

Another view of automotive emissions control

Your feature article, "Controlling Automotive Emissions," by the writers from the Ford Research Laboratory, gives some idea of why the U.S. auto industry has lost so much market share to Japan. The article deals with history (the three-way catalytic converter introduced by Volvo), not the future benefits that can come from a better understanding of the physics of combustion.

A small glimpse into the future can be had from an article in *Cycle World*, February 1995, on AR (active radical) combustion, "Honda EXP-2, New Wave Combustion." This is the practical result of many years of research based on writings about radical initiated combustion by N. N. Semenov, the Russian Nobel laureate. A follow-up technical article, SAE 960742 (Society of Automotive Engineers), was scheduled for the SAE Congress in February 1996.

Our own Sonex combustion system work involves applying the underlying fundamentals of AR combustion (ARC) to not only two-stroke engines but also four-stroke spark-ignited (SI) and direct-injected (DI) engines. We came upon the origin of ARC in the SAE literature thanks to an introduction by Dr. Ben Shaefer, Director of Research, Mercury Marine, to the original Japanese work, active thermo atmosphere combustion, and TS combustion (Toyota-Soken). After reading those papers we realized that our research was closely related to theirs and ultimately to the radical ignition process described by Semenov. We found we could run SI engines, either two- or four-stroke of our special design, with no spark, once started with a spark. They had remarkable cycle-to-cycle stability, significantly lower emissions and low fuel consumption. Moreover, with our pistons this was possible with any combustible.

In 1994 we published an SAE paper demonstrating that this process could be explained by detailed kinetic calculations,

that is, we showed how radical or intermediate chemical species are retained from one engine cycle to the next (in "frozen" chemical equilibrium) allowing stable, repeatable autoignition to occur.

Using this principle we designed diesel-fueled SI two-stroke carbureted engines,

possible due to the joint development program announced by AE Goetze, (Bradford, U.K.) in December 1994. Tests of Sonex diesel pistons at several of the world's major engine producers have shown major reduction in soot (> 40%) at little or no fuel consumption penalty.

AR combustion is only a tiny corner of this "new ballpark" that has been in the technical literature for more than 100 years and finally is making its way to engine technology. Too bad the first commercial use will not be in the United States!

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Authors reply

Mr. Pouring's letter addresses potential new combustion technologies for emission reduction and does not specifically address the subject of our article. The purpose of

our brief article was not to discuss and compare various potential technologies for emission control; our purpose was to acquaint the readers with the main technology presently employed (and expected to be employed in the next several years), and to discuss some of the challenges this technology faces with respect to the new emissions requirements. We did not intend to imply that this is the only technology under consideration for future systems. Many companies, including Ford, are developing and evaluating new technologies, including the one that Mr. Pouring advocates in his letter. As these technologies develop, they may become the technologies of choice at some time in the future. We do not see this forum as the place to debate the merits or shortcomings of the complex set of possible technologies for emissions control or of the particular technology that Mr. Pouring is advocating.

However, we do want to correct Mr.



now under test by the U.S. Navy, that start and run on diesel fuel or JP8. These engines retain spark ignition, but the Sonex chemical process reduces the energy required for ignition, allowing ultra-lean burn. (Today, every Japanese auto manufacturer has a lean-burn engine in development.) The approach to ARC is very gradual, with ignition occurring only when a threshold in chemical activity is reached.

We also learned how to use our process to ignite methanol in a DI diesel engine at a 17.5:1 compression ratio, using no in-cylinder spark plug, glow plug or chemical ignition improver. A research program, funded by the National Renewable Energy Laboratory Division of the Midwest Research Institute, field manager for the Department of Energy's Alternative Fuels Program, is now under way at Sonex to publicly document this technology.

Production of Sonex diesel pistons using our broader version of ARC soon will be

Pouring on one point in his letter. He emphasized that Volvo was the first to introduce the three way catalytic (TWC) converter system, suggesting that U.S. industries are “followers.” While it may be true that some Volvo vehicles were the first vehicles sold with this technology on board, several U.S. companies (Bendix, GM, Ford, Engelhard, and others) played a *leading* role in the development of the concepts and the eventual products for the entire TWC system (e.g., TWC, oxygen sensor, electronic fuel injectors, etc.). In fact U.S. companies hold many of the pioneering patents on the critical technologies that are still used in the TWC system. Furthermore, in the mid-1970s, the *entire* worldwide automotive industry was implementing this TWC technology at the same time to meet the emissions requirements of the late 1970s. It is unjustified to single out any one manufacturer as the leader during this period of rapid change.

In summary, as members of U.S. industry, we understand the pressures of a highly competitive market and we would like to assure Mr. Pouring that Ford and its competitors are working diligently to introduce the most efficient, durable, and cost-effective emissions control systems possible to meet future regulations.

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Global positioning

The “GPS Industry Prepares for Boom” report [December 1995, p.8] starts with an egregious error. Physicists should always be wary when using economic statistics—the ratio of \$1 billion in exports equals 20,000 jobs is not only wrong, but has been used by government officials who know that it is incorrect. This estimate was prepared by a government statistician for one basket of commodities for a period of time prior to 1987. The number was presented together with the caveat that it applied only for that time and for those products. It was also noted that high-tech industries used far fewer employees to produce the product.

The reader implicitly will make the

assumption that this news article predicts 100,000 jobs in the U.S.A. for \$5 billion in product. Even if this ratio were correct—and it isn't—most of the product will be produced abroad. Far fewer jobs will be created; and, what is more, they won't be jobs for physicists.

The acceptance of military interference with civilian activities must also be deplored. The sentence implying tacit acceptance of interference by the U.S. government to insert random errors into GPS code is part of the government's secrecy to prevent the dissemination of knowledge under the false rubric of national security. This is a stance that slows industrial development and improvement of our national well-being. GPS developments are a fine example of the pace at which a technology develops once freed of military secrecy to the benefit of both the nation and its government.

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Leo Gross
New York City

Inventive thinking

I'd like to propose you publish an article about inventive problem solving, known in Russia by the acronym TRIZ. This is a very powerful and successful development for industrial science that generalizes and systematizes the human innovative experience. The methodology of TRIZ developed from 1946 in the former U.S.S.R., but was unknown in Western countries because of political barriers in recent decades and linguistic difficulties now.

The author of TRIZ, Genrich Samuilovich Altshuller, analyzed more than 500,000 worldwide patents in order to study the methodology of invention. He found that key patents consist of the resolution of fundamental technical contradictions and that there are only a few (about 40) methods to solve these problems in a wide range of different engineering and scientific fields. Altshuller and his co-workers systematized principles and effects (from physics, chemistry, and geometry) that could be applied to solve engineering problems. They linked these recurring factors with the uniform evolution of various technical systems and found methods to optimize technical products and processes.

The TRIZ methodology has been studied by hundreds of leading Soviet engineers and has been successfully used for developing

different products and processes in the military, aerospace, electronics and other industries in the former U.S.S.R. There are dozen of books in Russian about TRIZ, but to the best of my knowledge, there are no reviews in English.

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Semyon D. Savransky
Brooklyn, New York

Thank you for your well-timed letter and the interesting background. Perhaps our cover story, which was already in production when we received your letter, will be a first—Ed.

Government support

It was disturbing to see Ernest Gilmer's diatribe against government support of basic and applied physics research [December 1995, p.6], especially since he reports from a company that thrives on government contracts! Moreover, payments to the war materiel industry, of which this corporation remains a part, were one of the main factors leading to the federal government's current debt. Even now the extravagant production of weapons is protected from the budget balancing cutbacks affecting research and other social programs.

It is even more ludicrous to hear him complain about the "coercion on behalf of the friends of bureaucrats and politicians" when the military-industrial complex President Eisenhower warned about runs one of the largest open-handed lobbies on the hill involved in distributing the pork!

Until profits of arms manufacturers are either voluntarily given up when there is a threat to our country, in keeping with the volunteer nature of our military whose members put their lives on the line, or they are drafted as were the fighters in World War II, the appropriate balance of civilian versus military, or industrial versus academic-physics-research will not be ascertainable in this country.

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Letters should be mailed to The Editor, *The Industrial Physicist*, One Physics Ellipse, College Park, MD 20740-3843; or sent by fax (301-209-0842) or e-mail (tip@aip.org). Please include affiliation, mailing address, and daytime telephone number. We reserve the right to edit all letters that are accepted.