significantly more expensive than the other blends."

Dunbar says that a consensus on oils is sorely needed, but all told, "The industry should step up and pay for the smoke oil

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that will not make people sick, and besides, that will put out a decent quality of smoke. This is ultimately an essential aircraft system," argues Dunbar. "There are a lot of other areas an air show can save money on; smoke oil is not where they should skimp."

"None of the performers complained about the Vitrea 13 making them sick; it lingers in the air and does not dissipate right away. It worked for our civilians and our warbirds, and it worked for our skywriter. We're going to stick to the Aeroshell Vitrea."

Good for Terre Haute, but consensus is elusive: partially from laws against monopoly; partially because despite decades of experience, performers guard smoke oil materials and methods as a competitive advantage. Not so with the jet teams—who standardize until it hurts. Or the smallest pistons—the radio control modelers—who freely swap recipes, costs and test results. In any case, if someone has perfected safe, healthy and effective colored smoke for aircraft of any size or engine, no one is talking.

CLASSIC SMOKE

Like soda-pop, many figure that within reason, smoke is smoke. Kevin Murray of Sky-Dynamics of Moneta, Virginia, has customized exhaust systems for some of the top civilian performers.

"As far as the types of oil that are best, you can use anything that turns from a liquid to a vapor form. You could almost do it with water; but water doesn't hang there long enough." In choosing the fluid, Murray reminds that when you melt a liquid to a vapor by using heat, "At some point it cools back to a liquid, which is often all over your airplane."

By nature, oil is a slippery mess. The original purpose for what later came to be used as smoke oil, was a blend with liquid paraffin used by the concrete industry as a release agent; like Crisco on a cake pan, concrete molds were lined for a quick release after setting. Modern oils are refined specifically for aviation and despite the common ancestor, the rules are not set in concrete.

The basics are that smoke oil smokes, not burns. Smoke oils must produce the right size and color of particle, and be delivered at the proper rate and position for best effect, meaning good visibility and persistence (a long, lingering time). And ideally, with the least mess possible, no corrosion and no staining.

The air show fan sees a "thicker" or whiter smoke when the light refracts both within and through each particle of oil vapor that disperses from the airplane exhaust; the smallest particles make for the best refraction and drink the smallest amount of oil for the same persistence.

"When you take liquid smoke oil and turn it into vapor, it takes a whole lot more room and that takes the place of exhaust," says Dunbar. "Its volume expands by at least 50 times."

Some performers run a nozzle to spray oil into the stream of exhaust, but Murray welds as many as six tubes to inject directly into the highest-pressure portion of the pipe itself to yield the maximum expansion out of the tail end.

Steve Oliver uses the same oil for aerobatics and for skywriting, but—for the latter—gulps at least 1.5 gallons per minute rather than about .5 to 1 gallon for most aerobatic pilots (some Stearman barnstormers chug-a-lug two gallons per minute).



Michael Haberin



FILL 'ER UP

With long flight lines or a remote, secure hangar, Jim LeRoy is often a half-mile from the source of smoke oil. "Asking pilots to bring their aircraft to one location because the smoke oil is not mobile will waste everyone's time." LeRoy suggests that event organizers use a truck, or a trailer if the trailer can be moved quickly and with agility. Preferably, shows should fill needs the night before performance.

"Make sure that your smoke oil rig is set up with an acceptable hose. Many shows use a water hose and you can get away with this sometimes, but next year they try to use the same old hose, and — by this

time — the oil has eaten in and ruined the hose. Chunks can break off and flow into your smoke oil tank." LeRoy says to use hoses meant for oil and, even then, replace them as needed.

"Whether the smoke pump is manual, a battery pump or electric, it should be used for smoke oil only, or you end up with smoke oil in the engine oil or vice versa." If switched, the pump should at least be thoroughly purged: a process that requires time and money.

Performers should be present during any fueling or filling and typically specify this in their contract. LeRoy has had to confront crews because — as soon they thought he was out

of sight — the purged oil was poured back into the drum.

LeRoy says that each system should have a filter, because some oil contains rust or contaminants. "One time, I ended up with a bunch of oil absorbent in my tank (it looks like kitty litter); it took about 16 hours of labor to get everything out." He now carries his own paint filter for everything entering his system.

"The smoke oil truck should carry empty five-gallon buckets and lots of rags. Fittings should be tight and double-checked. Many times, I have seen the smoke oil truck make a complete mess because of leaks and this creates unnecessary work for volunteers and pilots as they clean the ramp and the planes." Finally, "Make sure you have enough hose, at least 20 feet. At about half the shows, we have to park the smoke rig ridiculously close because they skimp on the hose length."

Air show performer Ed Hamill fills his seven-gallon smoke oil tank with a fine, paraffinic machine oil that smokes for 10 minutes. "Typically, people just have a garden hose, clear vinyl tubing

of about 1.25 inch diameter. It works better with a nozzle at the end rather than using your thumb to pinch."

At arrival, Hamill fills once. "I bring my own 30-gallon tank from show to show and wheel it out on a cart. The show fills it in their standard way, then I

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use a quick disconnect fitting and reversible pump for my own hose and put the oil in as needed. Any supplier that sells approved plastic tanks is fine; I used Grainger. With the tank, pump and quick-disconnect fitting, I'm at about \$350 plus my mechanic's time. You help the show out by being lower maintenance, since we're set for the whole weekend."

Dennis Dunbar buys new tubes each year, and cleans all mechanical parts before storing until next season. "I would advise air shows to use an electric pump; if you're pushing airplanes out left and right or planes will fly more than once, with an electric it goes that much faster. We pre-position the smoke oil on pallets, then put each on a little forklift, then have two people dedicated to provide smoke oil for the entire show; they can drop the empty and put the pump back on again in five minutes."

Dunbar adds that shows should position a waste oil container so that performers can empty their excess oil before departing the site for the weekend.

JET TRAILS

While civilians slip for a good oil, jet teams have standardized



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to the extreme. The Blue Angels and Thunderbirds field questions about the environmental impact, but rarely about its type, which is explicit in military specifications. The Canadian Snowbirds smoke with Grade 2 Low Sulphur Road Diesel, even citing its flash point, density and viscosity, plus some folksy tips. "The less refined or 'dirtier' fuel, the better." Snowbirds cannot use the same mil-spec as the Angels or Thunderbirds; that formula is more heavy engine oil than diesel. Some individual jet demonstrations use a wingtip pod generator; for example, the Smokewinder product occupies the same center of gravity, gross weight and inertia as the Sidewinder missile. The system can run continuously for about seven minutes with 4.5 gallons of premium automotive gaso-

line plus 23 gallons of Canopus 13. The manufacturer adds, "Experimentation may show local oils available."

"An aerobatic routine, with tumbling in the smoke, gets the cockpit full of smoke and the pilots breathe it and can get nauseous."

For most military performers, the issue is not whether oil needs are met; they are, or the birds don't fly. The larger question is whether the bulk oil bought by organizers for such jets can fill the piston planes. In the overwhelming number of cases: No.

Charles Hutchins of Tora Tora puts it plainly. "An aerobatic routine, with tum-



Ty Rinninger

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bling in the smoke, gets the cockpit full of smoke and the pilots breathe it and some types can get you nauseous. We've looked at the material safety data sheets (MSDS) and they all say non-toxic, but there have been complaints. Like the jet teams, we only use trailing smoke, so we never breathe it in and it doesn't affect us. The guys who are breathing it for several minutes; they're concerned."

Ed Hamill refuses the mil-spec oil. "In small aerobatic planes, you can't get away from getting some smoke in the airplane through the vents; maneuvers where you fly back into the smoke. The jet team-type oil is a lot more toxic than the paraffin-base oils and besides, it doesn't show well or as white for a piston engine."

GETTING TESTY

At the U.S. National Aerobatic Championships in Texas, the chamber of commerce mixes up a frosty drink for the performers it calls "Smoke Oil," to serve at the Sunday night Smoke Oil Party. The formula is, of course, secret. Most performers quietly learn about "smoking" from the veterans and mentors, but rarely discuss methods and recipes. One of the only segments testing the status quo, and sharing tips widely, are the radio-controlled modelers. Active forums appear on the Internet; smoke oil formulas are published in High Flyer; and modelers speak at meets and clubs.

The number one modeler favorite is a 50:50 mix of diesel fuel plus concrete form release oil, i.e. the various brand names of Canopus 13, Unuius 15,

Sunoco 222, and Corbisol. Other small-scale fliers use a 50:50 mix of kerosene diesel with kerosene; some use diesel with automatic transmission fluid; some prefer all Exxon Mentor 28. Still others prefer a mix of lamp oil with 40 percent Havoline 5. Some have tried transformer cooling oil from the power plant (highly toxic) while others go the safe extreme and use lemon oil, peanut oil or citrus oil, which are sloppy but fragrant.

“The last thing you want to do is run out of smoke oil.”

Modelers discuss the “chunking” described by the big guys, caused by the corrosive petroleum. Their solutions include switching to non-corroding tubes such as neoprene, and avoiding petroleum-based oils. Modelers have built backyard labs to run smoke pumps, tubes, oil filters and, of course, the oil

itself, simply bolting the pump to a stand in a safe area, filling a Campbell’s Soup can with fluid and smoking away.

Like the full-size aircraft, technical problems include the proper oil flow (the amount of fluid from the pump to the muffler); the oil pressure (the back pressure from the nozzle installed on the muffler); the oil viscosity; the method of oil distribution in the muffler or the exhaust port; and the correct tailpipe temperature and vacuum.

The point is not whether these modelers’ tips will work safely and effectively in full-scale aircraft, but rather the spirit of discussion to build consensus. At least one of the big guys has adopted that spirit.

Like his modeller colleagues, Jim LeRoy has tested smoke on a stand. “We used a propane torch with some oil inside a cap just to see its properties. It smokes, then it bubbles, then

it fires and burns a black smoke and then it doesn’t want to go out.” The common EGT of about 1,200 degrees, above the flash point of oil, can burn if not managed properly. LeRoy warns that oil can pool from inverted maneuvers, so he may fly an oil-clearing pull-up.

Mike Goulian has tried the range for his CAP 232 and concluded, “The preferred oil is Canopus 13 or 519, by far the best.” However, “if Canopus is not available, other paraffin-based oils may be used.” To avoid carte blanche substitution, Goulian lists the specific acceptable alternates as Standard Oil Facto 39, Texaco Regal B, Sun Oil Circle X, Shell Carnea 10 or 22, Union Oil Unax 105, Gulf Oil 370, Arco Duro-S 105, and Exxon Faxam 40.

Ed Hamill asks for 42 gallons to cover the media day, practice day and two show days. His acceptable types are

Corvus, Exxon Mobil Tellux, Shell Pella, and, of course, Canopus 13. “We cannot use 1010, MIL-L-6081, or Fed stock #9150-00-231-6675 (the Thunderbirds standard).”

WHITE WASH

Steve Oliver doesn’t color the facts. “Jet teams can have colored smoke because it touches nothing while coming out of their tailpipe. We can’t use colored smoke; the substances that make the color are very corrosive. See someone who has wingtip smoke and look at their wings after a performance. And Skydivers with colored smoke will tell you that their underwear is pink!”

During the F-9F Panther era for the Blue Angels, the team tinkered with dyed fluid for the wingtip tanks. After painting fans, cars and laundry, the team stuck with white. Most non-U.S. teams kept experimenting; the Italian team is even named Il

Ty Rinninger



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Frecce Tricolori for its flag and three-color display of red, white and green.

Such color agents, whether a CO2-based product, a vaseline with dye, a magnesium powder or a petroleum jelly oil, typically require a very high exhaust gas temperature to properly vaporize and in any case, remain well behind the pilot. Most teams are to the point where such "smoke" dissipates before reaching fans, but not all.

The Turk Yildizlari (the Turkish Stars demonstration team, which flies the NF-5), brewed up 1,200 lbs of JP-4 or JP-8 jet fuel mixed with tint, but the red was not vivid enough. Their current mixture is a common house paint with automotive gasoline; 1:1 ratio for white and 1:2 for red. Though most Turkish shows are over remote fields, the ramp at the team's base in Konya and even the temporary fill points

are permanently stained.

Yet again, the model airplane crowd tested the waters, reporting best success in yellow and limited success in blue smoke. A prominent radio-control manufacturer sold the mixes several years back before pulling from the market both for high cost and safety. Some of the big guys have called colored smoke, "a black art," which if ever perfected for piston engines, will be a powerful and lucrative secret.

GOING TO EXCESS

Smoke oil is commonly sold in one-gallon jugs, four-gallon cases, five-gallon pails, then the big leap to 55-gallon drums. How much should an air show buy, and what if they buy too much?

Mike McCabe of AirSupport LLC tells his clients to get a handle on smoke requirements 90 days out, preferably 120 days. "I have heard of a number



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of shows trying to unload excess oil; that's fairly common. Or a show decides for whatever reason not to go forward. As long as it's in sealed barrels, it's fine. The opened containers can go rancid and absorb water."


Steve Oliver cautions that "Smoke oil is a paraffinic oil, not a mineral oil. It has no preservative quality. If a barrel is left open, the barrel will rust."

Though unopened smoke oil will in theory last for several seasons, Jim LeRoy has had a show cancel a practice day simply to avoid buying enough smoke. "Have a practice day anyway. It will make your show better and safer for your spectators." He also suggests that a show dedicate a crew just to smoke oil and reiterates his feelings on safe pumping. "A brand new water hose will work for one weekend, but why do that? We wouldn't do that for fuel; we would use the proper materials."

Dennis Dunbar calculates. "The performer contracts state

how much oil they will use and we take that number and add a 20 percent fudge factor. The last thing you want to do is run out of smoke oil. Last year, it was good we had extra because a show nearby didn't have enough and they called us up on Saturday, and one of our line guys drove the extra smoke oil over."

If Dunbar's show has remaining oil, "I'll just treat it as used oil; we treat smoke oil with the same care as fuel. Our smoke oil provider will buy [back] the excess, so I'm not going to have a barrel from last year sitting around." In case of a spill, "We'd treat it as a Hazmat situation. We would hate to feel responsible due to our negligence in cleaning or maintenance. These performers should be treated as superstars. The air show community is like family. The last thing you want is a performer to land because you tried to skimp on smoke oil." ✈



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