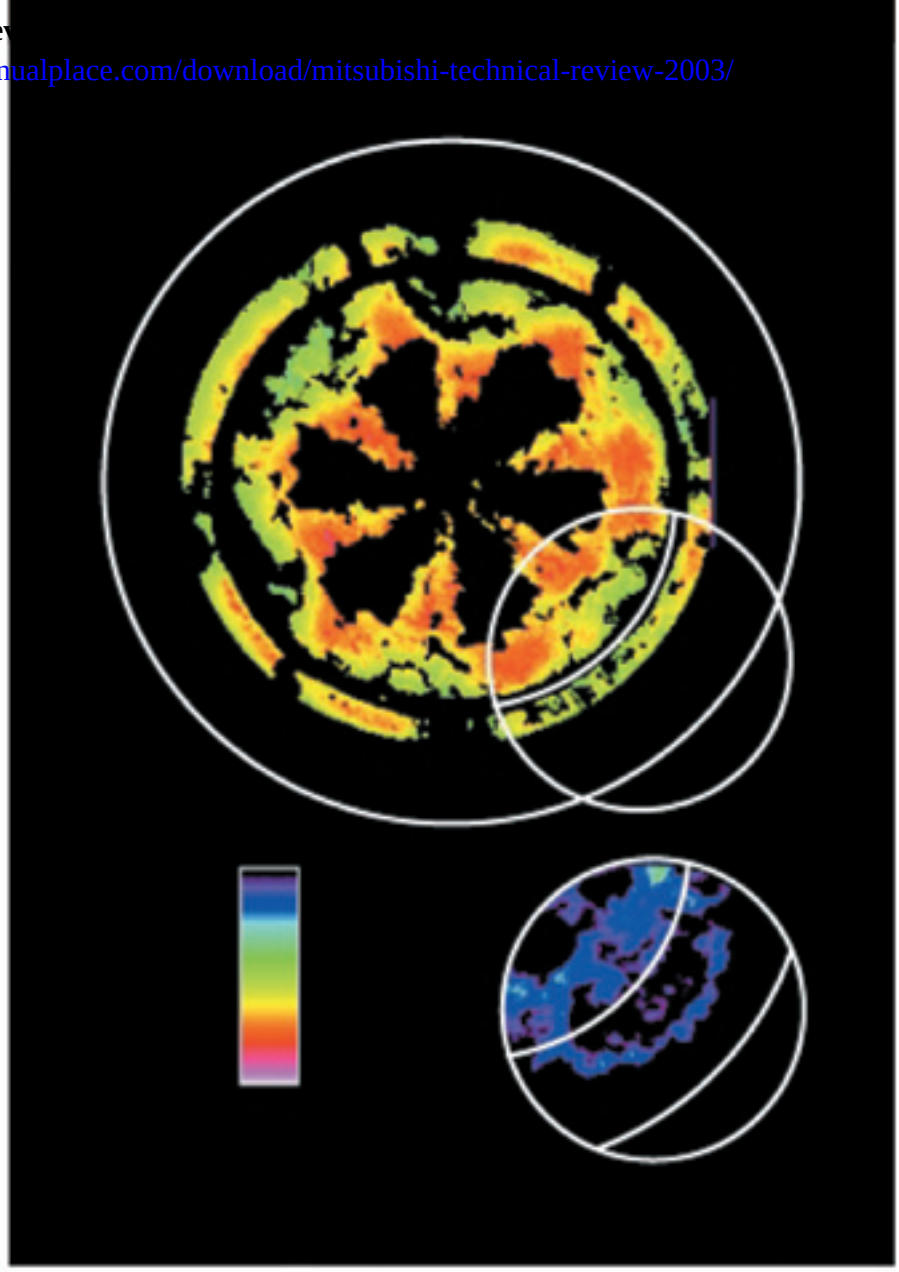
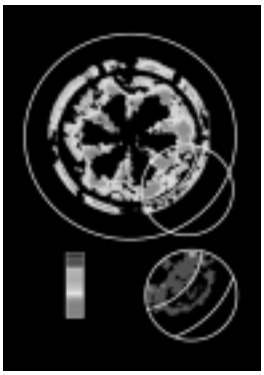


TECHNICAL REVIEW

2003 NO. 15

MITSUBISHI MOTORS FUSO



- **Cover Photograph**

The cover photograph shows an image of combustion with the Mitsubishi Innovative Quiescent Combustion System (MIQCS), a new combustion system developed for diesel engines in heavy-duty trucks. The MIQCS realizes a two-stage combustion process that suppresses first-stage combustion by limiting in-cylinder swirl and promotes second-stage combustion by effectively employing air throughout the cylinder. The results are minimal exhaust emissions and maximal fuel economy.

Published by Editorial Committee for the Technical Review
c/o Enviromental & Technical Affairs, Department
MITSUBISHI MOTORS CORPORATION,
16–4, Kohnan 2-chome, Minato-ku, Tokyo 108–8410, Japan
Phone: +81–3–6719–4207
Fax: +81–3–6719–0034

MITSUBISHI MOTORS FUSO

Technical Review 2003 15

TECHNICAL REVIEW

2003 NO. 15

Contents

Previous page
In the 2003 Dakar Rally, which finished on 19 January, Hiroshi Masuoka, driving a Mitsubishi PAJERO EVOLUTION, claimed his second consecutive victory and began a first-second-third-fourth sweep for Mitsubishi Motors. The photos show Masuoka and second-placed driver Jean-Pierre Fontenay powering toward the finish line.

Quality Thesis

New Products

[Company names used in this publication]

On January 6, 2003, Mitsubishi Motors Corporation spun off its truck and bus operations to form a new company, Mitsubishi Fuso Truck & Bus Corporation. This edition of the TECHNICAL REVIEW was jointly produced by the two companies.
Authors of papers in this publication are indicated not only by name and department but also by company. For simplicity, the company names are abbreviated as follows:

Mitsubishi Motors Corporation: MMC
Mitsubishi Fuso Truck & Bus Corporation: MFTBC

New Spirit, Mitsubishi Motors

Rolf Eckrodt
Mitsubishi Motors President & CEO

The start of the new millennium has been accompanied by widespread interest in how technologies should be developed and attempts to predict how technologies will evolve in the future. What course the development of automobile technologies should take is also the subject of considerable debate, for while the automobile brings with it improved quality of life, it also gives rise to other concerns, such as environmental and safety issues. Mitsubishi Motors is working wholeheartedly toward finding solutions to these issues in order to build a prosperous future and give customers the vehicles that they really want. Covering a number of topics, TECHNICAL REVIEW describes the various technical challenges faced in solving these issues.

Tackling a multiplicity of tough problems requires teamwork, such as engineers working together on research and development. Ideally, though, larger scale teamwork in the form of cooperation between companies also has an important part to play. It is the benefits of such teamwork that Mitsubishi Motors aims to achieve through its alliance with DaimlerChrysler. As a member of the Mitsubishi group with a long and well-established reputation in the automobile industry, Mitsubishi Motors has made a valuable contribution to the development of Japanese manufacturing. DaimlerChrysler, meanwhile, has been making automobiles ever since it gave the world the first motorcar at its inception over a century ago. By working together and combining the best of both companies, we are confident of delivering the products that customers want and need. And following the spin-off of the truck and bus division in January to form Mitsubishi Fuso, we are even better placed to create just such high-quality products in collaboration with our partners DaimlerChrysler and the newly formed Mitsubishi Fuso. Doing so naturally requires that numerous reforms be made so as to create the conditions for collaboration with other companies and efficient R&D within the company. That is what the Turnaround Plan now underway is designed to achieve, and indeed considerable progress toward this goal has already been made.

The Turnaround Plan is gradually making its impact felt on the company's automobile design. The eK-WAGON launched in October two years ago, for example, has been widely acclaimed for its utility and innovative design, and has grown to become one of our most popular models, while the new CANTER small truck launched last June has won plaudits for its spacious, comfortable interior. November saw the launch of the new COLT model, the first product to come out of our alliance with DaimlerChrysler. While the original COLT marked a major milestone for Mitsubishi Motors when it first appeared on the market 40

years ago, the new COLT has proved an even greater hit. The appeal of products depends not only on the incorporation of new technologies, but also on close attention to quality and detail in everything from fulfilling customers' needs to quality of service at the sales end of the supply chain. The criticisms leveled at us in the past regarding the quality and specifications of some of our products have imprinted on us all the more firmly the crucial importance of these factors. Enormous strides have been made in quality control thanks to the introduction of the "quality gate" system. Advances have also been made with regard to specifications, as shown by the popularity of our products with customers – and we intend to continue listening to their needs.

At last year's soccer World Cup, the Japanese team made a major impression. This was only a start, however, upon which Japan needs to build at future World Cups. Sustainable progress is the name of the game for Mitsubishi Motors as much as the Japanese soccer team. Under the banner of our brand statement – "Spirited Products for Spirited People" – we intend to bring to market a constant stream of outstanding new products to meet customer needs. Outstanding products require outstanding technologies in every sphere of automobile manufacturing, and these you will find in this and future editions of TECHNICAL REVIEW.

TECHNICAL PERSPECTIVE

Emerging Situation and MMC's Policy on Automobile Recycling – New Technical Issues and Future Activities –

Harushige YAMAMURA* Takehiro ISHIURA** Motokazu KOBAYASHI‡**

Abstract

In order to improve the recycling ratio of end-of-life vehicles, recycling and appropriate treatment of shredder dust from the remains of automobile bodies are indispensable. It is equally important to appropriately handle the chlorofluorocarbons, air bags and hazardous substances. In Japan, a recycling ratio of at least 95 % must be achieved by 2015, by introducing relevant laws and voluntary efforts to tackle the problem. As the recycling of automobiles involves many parties, widespread cooperation is crucial.

Key words: *Discarded Vehicles, Automobile Recycling Law, Shredder Dust, Material Recycling, Thermal Recycling, Gasifying Melting Technology*

1. Introduction

In July 2002, legislation on Recycling End-of-Life Vehicles (hereinafter referred to as the Automobile Recycling Act) was enacted in Japan. Generally speaking, in terms of recycling, motor vehicles are considered the leader compared to other industrial products. Currently, as shown in **Fig. 1**, 70 to 80 % of these vehicles are being recycled. However, the current recycling system in Japan is losing impact as a result of the ever-increasing disposal costs of industrial wastes due to the space restrictions on landfill disposal sites, and the weak price for scrap iron. Further, it is feared that illegal disposals and inappropriate recycling treatments will worsen. This law was enacted as a result.

There are approximately five million motor vehicles de-registered every year, approximately one million of which are exported as used vehicles. The rest, approximately four million units, are dismantled in Japan. The amount of shredder dust, or Automobile Shredder Residue (hereinafter referred to as ASR) discharged is likely to reach 550 to 700 thousand tons. By the law, automobile manufacturers are responsible for the collection and treatment of ASR. As a result, the recycling and/or appropriate treatment of ASR has become quite a big issue for automobile manufacturers.

Under the Promotion of Effective Resource Utilization legislation (amendment enacted in 2001, abbreviated as the 3R Act), automobile manufacturers were also obliged to design and manufacture motor vehicles taking the 3R factors (Reduce, Reuse and Recycle) into consideration. Reducing the environmental impact from the design stage and promoting the manufacturing of motor vehicles which produce the least amount of waste possible are necessary for building a recycling society, in which automobile manufacturers can display their conservation efforts for the environment.

As motor vehicles are a form of international merchandise, they must be designed to comply with not only Japanese regulations, but also European Union (EU) directives regarding those vehicles that have reached the end of their lives. In addition, due to the current situation where nearly one million used vehicles are being exported, it is essential that these vehicles are easy to dispose of anywhere in the world once they have reached the end of their lives. It is also essential that they place only a small impact on the environment.

In this paper, the latest issues to be tackled regarding motor vehicle recycling, motor vehicle recycling trends in Japan, USA and Europe, as well as technical trends on recycling are outlined, and based on these, ways of developing motor vehicles that take into account recycling are discussed.

2. New issues in motor vehicle recycling

2.1 Promotion of ASR recycling

At the moment, the most common method for end-of-life vehicle recycling involves crushing vehicle body remains, after dismantling useful parts from the end-of-life vehicle, by hammer (shredding process), then classifying the metal portions by magnet and/or specific weight for recycling. The residual mixture, once the metal content has been removed, is classified as ASR which, in most cases, is not recycled but disposed of by landfill. Since Japan's land area is so small, the land usable for landfill is limited, resulting in treatment costs increasing year by year. As motor vehicles are, for the most part, constructed from metal, the recycling ratio is already high. At this moment, therefore, promoting the reduction in the amount of ASR and recycling is the most important issue. To achieve this, it is important

* Recycling Promotion Office, Business Dev. Office, MMC
** Material Engin. Dept., Car Research & Dev. Office, MMC
‡* Material Engin. Dept., Research & Dev. Office, MFTBC

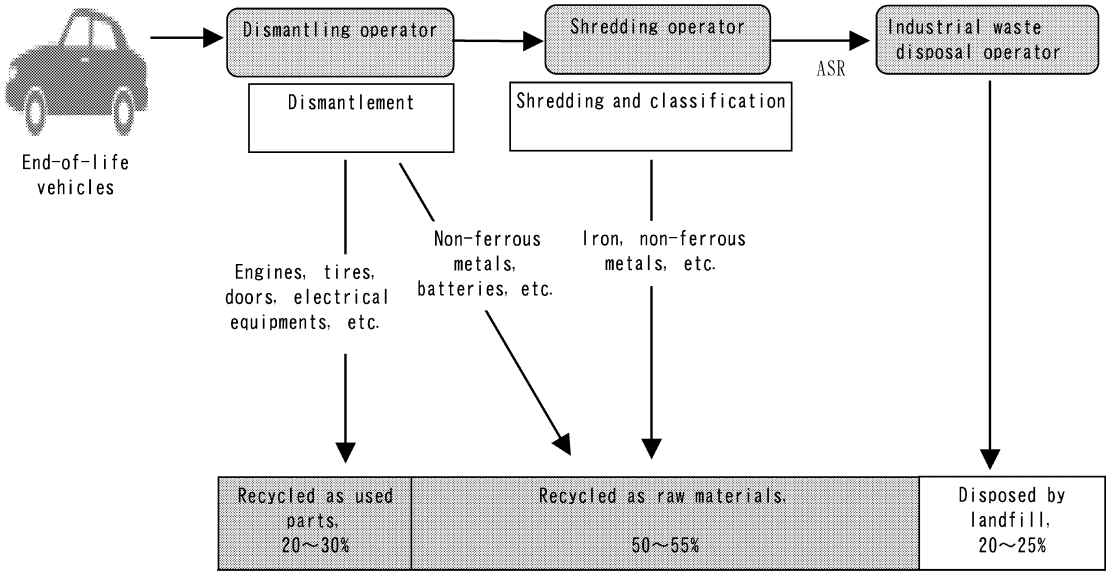


Fig. 1 Current recycling situation for end-of-life vehicles

that technologies is developed that correspond to the requirements in terms of both the treatment infrastructure and automobile manufacturer. Among these it is vital to promote the establishment of more recycling facilities.

2.2 Air bag and similar equipment disposal measures

One new problem is that although an air bag is a device designed to protect passengers in a collision, it may itself cause damage during the recycling process as it contains a gas generator that deploys the bag instantly. It will become more important in the future to remove the deactivated gas generator or intentionally activate it within the vehicle before the vehicle even starts the recycling process.

Air bags have been adopted since the latter half of the 1980's, and, at the moment, almost every new motor vehicle is equipped with them. In the beginning, it was only installed on the steering wheel. Air bags can now be found in the instrument panel in front of the passenger, as well as to the side of the seats.

Nowadays, seat belts with a pre-tensioner (a device that winds the seat belt immediately after collision thus removing the slack in the belt), which also has a gas generator, are increasingly being utilized. From 1998 on a system was installed, which is now standardized across the industry, that activates gas generators on the vehicle (by connecting deploying devices, air bags and pre-tensioners deploy in sequence once a switch is turned, which makes these devices harmless). At the moment, almost every new motor vehicle is equipped with this system. The system ensures the safe treatment of gas generators, the use of which is expected to increase in the future.

2.3 Measures for disposing of chlorofluorocarbon gas (CFCs)

In Japan, preceding the enforcement of the Automobile Recycling Act, the recovery and destruction of motor vehicle air conditioner refrigerant began in October 2002. These actions were obligatory for automobile manufacturers under the Fluorocarbon Recovery and Destruction Law, legislation introduced by Diet members.

From 1994, our company discontinued all use of CFC12, a type of motor vehicle air conditioner refrigerant which destroys the ozone layer, and switched to a CFC alternative – HFC134a. However, since HFC134a has a far higher global warming effect than CO_2, it is necessary to reduce the amount used and ensure a 100 % recovery of the material at the end of the vehicle's life. Each country regulates the amount of CFCs emitted to the atmosphere. As well as recovering and destroying refrigerant for motor vehicle air conditioners, these are enforced under motor vehicle recycling laws and regulations. Furthermore, the introduction of new refrigerant, which at present does not need to be recovered, is progressing.

2.4 Reducing the utilization of hazardous substances

Hazardous substances include heavy metals such as lead, mercury, cadmium and hexavalent chromium, as well as others such as sodium azide, which was once utilized as an agent to generate gas for air bags, etc. Motor vehicle recycling is regulated by various laws and regulations designed to prevent environmental contamination by these hazardous substances. However, if these materials are abandoned illegally, then they will contaminate the soil and/or water. The Japan Automobile Manufacturers Association (hereinafter referred to as JAMA) is already voluntarily tackling the problem of reducing the amount of lead, for example, being used in order to prevent these situations occurring.

As mentioned later, utilizing the four hazardous substances (lead, mercury, cadmium and hexavalent

Table 1 Outline of the Domestic Automobile Recycling Act

Item	Outline
Proclamation and enforcement	• Publicized on 12 July 2002 • Enforcement aimed at December 2004
Type of vehicles to which the Act applies	Four-wheeled passenger vehicles and four-wheeled commercial vehicles (Including all vehicle types, from mini-sized vehicles to large-sized trucks and buses)
Obligations of automobile manufacturers	• Carrying out the recovery and recycling of CFCs, air bags and ASR • Setting up a recycling fee and publicizing it [Responsibility] • Designing and manufacturing motor vehicles considering the environment and recycling • Offering information related to motor vehicle structures and components
Cost	Borne by motor vehicle users

Table 2 Outline of domestic voluntary plans

Item	Outline
Hazardous substance	• Public announcement of the target value of material to be reduced On lead, mercury, cadmium and hexavalent chromium • Applied to the new type of vehicles regulated by the Automobile Recycling Act • Research and development of alternative technology
Body structure of commercial vehicles	• Promoting vehicle designs that make recycling easier • Reducing the use of hazardous substances • Promoting recycling and the appropriate treatment of materials which are difficult to recycle and/or treat • Building a network of cooperating treatment and resource recovery operators
Two-wheel motor vehicles	• Installing facilities that collect and recover resources from end-of-life vehicles • Free take-back of vehicles with recycle markings • Reducing the use of hazardous substances

chromium) is, as a general rule, prohibited under the EU directive on end-of-life vehicles. In Japan, JAMA reconsidered past efforts, which have only been on lead, and announced reduction targets for the above-mentioned materials. Our company, as a part of our green procurement program, promptly introduced a management system, International Electronic Material Data System (IMDS), which is already operating in Europe, to actively tackle the management and reduction in use of hazardous substances.

2.5 Expanded producer responsibility

At the moment, fundamental improvement of the economic aspects of recycling by considering the ease of recycling, starting from the design stage, is required. Expanded Producer Responsibility (EPR) is a motivational method taken very seriously that considers the ease of recycling from design through to manufacture.

This is one concept that aims at promoting recycling, by expanding the responsibility of manufacturers achieving the most economically effective recycling methods, in order to bring product recycling within the decision-making domain of the manufacturer's management structure.

Up to now, the economic fruits of recycling design improvement have gone to recycling operators as increased profit. The manufacturers' efforts in terms of design improvement have only been achieved as a voluntary environmental activity. Under the EPR philosophy, however, the fruits of design improvement will promote effective action that assumes manufacturers' responsibility.

On the other hand, if everything becomes the manufacturers' responsibility, it might create problems. Recycling operators are making efforts to improve efficiency in order to increase their own profitability. This is the reason for the current high recycling ratio. The domain where manufacturers should assume responsibility, should be decided according to the actual state of affairs, that is, depending on which side's efforts, those resulting from the infrastructure or achieved by the manufacturer, will lead to better results. Therefore, the way in which EPR should be applied differs country by country. Information from each country will be described later.

3. Legislative trends related to recycling in various countries and regions

3.1 Japan

The Automobile Recycling Act in Japan was announced in July 2002, the background of which is mentioned in the foreword, and is scheduled to come into effect in December 2004.

The basic philosophy of the Automobile Recycling Act is expressed in the following four points: ① Preventing illegal disposals; ② Continuous operation of recycling and the appropriate treatment of end-of-life vehicles; ③ Minimizing the amount of final landfill disposal, and ④ Achieving the principles of appropriate competition on the basis of making good use and improving the existing infrastructure.

According to the basic philosophy above, and based on the aforementioned EPR philosophy, the Automobile Recycling Act obliges automobile manufacturers to recover, recycle and/or treat appropriately, those CFCs used in motor vehicle air conditioners, air bags and similar equipment as well as ASR, all of which have been difficult to treat appropriately due to the existing infrastructure. The costs necessary for carrying out the recycling and appropriate treatment of these three items will be borne by motor vehicle users as a fee (**Table 1**).

Under this scheme it is necessary to achieve the target of a recycling ratio of end-of-life vehicles of more than 95 % by 2015. This target is stated in the recycling of end-of-life vehicles initiative stipulated by the Ministry of International Trade and Industry in 1997.

Furthermore, recycling of hazardous substances as well as the body structures of commercial vehicles and two-wheeled vehicles, which are currently exempt from the Automobile Recycling Act, will also be carried out voluntarily by the related industries at the same time as enforcement by the Automobile Recycling Act (**Table 2**).

Although the end-of-life motor vehicle recycling system stipulated in the Automobile Recycling Act is the largest one, one which the automobile industry has never experienced, the preparatory work, including the recycling fee deposit system and the manifest informa-