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# GETTING THE LEAD OUT

*Once hailed as a key ingredient in premium gasoline,  
lead is all but disappearing . . . but not without causing problems*

by John Hamilton

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One day in the early 1920s, an assistant to the well-known inventor, Charles F. Kettering, made a discovery that changed the automotive industry.

He found that a solution of tetraethyl lead in gasoline was a miraculous anti-knock agent. "Ethyl," or leaded gasoline, was born.

Detroit needed a cure for engine knocking because consumers were starting to demand higher compression ratio, higher performance engines, and some gasolines were burning irregularly (knocking) in those engines. Events moved swiftly. A process was developed to produce the fluid in commercial quantity. Another chemical to "scavenge" undesirable lead oxide deposits from valves and cylinders was found and added to the mixture.

With a partner, General Motors formed the Ethyl Gasoline Corporation to market the final lead additive. The Surgeon General considered public health questions based on contemporary knowledge and gave lead his okay.

By 1929, most oil companies, including Chevron, were selling gasolines with the ethyl lead additive. Detroit was now free to increase engine compression ratios even more, and did so. The benefits of the additive proved so great that decades later, one historian of the petroleum industry wrote: "The discovery and commercialization of tetraethyl lead as an anti-knock agent was undoubtedly one of the most remarkable innovations of the 20th century."

The first lead limit set by the government back in the 1920s was about 3 grams a gallon. That was later increased to 4 grams a gallon, although Chevron motor gasoline specifications never permitted more than the original three.

Now, more than half a century later, leaded gasoline is on the way out — by

order of the Environmental Protection Agency (EPA). In January 1985, the permissible limit was down to an average of 1.1 grams a leaded gallon (0.8 grams in California). At that point, on health and other grounds, the EPA ordered the limit slashed to 0.5 grams a gallon by July 1, and further to 0.1 grams a gallon on January 1, 1986 — a total reduction of 91 percent in a year.

With the possibility of a total ban by 1988, consumers are asking what it means to them. What will happen to older engines designed for leaded fuel? Will gasoline prices go up? Will there be shortages? At the same time, refiners are facing the problem of maintaining octane levels (which measure the resistance of gasoline to knocking) while lowering lead content. Technically this can be done, but not without repercussions economically.

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## ***The EPA's action has been controversial and misunderstood.***

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The EPA's action has been controversial and misunderstood. There was, to begin with, discussion of the EPA's motives for reducing the lead content of gasoline. Although agency officials cited studies suggesting that the IQs of children are adversely affected by exposure to very low lead levels, the agency also was trying to discourage automobile "misfueling" by making leaded gasoline at least as expensive as unleaded.

Undoubtedly, misfueling is a problem. It had been expected that leaded gasoline gradually would disappear because of the unleaded fuel requirements of cars manufactured since 1973. But by filling up with cheaper leaded gasoline, significant numbers of new car owners — as many as 17 percent of all "unleaded" vehicles are using leaded — have been perpetuat-

ing the demand for leaded gasoline.

After two or three fill-ups of leaded gasoline into an engine designed for unleaded, misfueling poisons the catalytic converter, causing more emissions than allowed under the Clean Air Act. Alarmed by the situation, the EPA decided it had to act.

Lead phase-down attacks the misfueling problem by eliminating price incentives. To continue to meet octane requirements at the lower lead level, leaded regular gasoline will have to be made up of slightly higher quality components than unleaded regular, which will increase the cost.

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## ***Doing without lead in gasoline is not going to be simple or painless.***

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All the controversy has made one point clear: Doing without lead in gasoline is not going to be simple or painless. On the contrary, there will be a significant impact on both consumers and the petroleum industry.

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## ***Will unleaded gasoline damage engines?***

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The phasing-out of lead in gasoline is causing anxiety for owners of certain older model cars (generally pre-1973), trucks, motorcycles, farm equipment, boats and even lawn mowers. They've heard that certain engines, designed to thrive on leaded gasoline, won't run properly — or at all — on unleaded.

In particular, it's often claimed that the older engines need lead to prevent excessive exhaust valve seat wear when operated continuously at high speeds. While excessive valve seat wear has been caused with unleaded gasoline under severe laboratory conditions, the results of these tests are not necessarily relevant to the fleets of the same cars and trucks that have been

run on unleaded gasoline for years with no problems.

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In fact, taking the lead out shouldn't cause serious problems, according to Chevron researchers. It's all right to use unleaded gasoline in all typical passenger car engines, light-duty truck engines, antique car engines and most two stroke cycle engines — in short, in the overwhelming majority of engines in all categories. To clarify the situation and reassure customers, Chevron U.S.A.'s Marketing Department has published a Technical Bulletin (No. 17) giving detailed information on the use of unleaded gasoline in all types of engines. (Readers who would like to receive a copy may write to Chevron U.S.A., Product Commercialization/Technical Services, P.O. Box 7006, San Francisco, CA 94120.)

For the very few heavy duty, marine and industrial gasoline engines without valve seat inserts, the bulletin advises owners to avoid "full throttle operation for extended periods," or as a last measure, to install hardened valve seat inserts and special valves. Also, the paper briefly discusses V-4 and V-6 outboard engines of one manufacturer.

"Some dealers and repair shops have been telling customers they'd better keep using leaded gasoline or their engine valves will suffer damage," reports the technical bulletin's author, John Skellchock. "The news media have not been very helpful — they've been picking up this misconception and perpetuating it."

He acknowledges that valves in some older cars theoretically could be damaged by extremely hard service. However, that's been observed almost exclusively in laboratories where damage was deliberately induced. "If

people are worried, all they have to do is take it easy — avoid hauling trailers up mountains at high speeds, for example," he adds.

The bulletin's conclusions are backed not only by Chevron's 15 years of experience in marketing unleaded gasoline, but also by a Chevron Research Company survey of technical literature and of fleet operators, engine rebuilders and manufacturers.

Lew Gibbs, the fuels research engineer who directed the survey, says it focused in part on the favorable experience of truck fleet operators who switched to unleaded gasoline because their new vehicles required it and they couldn't store two grades of gasoline.

Unfortunately, no equivalent fleets were found to provide similar data on the use of unleaded gasoline in four stroke cycle marine engines. This was disappointing to Gibbs, because spokesmen for marine industry groups have been insisting publicly that these marine engines need lead as a valve lubricant even if they have hardened valve seats. "Well, they have no data either, and personally I don't think it will be a problem for most boaters," says Gibbs, who has talked to some of these critics. "For those who do think they have a problem, the remedy is to go to hard valve seat inserts and valves, as discussed in the Chevron technical bulletin."

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**Will the cost of gasoline go up?**

Another problem facing both consumers and the industry is the higher cost of making gasoline. "Lead phase-down will increase the average cost of making all grades of gasoline by up to 3 cents a gallon, or about \$3 billion annually," says George Nanche of Chevron's Economics Department.

Whether conditions will permit these costs to be passed through to consumers remains to be seen. Certainly, the EPA acted at an unfavorable time for refiners, who are struggling with a combination of low oil demand, low-to-negative profit margins and fierce price competition. If costs can't be passed through, additional business pressures could drive some refiners to the wall (111 U.S. refineries have

closed since the beginning of 1981).

Basically, costs will be higher because of a sequence of historical events. Over the years, engine compression and octane requirements increased beyond the ability of lead alone to prevent "pings," so higher octane was provided through additional processing. Now the lead is being taken away, so the higher octane level will have to be provided entirely through processing, which will increase the expense.

Assuming some construction of new facilities, the oil industry will be able to maintain octane levels. There is no technical obstacle. As Larry Shanks, Planning Coordinator for Chevron U.S.A.'s Manufacturing Department, puts it, "It's just a matter of economics — for a price you can do almost anything."

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The potential for higher costs becomes clear once it's understood that, after lead, the most economic way to increase octane is up to eight times as expensive. This is through additional "catalytic reforming," a modern refining process. To achieve required octane levels, however, it's often necessary to run reforming units more "severely" (at higher temperatures and stopping to regenerate catalysts more frequently).

More attractive for some refiners is the approach of using MTBE (an ether) or one of the other oxygenates as a replacement for an anti-knock additive. MTBE production capacity is limited, however, and there won't be enough to go around. Ethanol is available, but is more costly, apart from tax considerations. Additionally, ethanol is sensitive to water and separates from gasoline if



contacted by water.

Another high octane blending component — toluene — is available from refiners with surplus octane capacity, but tends to be priced at a premium because of its other uses as a petrochemical building block. There also are a variety of modifications and additions that can be made to refineries to increase the supply of high-octane gasoline components. New construction is a costly approach, however, and Chevron hopes to avoid building new facilities by relying on other strategies tailored for each refinery.

In general, retail gasoline prices will be governed by supply. "If supplies remain adequate, prices won't increase significantly," Nanche says. "If supplies tighten, the price of gasoline could go up some." However, he points out that, in the long run, lower demand for

gasoline should ease supply pressures, resulting in moderate prices. Last year, the U.S. consumed 6.7 million barrels of the fuel a day. Chevron predicts that in the year 2000, gasoline consumption will be only 6 million barrels a day.

No one really knows how consumers will react after the lead phase-down is implemented.

It could result in the appearance of an intermediate-octane level unleaded as the third grade at the pump block in place of leaded, Nanche says, adding: "A grade of gasoline becomes vulnerable when its market share drops below 15 percent. Current projections show leaded gasoline's share of the market falling to 10 percent around 1990."

#### Will there be gasoline shortages?

Industry trade publications such as the *Oil & Gas Journal* have warned of

possible shortages in 1986, or least an "octane shortfall" leading to higher prices for premium unleaded gasoline.

Chevron, however, predicts no shortages for its customers, and the American Petroleum Association (API) expects that the industry will escape shortages as well. The area most likely to feel a supply pinch is the Rocky Mountain states, where there is an above-average demand for leaded gasoline and few refineries. But last July 1, the region met the first phase-down deadline without difficulty.

Ultimately, lead phase-down may be remembered not for engine troubles or price increases or shortages, but as another policy that served to increase U.S. oil imports (by forcing refiners to maintain octane with more energy-intensive methods). In Chevron's case, if the company holds to its present mix

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of light products (gasoline, jet fuel, kerosene), lead phase-down will increase the company's consumption of crude oil by about 1.5 percent, says Shanks.

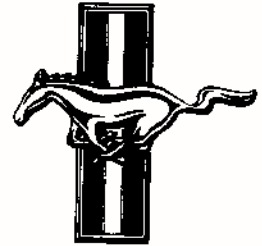
For the country as a whole, the API estimates that increasing octane without lead will boost oil consumption (and imports) by at least 100,000 barrels a day. Quoting that figure, *Barron's* suggested that the EPA was "OPEC's best friend."

While some may consider the EPA politically vulnerable on that score, the agency gets good marks from Chevron for one bit of regulatory flexibility — a system of "lead banking rights" that will help refiners meet lead phase-down deadlines. Under this system,

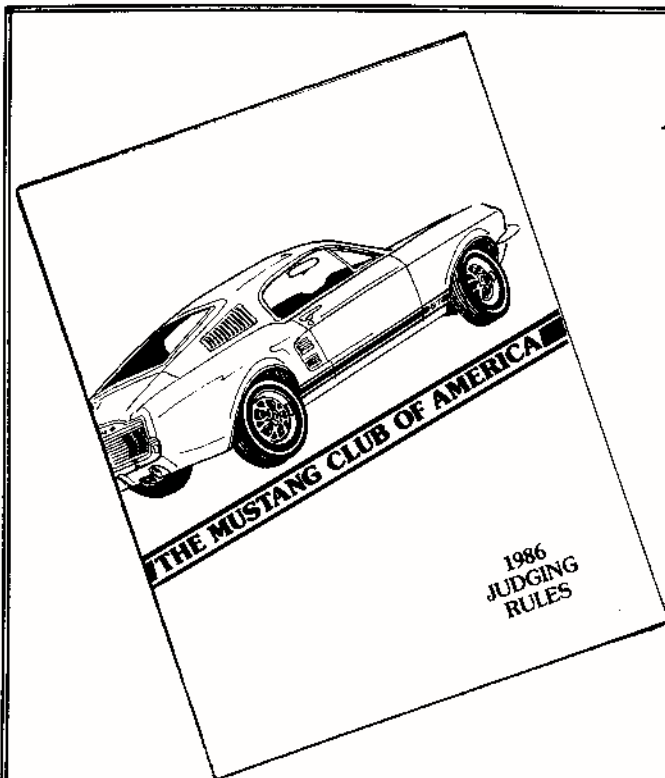
Chevron is earning credits this year by holding the lead content of its gasoline below permitted maximums at most of its refineries.

Next January, these credits may be "spent" to permit the manufacture of leaded gasoline containing more than the allowed 0.1 grams a gallon. On January 1, 1988, all unused credits become worthless, so at that time the industry actually will go to 0.1 grams a gallon.

"The lead banking system allows us to find the most economic solutions and avoid hasty, wasteful decisions," said Shanks. "Thanks to their approach, we see our transition as being as smooth and efficient as possible — costly maybe, but smooth."



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