"WHO SAYS — BAD GAS?"

by **Harry Zeisloft**

The March 1986 issue of **Popular Science Magazine** carries an article titled "Bad Gas". A number of members have called expressing their concern about using such "bad gas" in their airplanes. Three basic points are claimed:

1. Vapor pressure has been rising for several years.
2. Alcohol added to gasoline damages fuel system parts.
3. Detergency of fuel is falling.

Our interest is in the aircraft use of **unleaded** autogas, and EAA has taken steps to assure prompt attention to any significant changes in auto gasoline sold. We monitor the ASTM auto and avgas specification subcommittee actions; we keep up to date on FAA Malfunction and Defect reports; and are on the distribution list for the American Petroleum Institute reports on autogas composition.

Of the three points raised in the **Popular Science** article only one continues to be of concern in the quality for aviation. That is the effect of methyl alcohol, or methanol, on both auto and aircraft fuel systems. Methanol is not compatible with the materials, metallic or non-metal, of parts in our aircraft fuel system.

Although a different (and more expensive) kind of alcohol, ethanol, is not as reactive with fuel system materials, the lack of real test data leads the EAA to recommend against the use in an aircraft of any fuel containing **any** type of alcohol.

As for the first point in **Popular Science** article — is volatility of autogas wildly out of control? Well, not hardly. In order to minimize the problem of vapor lock in automobiles at lowest cost, fuel pump capacities have been increased, requiring corresponding attention to the increased fuel temperature caused by the higher quantity of fuel recirculated. See Figure 1 showing volatility trends since 1979 (first data on unleaded autogas).

The article mentions the real solution (a more expensive solution at this time for car makers) which is to install the fuel pump in the fuel tank and push, not pull, the amount of required fuel to the engine.

The claim that the gasoline makers are being careless with volatility characteristics which would be indicated by increasing RVP values cannot be substantiated by the American Petroleum Industries biannual reports on gasoline on the market in the United States (see Reference 1).

EAA's STC approvals for unleaded autogas are based on fuel meeting ASTM D-439 specification (see Reference 2). While the API sponsored reports show that with very few exceptions, all gasoline sampled in the US meets this specification, the specification permits RVP values up to 15 psi (higher numbers mean more volatility; avgas is generally limited to 7 psi by the avgas manufacturers, even though they are not at present bound by the FAA to any specification requirement). Present levels average about 13 psi for automotive winter fuels.

Flight tests were conducted by the EAA and FAA at nearly 100 degrees F ambient temperature and with a specially compounded winter grade fuel of 15 psi, RVP to insure covering the most extreme conditions (see Reference 3). EAA test data was also taken with a special fuel of 16 psi RVP, one psi over specification. It was extremely difficult to combine a hot airplane and fuel system and the 16 RVP fuel. This fuel was so volatile that it was transported and held in a refrigerated truck at 40 degrees F until pumped into the test airplane . . . a condition not very likely to happen casually in the field.

And now the third point in the **Popular Science** article: The level of detergency is decreasing in the field? We have been told by oil company people that this is good . . . is bad. . . is indifferent. We believe that the real point here for aircraft engines is the likelihood of varnish or gum formation. EAA's considered opinion is that good quality autogas is no different than avgas in this regard. In fact, real life problems favor the autogas which is almost certain to be much fresher than the avgas pumped in your tank. High volume usage and handling almost automatically insures receiving fresh autogas. The fact that avgas, in such a small total market, gets shipped from the refinery (a year's supply might be made in a few days) storage tank to the distributor storage tank only twice a year doesn't fill one with confidence on its continued good quality when it finally reaches your tank.

Since many automobiles now utilize fuel injection detergent, additives to the gasoline have taken on more significance than the advertising point of "maintaining a cleaner carburator". With pintle type fuel injection nozzles and their sealing problems and very small metering areas any build up of varnish, lead, or dirt of any kind interferes with proper metering and or ease of starting. Detergent additives range in amounts of up to 30 parts per million in the gasoline. Water entrainment is not a factor at any practical level of concentration of detergents.

Beyond their properties of minimizing contaminant build ups (which many gasolines on the market do not need, and thus are sold without detergent additives), there are no detrimental affects for our aircraft fuel systems and engines.

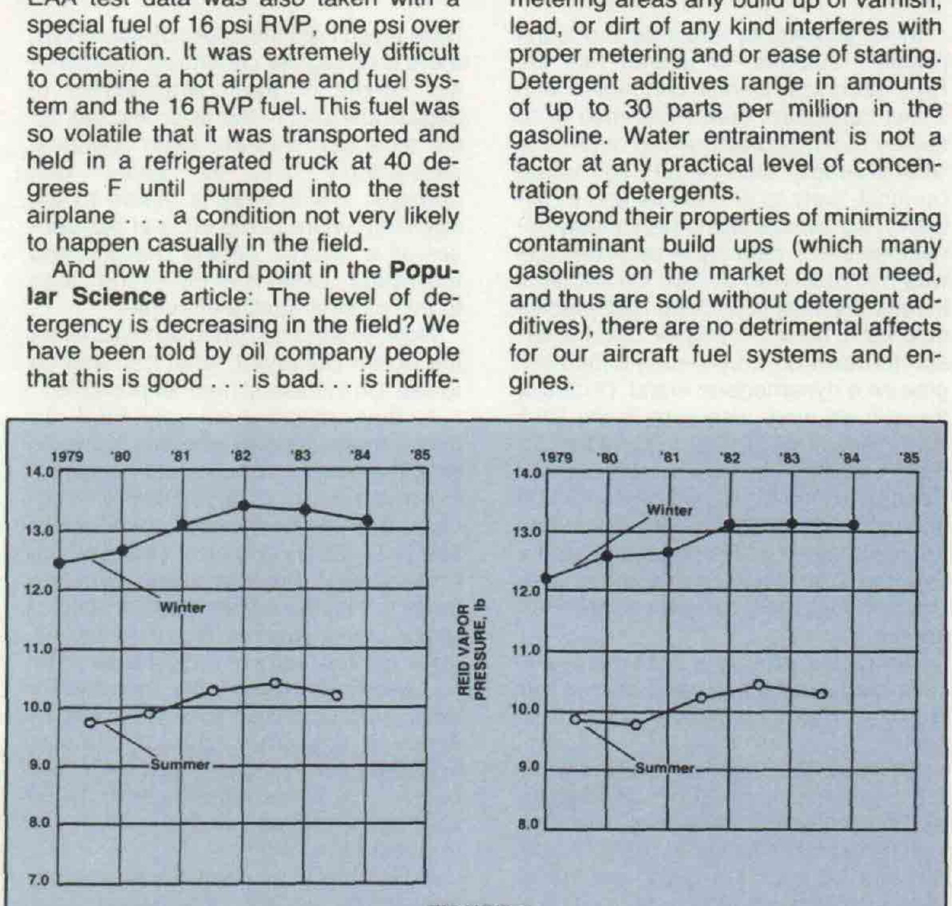

FIGURE 1

Volatility trends for unleaded autogas, indicated by RVP values measured. The ASTM D-439 spec permits 15 psi max for RVP. EAA tests used this fuel. Below 90 Anti Knock Index on the left, Premium, or above 90 AKI on the right. Source: Reference No. 1.

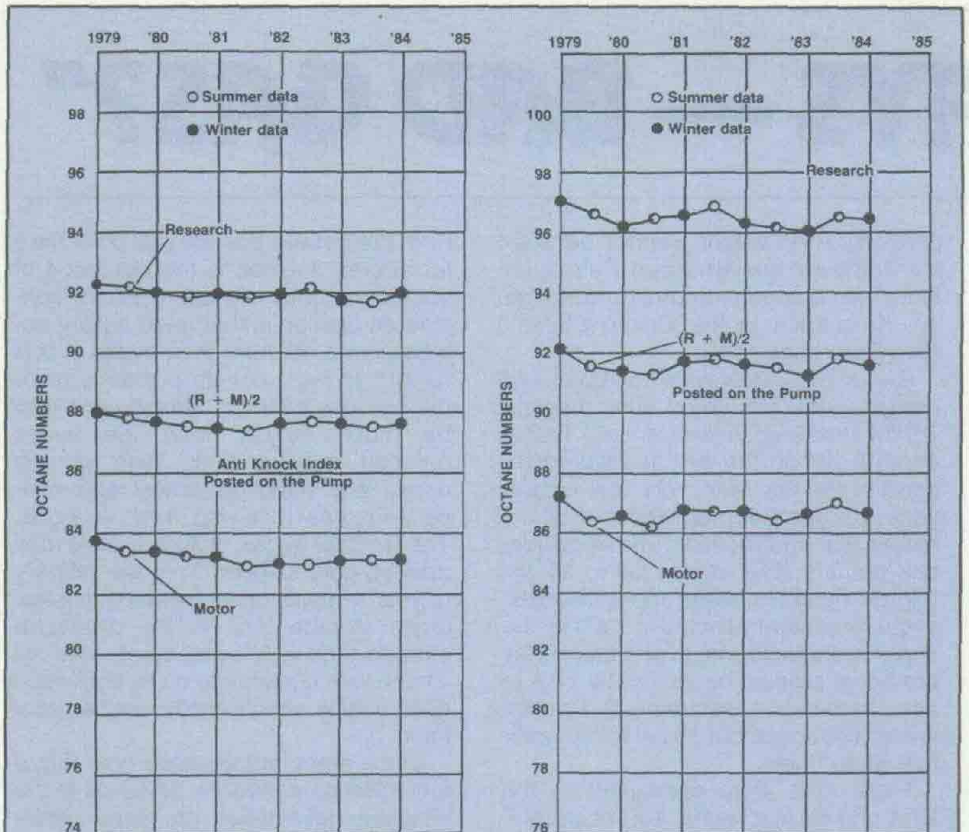

FIGURE 2

Octane number trends for autogas. Below 90 Anti Knock Index on the left, Premium or above 90 AKI on the right.

In an attempt to evaluate the worst possible autogas for aircraft use the FAA Technical Center contracted with a fuel consultant (see Reference 4) to survey fuel manufacturers to determine what characteristics of auto fuel would be most likely to prevent its use in aircraft. Two specifications were finally developed and a quantity of each test fuel was manufactured by Sun Oil and sent to the University of Michigan automotive laboratory under Professor Don Patterson for tests on a Lycoming O-320 engine on a dynamometer stand. Drums of these fuels were also sent to the EAA Flight Research Center in Oshkosh for flight testing in our instrumented Cessna 150 with a Continental O-200 engine. A full series of performance and functional testing was conducted and a vapor lock test was run at ambient temperatures up to 85 degrees F (see Reference 5).

Both engine test and flight tests demonstrated satisfactory performance with these oil industry defined worst case fuels!

So, what about airplane owners wanting to take care of 80 octane engines and fly safely with autogas — is it bad, getting worse? Decidedly not. It is safer for your 80 octane engine than 100LL avgas. We think that the major oil companies do a pretty good job, in spite of their obsessive fear of airplanes. After all, they have had **no specification requirement from the FAA** (such as you have if you hold the EAA autogas STC); there is no regular continuing independent survey of the characteristics of avgas now sold in the field; and yet, for the most part we have been operating satisfactorily over the years. But, perhaps, this is more a tribute to the forgiving nature of the 40 year old, conservative aircraft engine designs and fuel system designs of the aircraft, than to the pristine quality of avgas!

Now, to wind up, since autogas is not the horror portrayed, what can you do to use it in the safest manner possible?

1. Buy autogas from your FBO; or, from a major supplier who has his name on the product from oil well to dispensing pump; or, from a supplier who advises that his fuel meets specification ASTM D-439. Amoco and Conoco both have advised that their fuel is manufactured to meet this specification. Also, a major brand supplier who bills the retailer on the basis of gasoline pumped has effectively removed the incentive for adding unauthorized "extenders" like alcohol or any other "cheap" burnable fluid. Be extra cautious if you carry your own — it is hazardous to use 5 gallon cans and exposes you to a greater risk from contamination.

2. Do not use gasohol or any gasoline containing alcohol. Encourage your state to require and enforce posting this information on the pump. If you suspect the presence of alcohol and want a very simple method of testing for its presence refer to the EAA Field Information Report, No. 8501.

After comprehensive surveys of FAA Malfunction and Defect reports, (Reference 6) FAA fuel related accident reports, (Reference 7) NTSB (Reference 8) fuel related accident tab runs, we conclude that most fuel related accidents are caused by running out of fuel or having the fuel selector on an empty tank; or by contamination, primarily water.

3. When your airplane is going to be unused for 3 months or more, follow the manufacturers' instructions for preparing for storage, whether you use avgas or autogas. Follow the manufacturers' instructions for starting up again after storage and fill up on fresh fuel, whatever it is you're using. Remember, when the manufacturer made these recommendations, they applied to AVGAS!

4. Vapor lock has occurred in airplanes even with low volatility avgas. Use caution when operating in very high ambient temperature, using either avgas or autogas. Autogas will almost always be higher in volatility than avgas, which is why each test airplane flown was tested at high ambient temperature (summer) with high volatility (winter grade) fuel for FAA approval even though this testing was not required to meet the FARs.

The total number of aircraft legally using autogas has grown from the first Cessna 150 certificated in 1982 to more than 23,000 at present.

For general information and field operating information on fueling and operating with autogas under the EAA STC approvals contact: EAA-STC, Wittman Airfield, Oshkosh, WI 54903-3065.

References

1. Motor Gasolines, Winter 1984-5 by Ella Mae Shelton and Cheryl L. Dickson, National Institute for Petroleum and Energy Research, P.O. Box 218, Bartlesville, Oklahoma 74005

2. Annual Book of ASTM Standards, Part 23 (ASTM D-439 - Standard Specification for Automotive Gasolines and ASTM D-910 - Standard Specification for Aviation Gasolines) American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103

3. EAA Autogas Flight Test Report No. AFR 84-13, PA-28-140, EAA Flight Research Center, Wittman Airfield, Oshkosh, Wisconsin 54903-3065

4. Letter Report M. Remondino to Professor Patterson, University of Michigan.

5. EAA Autogas Flight Test Report No. AFR 83-3, Special Blend Autogas, University of Michigan P.O. RO 1506

6. Malfunction and Defect Report on the TCM O200 engine, from FAA records. Source: AOPA, Oklahoma City, Oklahoma

7. Office of Aviation Safety, FAA National Headquarters, 800 Independence Ave. SW, Washington, DC 20591

8. National Transportation Safety Board. Data on fuel related accidents. NTSB, Washington, DC