Technical Whitepaper: Environment

Introduction

Automotive aluminum use has doubled in the last decade, and is increasingly the material of choice for automakers as they address growing concerns about the environment.

Aluminum allows manufacturers to maintain the size of their vehicles while reducing weight and improving fuel economy. Improved fuel economy reduces greenhouse gases from motor vehicles.

In addition, automotive aluminum is highly recycled due to the high value of aluminum scrap, and the use of recycled aluminum for motor vehicles provides additional environmental benefits. Today, nearly two-thirds of the aluminum used in automotive applications is recycled metal.

Key points discussed in this paper include:

- Vehicle lightweighting through increased aluminum use can greatly improve fuel economy.
- Greenhouse gas reductions result from aluminum's ability to improve fuel economy.
- Lifecycle analyses demonstrate reduced CO2 emissions from greater auto aluminum use.
- Aluminum's high recyclability is good for the environment.
- The aluminum industry is continuing to make environmental improvements in its production processes.

Weight Reduction and Fuel Economy

Automakers have studied the relationship between vehicle mass and fuel economy for decades. The majority of studies to date conclude that for every 10 percent reduction in vehicle weight there will be a corresponding 6 to 8 percent decrease in fuel usage.

In recent years manufacturers have concluded that, in order to keep vehicle size, but lose the weight, they need to use high-strength, low-weight materials. This is especially important in today's market with steadily increasing demand for light trucks, minivans and sport-utility vehicles.

Aluminum provides a high-technology solution. One pound of aluminum typically replaces two pounds of conventional metals, resulting in dramatic weight savings without compromising safety. The resultant fuel savings can significantly lower the operating costs of the vehicle over its lifetime.

An example of aluminum's potential for fuel savings can be seen in Ford Motor Company's Aluminum-Intensive Vehicle (AIV) program. Forty aluminum-intensive 1994 Sables were built, achieving weight reductions of 688 pounds compared to their conventionally built counterparts. The measured result of this lightweighting was an 8 percent reduction in fuel consumption.

This improvement would translate to a savings of over 700 gallons of gasoline over 100,000 miles*. To date, six studies** have shown fuel savings (as a function of mass reduction) from 5 to 10 percent for every 10 percent mass reduction.

Aluminum is a key material in the largest automotive industry-government research program in U.S. history. The Partnership for a New Generation of Vehicles (PNGV), a research and development partnership between the federal government and DaimlerChrysler, Ford and GM, is looking to aluminum as the leading material to help improve fuel economy.

PNGV's goal is to produce prototype family sedans by 2004 that achieve up to 80 mpg, without compromising safety, size, utility or cost. A recent Peer Review from the National Research Council states, "aluminum continues to be the leading candidate material for the Goal 3 [80 mpg] vehicles."

Because of its ability to maintain vehicle size, but lose weight, aluminum will be a growing factor in the auto industry's strategy to address global climate change concerns and related fuel economy needs.

* Assuming a combined city/highway mileage of 23 mpg for a standard model Sable.

**Ford, BMW, Argonne National Laboratory, Ross, International Aluminum Institute and the European Aluminum Association.

Reducing Greenhouse Gas Emissions

An ever-growing concern among government, industry and environmental organizations is global climate change. A buildup of carbon dioxide (CO2) in the atmosphere over the last century has been identified as a possible contributor to climate change. Automotive companies are working on a number of initiatives to improve vehicle fuel economy in order to reduce CO2 emissions.

The use of aluminum in vehicle structures can significantly reduce CO2 emissions as a direct result of vehicle weight reduction. According to the International Institute (IAI), every pound of aluminum that replaces two pounds of steel saves 20 pounds of CO2 (by burning less fuel) over the lifetime of that vehicle. The IAI study, which used Peer Reviewed data, was compiled in accordance with ISO standards.

Ford estimated that vehicle weight reduction also reduces solid, waterborne and airborne emissions by more than 13,000 pounds over the life of the vehicle. Auto manufacturers' use of aluminum has doubled in less than 10 years and is likely to continue its steep upward climb. If the average of 250 pounds of aluminum in each vehicle produced today replaces iron or steel, on average the CO2 emissions savings for the 1999 model year alone would total 75,000,000,000 pounds (15,000,000 new vehicles sold in the US x 250 pounds x 20 pounds CO2 savings per vehicle)!

Lifecycle Analysis

Auto manufacturers are increasingly concerned about minimizing the environmental impacts of their vehicles.

DAIMLERCHRYSLER
Bob Eaton of DaimlerChrysler observed, "In the past century, the automobile dramatically changed society. In the next century, however, society will dramatically change the automobile."

Ford's Chairman William Clay Ford said, "There is a rising tide of environmental awareness and activism among consumers."

GM
GM's Chief Environmental Officer, Dennis Minano remarked, "Indeed, individual businesses and industry sectors will be judged by looking at their total environmental impact."

Auto companies are beginning to use new analytical tools to measure how their vehicles affect the environment. Called "lifecycle analysis," this approach quantifies the environmental impact of a vehicle, beginning with its production and continuing through the end of its useful life and through the recycling of vehicle materials back into use.

USCAR, a pre-competitive research arm of DaimlerChrysler, Ford and GM requested that the aluminum industry conduct a lifecycle inventory (LCI) for the North American aluminum industry, with the objective of generating a resource consumption and environmental profile of the industry as a whole.

This comprehensive study included 15 unit process operations from 213 reporting locations around the world and was completed in 1995.

The results of the LCI confirmed and reinforced the progress that the aluminum industry has been making, especially in regard to energy efficiency, recycling, and the reduction of CO2 emissions. Overall energy efficiency continues to be improved and the release of global warming gasses has been significantly lowered.

The most significant point from the lifecycle study is the fact that only 5 percent of the energy required to produce primary aluminum (from ore to finished product) is required to produce product from recycled aluminum. Accordingly, recycling drastically reduces the emissions that would otherwise be emitted from the production of primary aluminum.

Recycling: Aluminum's Unique Advantage

Aluminum has enjoyed a successful and sustained history of recovery and recycling, and has a well-deserved reputation as one of the most recycled modern materials, mainly due to the economic value of aluminum scrap.

While aluminum today accounts for about 5 percent of a car's content, it represents as much as 50 percent of the material scrap value at the end of car's life. Scrap values of aluminum is roughly 10 times that of steel on a per-ton basis.

The use and reuse of aluminum are the means by which manufacturers and automotive designers add value to their products. Presently, one-third of the total aluminum supply in the United States is domestically produced primary material, one-third is imported primary metal and the other third is recycled.

Presently, the automotive aluminum recycling rate is 85-90 percent. Two-thirds of the aluminum used in today's vehicles is sourced from recycled metal.

Unlike many other competitive materials, aluminum alloys can be recycled indefinitely without loss in quality. Consequently, automotive aluminum is often reused in automotive applications. In contrast, most auto steel scrap does not return to automotive use.

In the 1980s the phrase, "Design for Recycling" was first promoted, and since then it has become an accepted concept embraced by many industries, including the automotive industry. Recycling - both the use of recycled material in the vehicle itself, and the recyclability of that material - is now an important criterion used by automakers in designing vehicles.

As more cars use more aluminum, a higher volume of recycled content will be available, thereby ensuring that automotive designers preserve the recycling value of the aluminum. In 10-12 years as more aluminum-intensive vehicles reach the end of their useful life, larger quantities of aluminum will be recycled and a higher "steady-state" situation will be reached.

Present projections for this steady-state situation predict it to be reached during the second decade of the next century, with an expected content of 400-700 pounds of aluminum per vehicle. Due to the environmental benefits and lower cost, several automakers have announced long-term agreements with metal and parts recyclers to lock in supplies of recycled materials, particularly aluminum.

To further improve both recycling rates and the efficiency in aluminum recycling, the auto and aluminum industries have launched several joint initiatives to explore and improve systems for recovering and recycling automotive aluminum. The auto industry recently initiated a challenge to its supplier industries to document design concepts that facilitate recycling.

In 1997 The Aluminum Association signed a collaborative agreement with USCAR's Vehicle Recycling Partnership (VRP). The VRP's objective is to improve the already high aluminum recovery rate of vehicles manufactured by DaimlerChrysler, Ford and GM. As a result of its involvement, The Aluminum Association has published a set of Design Guidelines for automotive engineers to insure the continued economically successful automotive aluminum recycling record.

As part of the Auto Aluminum Alliance, the auto and aluminum industries are pursuing additional cooperative research projects to improve the efficiency of how aluminum is used in automotive applications. Recycling initiatives are among its most recent projects. One project is well on its way to demonstrating the successful separation of aluminum auto scrap back into its alloy families.

Aluminum Production Cuts Emissions

The aluminum industry has made great strides in cutting emissions from its production processes. Between 1968 and 1987, CO_2 emissions from aluminum production in the United States decreased by approximately one-third. This was in part due to greater use of recycled aluminum. The benefits of scrap recycling are especially dramatic in regard to reducing greenhouse gas emissions. It has been estimated that a savings of 2.75 metric tons of carbon equivalent is achieved for each metric ton of scrap aluminum substituted for raw ore product.

In the past, a primary environmental concern for the environment was emissions of perflourocarbons from the reduction cells at primary production sites. The industry has made significant achievements in reducing these emissions, and the focus of concern has shifted to CO_2 emissions.

The aluminum industry has partnered with the U.S. Department of Energy to support technical innovation, focusing on sustaining energy conservation without sacrificing competitiveness.

The industry continues to develop technical improvements in other ways, including company-sponsored research, university funding and partnerships.

Conclusion

For the auto industry, aluminum is increasingly the environmental material of choice. Because of its high-strength, low-weight characteristics, automotive aluminum allows automakers to maintain

vehicle size while reducing vehicle weight, thus improving fuel economy and cost effectively reducing vehicle exhaust emissions.

Environmental lifecycle studies conclusively document its environmental advantages over conventional materials. Those benefits are increased substantially with the use of recycled aluminum.

Coupled with the substantial progress the aluminum industry has made to cut greenhouse gases in the production process, it is clear that automotive aluminum offers significant environmental advantages for the auto industry.