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- The Need For Leaded Avgas -

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Availability Declining Worldwide

Normal, controlled combustion in a Spark-Ignition (SI) engine begins at the spark plug and progresses throughout the combustion chamber as a moving flame front, having a modest velocity of approximately 25 meters per second.

Detonation is defined as the instantaneous, explosive combustion of the entire air-fuel charge in a cylinder as the result of the high temperature in the chamber. Detonation causes a huge spike in combustion chamber pressure and temperature, and can destroy engine parts in a matter of milliseconds.

The detonation resistance of a given fuel is measured by comparing its detonation propensity to that of pure iso-octane (technically, 2,2,4 trimethylpentane). A fuel having 90% of the resistance to detonation of pure iso-octane is rated as "90-octane fuel".

Tetraethyl Lead (TEL) was discovered prior to World War 2 as an additive for gasoline which would provide a substantial increase in the resistance of the fuel to detonate in the combustion chambers aircraft engines. It was this discovery which made possible the economic production high-octane fuel (as high as 145 octane), which made possible the high specific-output of the piston engines in WW-2 aircraft. Prior to that discovery, the high-performance and highly supercharged engines required for effective aircraft performance at high-altitudes, had been essentially unavailable because of detonation limitations.

After the war, the use of TEL quickly spread to automotive fuels, which paved the way to the high-compression, high (in those days) output car engines of the mid-50's and onward.

Several years ago, the Environmental Protection Agency (EPA) legislation mandated the removal of Tetraethyl Lead (TEL) from all gasoline. The EPA granted a special-case reprieve for *leaded aviation fuel* as long as there is continued progress toward a suitable alternative.

Any TEL-alternative must, by definition, be less-toxic than the TEL it replaces. That has been a problem with proposed replacement additives such as certain Aromatics and Methyl Tertiary Butyl Ether (MTBE). Currently, there is no suitable replacement.

The piston engines used on most existing GA aircraft were certified for, and depend on, a diet of high-octane leaded fuel. This *"Avgas"* is known as "100-Low-Lead" or “100-LL”. It is interesting to note that "100-Low-Lead" actually contains more than FOUR TIMES the lead which was in Sunoco-260, one of the highest-octane fuels ever produced for street-use automobiles.

Without high-octane *Avgas*, most existing aircraft engines will have to be de-rated from their currently-certified power levels in order to maintain the FAA-required detonation margins. The resulting significant loss of power will reduce the payload of many existing GA aircraft so as to severely limit their usefulness. That is especially true of cropduster and bush-service aircraft.

Further, the exhaust valve seat wear and erosion problems that occurred when automotive engines switched off leaded fuel will need to be solved for the existing crop of aircraft engines.

Here are some of the factors which are making the demise of 100-LL increasingly likely, regardless of the EPA reprieve:

1. There is now only one factory in the world which produces TEL;
2. Although there are several hundred gasoline refineries in operation, there is only a very small number which produce 100-LL;
3. A production run of 100-LL (in the USA) requires a subsequent purge of the refinery (very costly) before resuming production of unleaded motor fuel;
4. The leaded avgas requires (in the USA) completely separate transportation and storage facilities;
5. The volume of avgas production represents an extremely small portion (less than 1%) of the gasoline marketplace.

Those, and other factors have already caused significant price increases for 100-LL. Mid-2007 prices

for avgas in Europe hover around $8 per gallon, and domestically, it is not uncommon to find prices around $5 per gallon. **There are now places in the world where 100-LL is not available at any price.**

Those increasing prices will result in declining usage, leading to further reductions in capacity, leading to yet-higher prices (the classical "supply and demand curve"). The likely result is that, eventually, oil companies will not view Avgas as a viable product. At that point, there better be retrofittable engines which can operate well on unleaded gasoline, or better yet, the fuel which is emerging as the "universal aviation fuel" Jet-A.

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