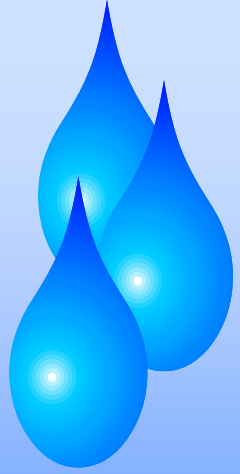
Ban of AVGAS 100LL

Lars H. Hjelmberg

2003



AVGAS 100 LL

A specialty product.

In volume
< 0.5 % of automotive gasoline
or
< 1/4 of automotive gasoline system evaporation

AVGAS 100 LL

Typical formula

- Alkylate ~ 70 %
- Isopentane ~ 15 %
- Toluene ~ 15 %
- Lead
- Dyes
- Scavenger
- Antioxidant

} additives

AVGAS 100 LL PRODUCERS CONCERN

Year 2000-2002 major consumers of leaded automotive gasoline, such as England, India, China, parts of South America

and others

have shifted to unleaded automotive gasoline

AVGAS 100 LL PRODUCERS CONCERN

Leaded automotive gasoline phaseout

(already done in 65+ countries)

Australia 2002, Bulgaria 2005, Czech R. 2003, Greece 2004, Indonesia 2003, Italy 2003,

Peru 2005, Poland 2003-2005, Portugal 2004, South Africa 2006, Spain 2004,

Venezuela On 20-year phasedown.

AVGAS 100 LL PRODUCERS CONCERN

The scavenger (lead-remover) = dibromoethane.

An ozone layer depleting substance.

Highly carcinogenic.

Listed in the Montreal protocol (1987)

= agreement exists to remove from use.

AVGAS 100 LL PRODUCERS CONCERN

Availability of tetraethyllead (TEL).

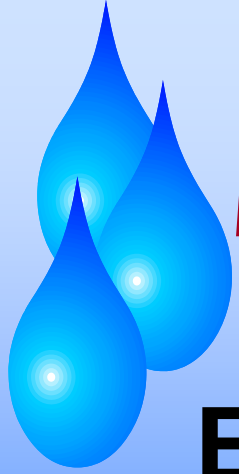
TEL-producers say:

TEL worldwide available

- until year 2002

- fairly certain 2003-2005

- no guarantees > 2005



AVGAS 100 LL PRODUCERS CONCERN

Environmental agencies around the world demand the elimination of

AVGAS 100 LL,

and

before any general replacement of unleaded

100/130 octane Avgas is available!

AVGAS 100 LL PRODUCERS CONCERN

Political
Environmental
Economical

} A leaded product in a lead-free system

ISO-certified operators in

- shipping
- pipelines/seaport
- storage
- distribution

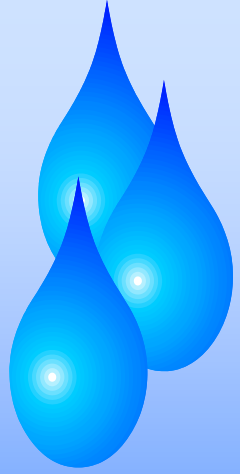
= expensive - high cost product

AVGAS 100 LL PRODUCERS CONCERN

AVGAS 100 LL conclusion:

Dead product

No future



BAN OF AVGAS 100 LL

~ 30 % of the piston engine powered aircraft fleet is certified for 100/130 octane and consumes ~70 % of all AVGAS

but

there is no general replacement fuel available today for these engines certified and required to use 100/130 octane.

BAN OF AVGAS 100 LL

~ 70 % of the 100 LL fleet can use approved substitutes such as

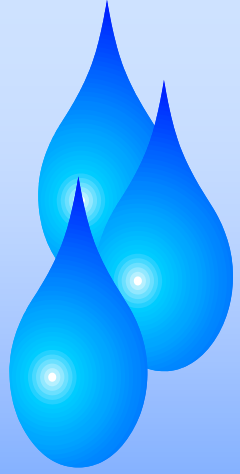
AVGAS 91/96 UL

AVGAS 80/87 UL

AVGAS 82 UL

automotive gasoline

but consumes only ~ 30 % of the total AVGAS market



BAN OF AVGAS 100 LL

Unleaded certified replacements available today:

91/96 UL for all 91/96 and 80/87 octane engines

80/87 UL for all 80/87 octane engines

82 UL for certain 80/87 octane engines

Nothing for 100/130 octane engines

Automobile gasoline for certain 80/87 and 91/96 octane engines

BAN OF AVGAS 100 LL

Unleaded certified replacement available today:

Unleaded AVGAS 91/96 in use in Sweden since 1990

Extensive use at ~ 65 airports

Experience:

Engines meet TBO with less problems.

An environmentally sound product!

BAN OF AVGAS 100 LL

Current fuel-research in 100/130 octane replacement:

Fuels based on

- ethanol (15-100 %)

- ethers (10-95 %)

- amines (1-10 %)

BAN OF AVGAS 100 LL

Currently most promising

100/130 octane replacement candidates:

Ether from ethanol (ETBE)

+ hydrocarbon gas

or

Amines + ether from methanol/ethanol

(MTBE/ETBE) + alkylate

BAN OF AVGAS 100 LL

Components in possible future

AVGAS 100 UL

Amines
- **toxicity**
- **freezing point**
- **stability**
- **solubility**
- **price**
- **?**

BAN OF AVGAS 100 LL

Components in possible future AVGAS 100 UL

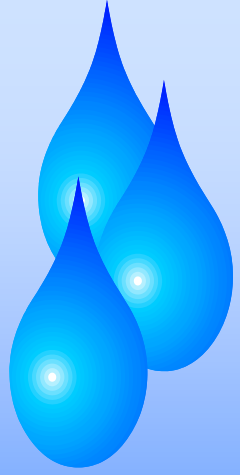
ETBE/MTBE - ground water contamination

Half-life of pure hydrocarbons ~ 10-14 hours

→ eliminated in ~ 20 years

Half-life of ETBE/MTBE ~ 2 years

→ eliminated in ~ 1000 years



BAN OF AVGAS 100 LL

100/130 octane

candidate replacement fuels

still 3-5 years from certification

and

some are of environmental concern

BAN OF AVGAS 100 LL

New Technology

General Aviation Modifications Inc. (GAMI) is in FAA certification of its PRISM Ignition System.

- **Uses fiber optic based pressure transducers to measure internal combustion pressures in real time.**
- **This unique technology allows the system to fully control peak cylinder combustion pressures and eliminate any tendency to detonate or pre-ignite.**

BAN OF AVGAS 100 LL

New Technology

- In March, 2002, observed by AOPA U/S staff, GAMI´s PRISM system succesfully operated a Lycoming TI0-540J2BD (Piper 31 – Chieftain) turbocharged 350 HP engine :

  - on unleaded HJELMCO OIL AVGAS 91/96 UL

  - at rated power (350 HP);

  - with the CHTs at redline (500° F);

  - at maximum induction air temperature

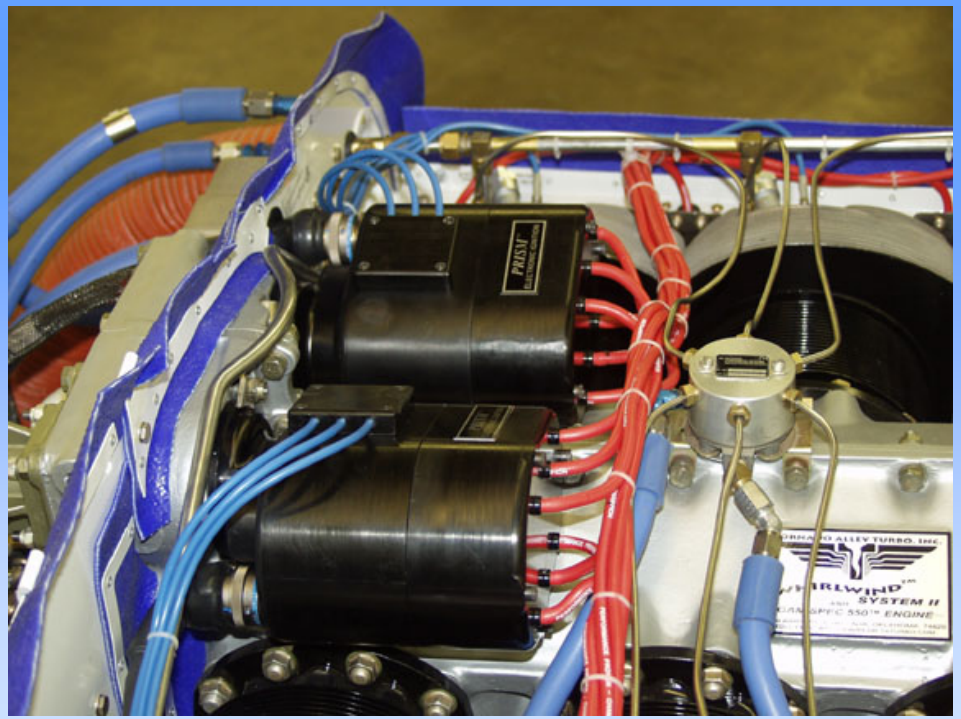
  - free of harmful detonation or pre-ignition

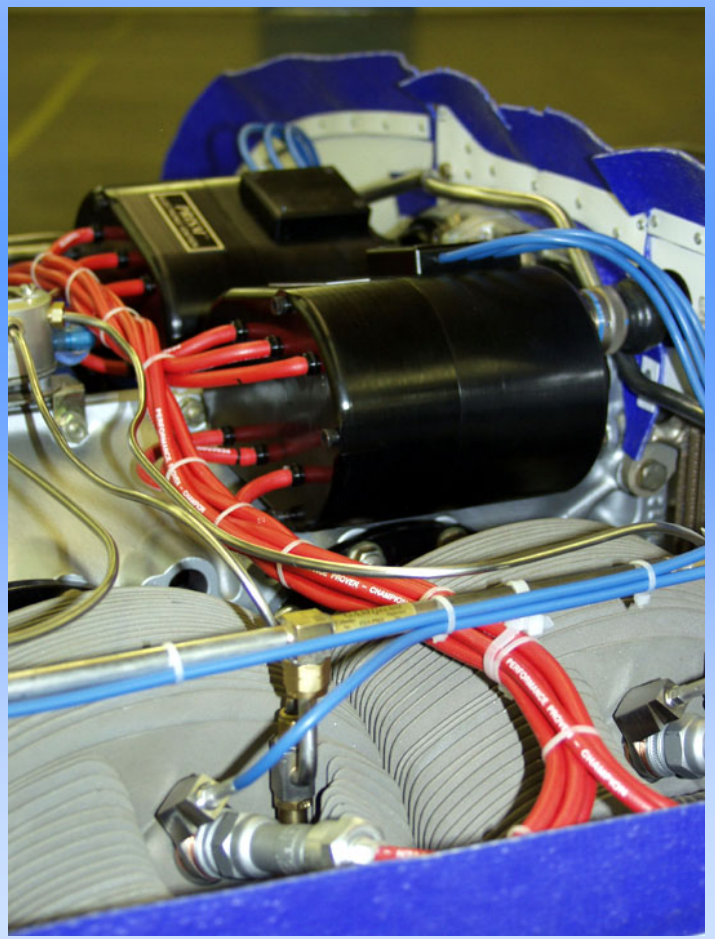
- This is a major milestone - as it demonstrates a known path to guarantee that even the most difficult general aviation piston engines can continue to fly when 100LL is no longer available.

BAN OF AVGAS 100 LL

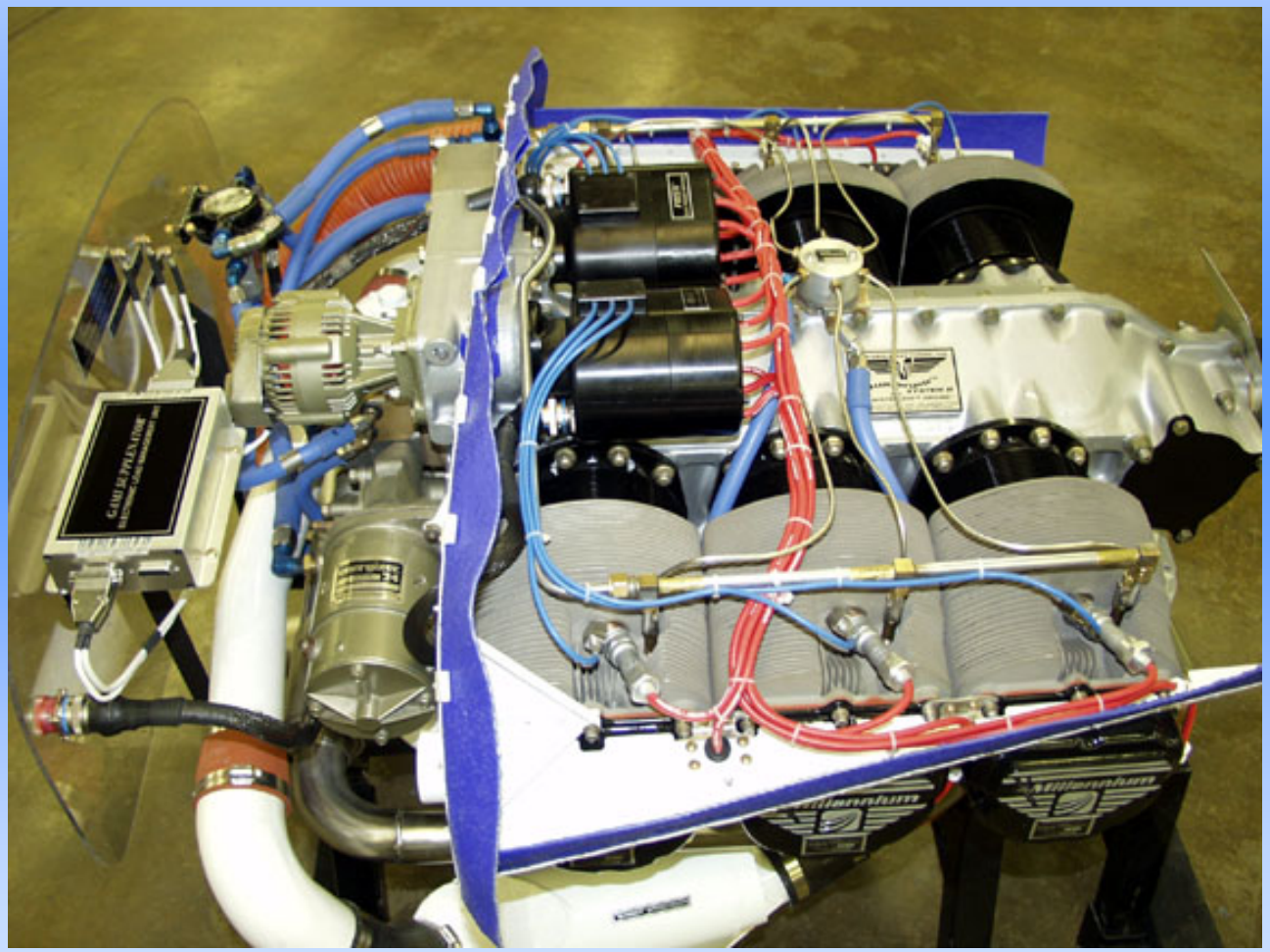
New Technology

GAMI´s PRISM System:





BAN OF AVGAS 100 LL



AN EASY REPLACEMENT FOR EXISTING MAGNETOS

BAN OF AVGAS 100 LL

Competition between fuels and new engine technology

Unleaded AVGAS 91/96 UL assumed ~ 20-50 % cheaper to produce than ether/amine fuels

BAN OF AVGAS 100 LL

Competition between fuels and new engine technology

Twin-engine aircraft

(turbo-charged 100 LL engines)

Assume an AVGAS price of US$ 0:50/liter

Amine/ether fuel alternative= ~+ 20 %=

130 liter/h x US$ 0:10 =US$ 13:00/hour

New engine technology =~ US$ 25.000:-

Break-even at ~ 2000 hours

BAN OF AVGAS 100 LL

Competition between fuels and new engine technology

Single-engine

(100 LL normally aspirated)

Assume an AVGAS price of US$ 0:50/liter

Amine/ether fuel alternative= ~+ 20 %=

50 liter/h x US$ 0:10 =US$ 5:00/hour

New engine technology =~ US$ 4.000:-

Break-even at ~ 800 hours

BAN OF AVGAS 100 LL

Competition between fuels and new engine technology

Assume 200.000 a/c worldwide

Each a/c flies 100 hours/year

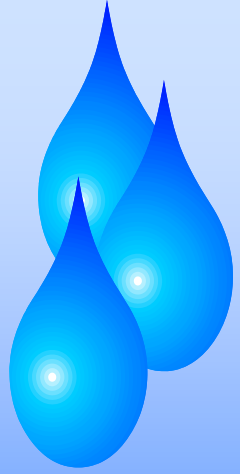
No engine investments for Avgas 80 + 91 engines

Assume an AVGAS price of US$ 0:50/liter

Amine/Ether fuel alternative= ~+ 20 %=

35 liter/hour x 200.000 x 100 x 0:10US$=

A/C owners save US$ 70 mil. annually



BAN OF AVGAS 100 LL

Competition between fuels and new engine technology

Unleaded AVGAS 91/96 UL

Existing, certified fuel

Extensive > 12 years flight-experience

Approved by Lycoming 1995

BAN OF AVGAS 100 LL

Competition between

fuels and new engine technology

Unleaded AVGAS 91/96 UL

Pure hydrocarbon fuel

Made from current

low-cost, environmentally sound

aviation gasoline components

BAN OF AVGAS 100 LL

Competition between

fuels and new engine technology

What

will be the choice of the market

?

Ban of AVGAS 100LL

HJELMCO OIL AB

Lars H. Hjelmberg