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TECHNICAL
REPORT

An Approach to Assessing the Technical Feasibility and Market Potential of a New Automotive Device

RAND Zero Emission Fuel Saver Study Team

Prepared for Save the World Air, Inc.

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Environment, Energy, and Economic Development

A RAND INFRASTRUCTURE, SAFETY, AND ENVIRONMENT PROGRAM

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Summary

This report describes research and assistance that the RAND Corporation provided to Save the World Air (STWA), a Nevada company with headquarters in North Hollywood, California. STWA has developed a number of magnet-based devices, including its Zero Emission Fuel Saver (ZEFS™), that it claims can improve vehicle fuel economy and reduce emissions. These devices are designed to be fitted as original equipment onto internal combustion engines or to be retrofitted onto existing engines. STWA approached the RAND Corporation for assistance in developing a plan for assessing the technical basis required for successful commercialization of ZEFS. STWA also sought RAND's advice in examining potential market opportunities for ZEFS. This report summarizes RAND's analysis of these two issues.

Understanding the Scientific Basis of the Device

The ZEFS device contains permanent, rare-earth magnets that are known to produce strong magnetic fields. According to STWA, when gasoline or diesel fuel passes through such magnetic fields, both the fuel's viscosity and its surface tension are lowered. This reduction in viscosity and surface tension is thought to cause improved atomization, and, thereby, improved combustion.

RAND researchers conducted a review of the published literature to determine what credible experimental evidence may be available regarding a magnetically induced reduction in the viscosity of automotive fuels that will persist as the fuel undergoes atomization. (Viscosity is a property of a fluid and a measure of its resistance to flow.) RAND found that the existing peer-reviewed literature does not contain credible evidence that the application of magnetic fields to either gasoline or diesel fuel oil will reduce the viscosity of these automotive fuels.

In light of the absence of supporting evidence in the scientific literature, RAND suggested that STWA consider funding research directed at measuring the viscosity of gasoline and diesel fuel after exposure to a strong magnetic field. At STWA's request, RAND managed a competitive proposal process that resulted in a research grant from STWA to Professor Rongjia Tao of the department of physics at Temple University.

Recent experimental work published by Tao and Zu (2006) shows that a pulsed magnetic field can reduce the viscosity of some crude oils. Tao and Xu also examined the effect of pulsed magnetic fields on gasoline and diesel fuel. Tao has reported to RAND that he has detected a

small effect, but this work on automotive fuels has not been fully documented nor yet submitted to and published in a peer-reviewed technical journal.

Further research could strengthen the knowledge base regarding the relationship between magnetic field treatment of fuels and engine performance. First, the results of Tao's research on gasoline and diesel fuel need to be fully documented, peer-reviewed, and published. Second, research is needed on the impact of magnetic field treatment on the surface tension of fuels, since surface tension also plays an important role in atomization. Third, important insights may be obtained by measuring the effect of magnetic treatment on the liquid droplet distribution leaving fuel injectors and carburetors. To be useful, this research needs to examine fuel systems operating at temperatures and pressures characteristic of those in use in actual engines. Further work is also needed to establish and verify the theoretical basis, if any, underlying the effect of magnetic fields on fuel viscosity, surface tension, and atomization.

Approaches to Testing and Verification

RAND developed a test protocol to measure the ZEFS device's effect on tailpipe emissions and fuel economy. RAND also analyzed a series of tests conducted on automobiles and motorcycles. The protocol was intended to support preliminary engineering tests and product development, as opposed to certification tests. RAND oversaw testing of the device designed for automobiles at an independent lab in California. STWA provided RAND with results from test facilities in Hong Kong, Thailand, and China.

An independent laboratory in California tested two vehicles and fitted devices, all supplied by STWA. The vehicles tested included a 1971 Volkswagen Beetle (VW) and a 1984 Ford Mustang (Ford). Results showed no statistically significant effects of the device on most pollutant emissions or fuel economy for the VW tested at this lab. Results showed no statistically significant effect of the device on the ozone precursors total hydrocarbons (THCs) and nitrogen oxides (NO_X) or on fuel economy for the Ford tested at this lab. However, the lab found statistically significant effects on carbon monoxide (CO) and carbon dioxide (CO_2) emissions in the Ford tests, with CO decreasing and CO_2 increasing. These findings led STWA to reassess and redesign the device for automobile applications.

STWA has also developed a magnet-based device for motorcycle engines and arranged for laboratories in Hong Kong, Thailand, and China to test the device. To test motorcycles in the various Asian labs, RAND recommended that testing should follow at least the reduced set of requirements, as developed by RAND, for conducting "engineering tests," and that test procedures relevant to the countries in which the motorcycles were being tested also be applied.

STWA provided RAND with the results of tests conducted on motorcycles in laboratories in Hong Kong, Thailand, and China. Among all test results provided, one set of results from an independent laboratory in Thailand was clearly consistent with RAND's basic protocol for testing. Based on the information provided, RAND could not ascertain the extent to which the data from other labs were consistent with all the criteria in RAND's basic protocol.

The results from the Thai laboratory's testing of a single motorcycle show a statistically significant reduction in CO and CO_2 emissions and fuel consumption (FC) when the device was installed. However, this same conclusion does not hold for the ozone precursors NO_X and hydrocarbons (HCs). In particular, the analysis shows a statistically significant increase in NO_X emissions in these tests when the device was installed. After RAND completed its work on this project, STWA informed RAND of additional tests conducted in California and completed in February 2007 on two on-road and one off-road motorcycles. These additional results may shed further light on the device's performance potential.

Market Potential

Should further laboratory analysis and in-use testing provide clearer and more positive outcomes, the market potential for the device will depend significantly on the advances realized from other technologies and regulatory policies for emissions reductions and on the cost-effectiveness of the device relative to other approaches. Markets within the United States may be limited, except perhaps in areas with large emissions of criteria pollutants from old off-road sources.[1] Potential international applications may be larger given the baseline for engine performance and environmental standards in developing countries. Assuming statistically valid and positive test results of the device, a more in-depth assessment of the international prospects of the retrofit device would need to be done.

If STWA pursues development of a retrofit device based on the magnetic treatment of automotive fuels, it should give highest priority to obtaining statistically valid data on performance in actual vehicles.

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1 EPA uses measures of six criteria pollutants to indicate air quality. Each criteria pollutant has an EPA-established maximum concentration, above which adverse effects on human health are more likely to occur (EPA, 2007).