Masazumi Konishi
Senior Managing Director
Chairman, Product Technology Subcommittee

Product Technology Subcommittee

The environment is the major theme for the 21st century. The Product Technology Subcommittee at Toyota Industries is committed to identifying and reducing the environmental impact of our products through technological development.

Toyota Industries must fulfill its social responsibility to provide its customers with products that are both environmentally conscious and deliver unsurpassed reliability. In addition, it is essential that we continue to grow as an enterprise in order to ensure our corporate survival. To develop and provide environmentally conscious products, we must ensure that environmental considerations are included throughout the product life cycle, which begins with the development and procurement of raw materials and parts and extends through to the use and disposal of our products. Toyota Industries continues to place a strong emphasis on measures to promote the development of environmentally conscious products, and is aggressively involved in implementing these measures in all aspects of our company.

We stand by our commitment to develop products that are valued by our customers both in terms of performance and their contribution to environmental conservation.

Developing Environmentally Conscious Products

Toyota Industries is taking aggressive steps to develop environmentally conscious products.

Products affect the environment in various ways throughout the product life cycle, such as global warming due to energy consumption and the release of substances of concern during product disposal. The environmental impact of a product can be greatly decreased by taking appropriate measures at the product development stage. The Third Environmental Action Plan specifies that Toyota Industries will pursue the following major objectives as part of its product development and procurement efforts, namely to: (1) manage and reduce the use of substances of concern; (2) promote life cycle assessments (LCAs) of products; and (3) promote recyclable designs. The Third Environmental Action Plan also sets specific targets to be achieved by the company as it works to adopt environmentally conscious designs for its products.

Future efforts will focus on the creation of an environmental data system. Toyota Industries will also seek to enhance its product development efforts by providing its customers with environment-related product information and enhancing its system for sharing environmental information within the company.

Guidelines for Developing Environmentally Conscious Products

		Textile machinery	Compressors	Forklift trucks	Automobiles	Engines	Electronic equipment
Product Category							
Environmental Impact		•Global warming •Environmental pollution from disposal	•Depletion of natural resources •Air pollution •Global warming	•Air pollution •Environmental pollution from disposal •Depletion of natural resources	•Depletion of natural resources •Air pollution •Global warming •Environmental pollution from disposal	•Air pollution •Noise pollution	•Environmental pollution from disposal
Common Challenges	Manage and reduce the use of substances of concern (green procurement)	●	●	●	●	●	●
	Promote LCA of products	●	●	●	●	●	●
	Promote recyclable designs	●	●	●	●	●	●
Challenges by Product Category	Improve fuel efficiency	●	●	●	●	●	
	Reduce noise	●		●	●	●	
	Reduce exhaust gas emissions			●	●	●	
	Develop clean-energy vehicles		●	●			●
	Prevent global warming caused by car air-conditioners		●				

Management and Reduction of Substances of Concern

In step with efforts around the globe, Toyota Industries has set medium-range goals for managing and reducing the company's use of substances of concern.

Under the European Union's end-of-life vehicle (ELV) directive*, the use of lead, mercury, cadmium and hexavalent chromium will be banned from all vehicles sold in Europe starting from July 2003. In response to the ELV directive, Toyota Industries' Product Technology Subcommittee has established objectives aimed at reducing the company's reliance on substances of concern in all of its business activities including its non-vehicle related businesses.

During FY 2002, Toyota Industries made changes to the design of parts that previously contained lead, cadmium or hexavalent chromium and switched to using alternative chemical substances. Toyota Industries also asked its suppliers to submit data regarding the inclusion and quantity of banned substances in materials and parts supplied to the company, and also requested that its suppliers submit plans for eventually phasing out the use of banned substances. In addition, Toyota Industries revised its in-house guidelines for substances of concern to reflect the policy of banning certain designated chemical substances.

■ Reduced Lead and Hexavalent Chromium in 1HD-FTE Engine

The 1HD-FTE diesel engine was co-developed with Toyota Motor Corporation and is currently manufactured by Toyota Industries. Toyota Industries has achieved a 73% reduction compared to FY 2000 in the use of lead in the 1HD-FTE engine by first eliminating lead in the crankshaft assembly during FY 2001, and later eliminating lead in the valve seat material during FY 2002. Toyota Industries has also reduced the use of hexavalent chromium by changing the design of the bolt nuts and washers used in the 1HD-FTE. The company plans to completely phase out hexavalent chromium in the 1HD-FTE engine during FY 2006.

1HD-FTE Diesel Engine

■ Reducing Lead and Hexavalent Chromium in Car Air-Conditioning Compressors

Toyota Industries manufactures car air-conditioning compressors that contain trace amounts of lead and hexavalent chromium in their components. The lead comes from lead additives used to improve the cutting performance of aluminum materials during forging, while hexavalent chromium is used in galvanizing and rustproofing coatings for bolts.

Toyota Industries is continuing to focus its technological development efforts at reducing substances of concern such as lead and hexavalent chromium. The company previously set a goal of identifying alternative substances so that it could completely eliminate its reliance on certain substances, which Toyota Industries successfully achieved in FY 2002.

The European Union's end of life vehicle (ELV) directive includes a ban on hexavalent chromium starting from July 2007, as well as a ban on the use of lead in free-cutting aluminum starting from July 2008. Toyota Industries Compressor Division is currently working to eliminate both lead and hexavalent chromium in its compressor products by gradually switching over to the use of alternative compressor parts in FY 2003. These changes will allow the company to reach regulatory compliance well in advance of the ELV directive's ban on lead and hexavalent chromium.

7SBU16
Variable Displacement Compressor

Green Procurement

Toyota Industries is working hard to ensure that its procurement of materials and parts is environmentally conscious.

Since March 2001, the company has incorporated green procurement practices as part of its corporate mandate to procure parts, raw materials and indirect materials that have a low environmental impact. In order to promote green procurement, Toyota Industries has asked its suppliers to satisfy the following prerequisites for continued procurement:

1. Establish an environmental management system (EMS).

2. Implement management of substances of concern and eliminate the use of banned substances.

During FY 2002, Toyota Industries revised its Environmentally Preferable Purchasing Guidelines and held briefing sessions on the subject of green procurement. The company also held seminars that were designed to assist its suppliers in their efforts to create environmental management systems.

■ Publication of Revised Environmentally Preferable Purchasing Guidelines

Toyota Industries revised its Environmentally Preferable Purchasing Guidelines in February 2003. The revisions were designed to reflect further tightening of regulatory restrictions since the original publication of the Guidelines in March 2001, including the stricter management of chemical substances required by the EU's new ELV directive. The revised Guidelines now include various forms that are used by suppliers to declare that banned substances are not used in their materials or parts.

Environmentally Preferable Purchasing Guidelines (2nd Edition)

■ Supplier Briefing Sessions on Green Procurement

During FY 2002, Toyota Industries held two briefing sessions on green procurement, in October 2002 and February 2003. The briefing sessions were attended by suppliers for all of Toyota Industries' business units. In addition to providing information on regulatory trends and the company's Green Procurement Guidelines, the briefing sessions provided an opportunity for Toyota Industries to ask for greater cooperative efforts from its suppliers.

Briefing Session on Green Procurement

*ELV directive: The end-of-life vehicle (ELV) directive has been adopted by the European Union to reduce the environmental impact and improve recyclability during the scrapping of used vehicles.

Life Cycle Assessments (LCAs)

Toyota Industries is committed to establishing a reliable and efficient LCA methodology in order to develop products that are environmentally conscious.

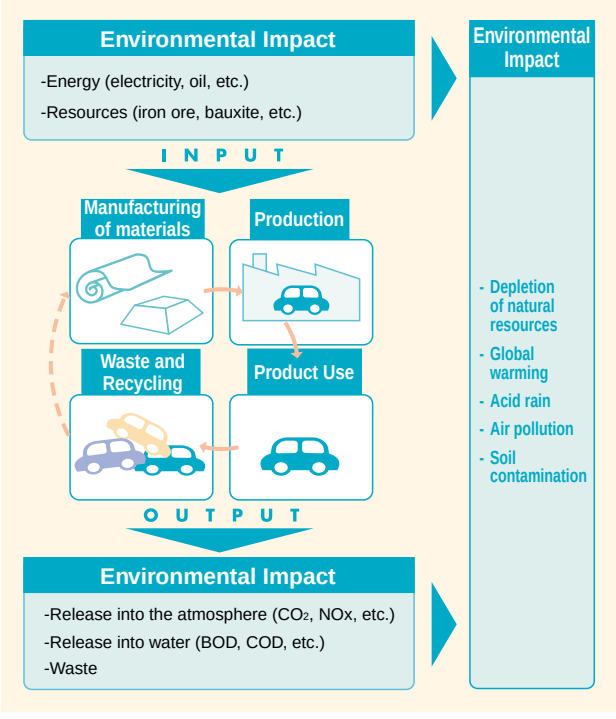
LCAs are used for quantitative analysis and assessment of a product's environmental impact throughout its entire life cycle, which includes the manufacturing of materials, production, product use, disposal and product recycling. LCAs also encompass the energy and resources expended at each stage of the life cycle, as well as the environmental impact on the air, water and soil quality throughout the product life cycle.

Toyota Industries' Product Technology Subcommittee is responsible for promoting activities that incorporate LCAs. The Subcommittee first began studying possible application of LCAs during the second half of FY 1999. In subsequent years, the Subcommittee has conducted LCAs for engines and forklift trucks in FY 2000 and FY 2001 respectively. For more information about these assessments, please refer to the Environmental Report 2001 and the Environmental Report 2002.

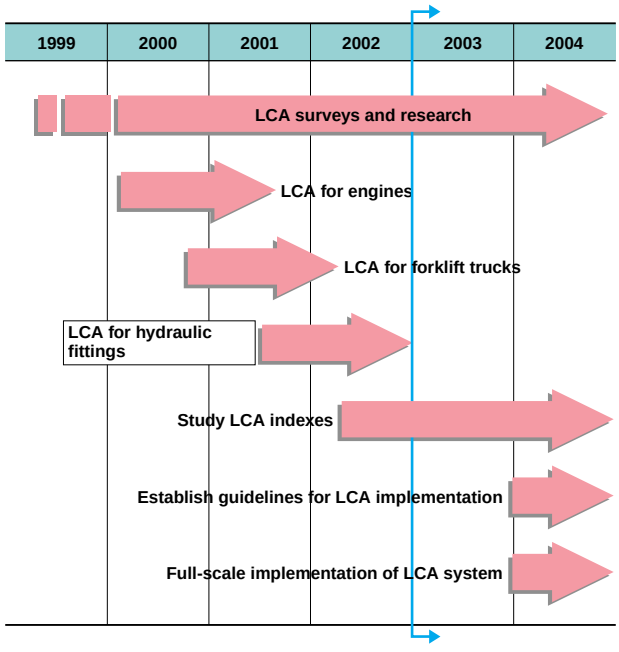
LCAs were originally intended to be used for finished products in order to assess and quantify the environmental consciousness of a product. However, LCAs are increasingly being used as the basis for Design-for-Environment programs (DfE), in which environmental considerations are systematically integrated into the product and process design.

LCAs can be time-consuming to implement as part of the product development process. Consequently, Toyota Industries is working to create an LCA methodology that can be quickly and reliably implemented within the available time frame for development.

The LCA Concept



Time-line for LCA Activities



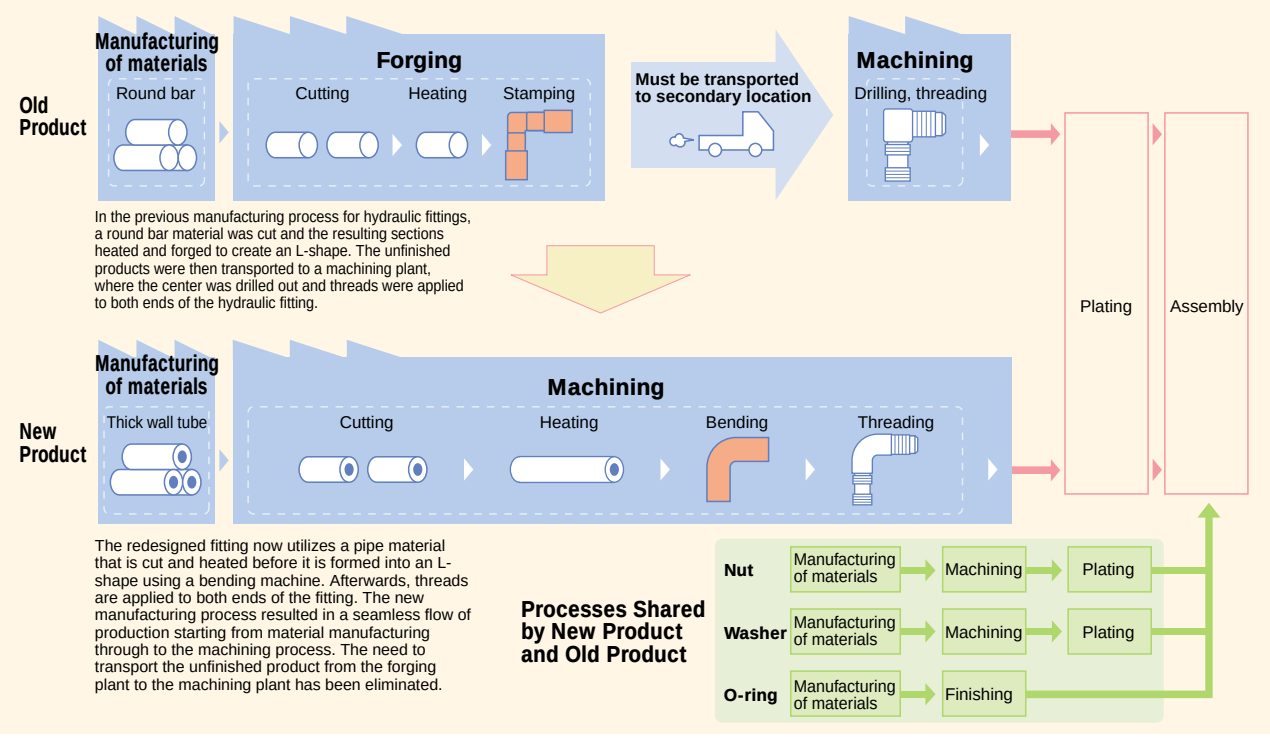
● FY 2002 Measures

In FY 2002, Toyota Industries conducted life cycle assessments focused on the manufacturing phase for both old- and new-style hydraulic fittings (see below) used in forklift trucks, assessing the amount of reduction in pollutants released into the air in the manufacturing process for the new-style fittings.

Hydraulic Fittings

LCA of Hydraulic Fittings

Comparison of Manufacturing Processes



Hydraulic Fitting Assessment

The life cycle assessment for hydraulic fittings was restricted to the manufacturing stage, commencing with the manufacturing of materials used for the fittings. Toyota Industries chose to focus the assessment on the manufacturing stage due to its impact on the cost of manufacturing the product. The assessment precluded the non-manufacturing stages of the product life cycle such as the product use, disposal and product recycling stages.

In order to assess the processes used in common by the old and new products, Toyota Industries made use of both published values and database values that are included in commercial LCA software. In contrast, all unique processes were assessed and compared using the following three assessment methods, due to the potential cost reduction and their impact on the overall assessment results:

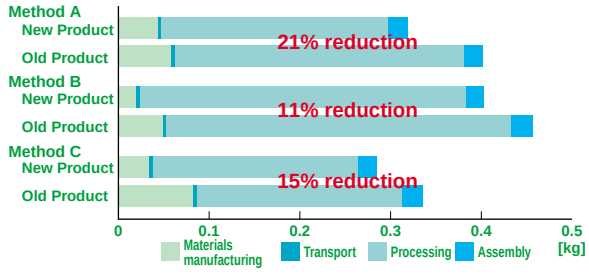
Method A: Assessment based on survey of actual energy consumption
Method B: Assessment based on functional unit* used for household appliances
Method C: Assessment based on functional unit used for automotive parts

*Functional unit: CO_2 emissions per material mass in a production process.

Assessment Results

The Method A assessment resulted in the greatest difference between the new and old products. The difference was smaller when using the Method B and Method C assessments despite the process change from forging to bending, which significantly reduces the overall energy consumed in manufacturing the new product. The variation between the various assessment results was caused by the absence of a functional unit for the forging process, which resulted in its exclusion from the assessment results for the Method B and Method C assessments. Therefore, the absence of a functional unit resulted in an over assessment of CO_2 emissions in the Method B assessment and an under assessment in the Method C assessment.

CO_2 Emissions per Product



*Percentages represent the difference in CO_2 emissions between the new and old products.

Future Activities

Toyota Industries will focus its future efforts on identifying functional units to be used in future life cycle assessments, which will help it to conduct assessments more efficiently within the available time frame for development of the product.

In order to achieve this goal, the company will measure the actual environmental impact when the functional unit used has a significant impact on the LCA results. In terms of using existing functional units, Toyota Industries will determine the source of the functional unit and establish a system that will allow it to verify the assessment results.

Furthermore, Toyota Industries will concentrate on creating an efficient and reliable LCA methodology that builds upon previous assessments and research. The company will establish a system so that life cycle assessments can be rapidly conducted at the product development stage, with the aim of assessing the environmental impact of the product throughout its life cycle.

Recycling

Toyota Industries revised its in-house recycling design guidelines in response to the introduction of international standards for recyclability evaluation.

Toyota Industries is strongly committed to the concept of recycling design, based on the principle of "reduce, reuse and recycle"—in that order of priority. The company believes that reusing rather than recycling and reducing rather than reusing will result in the least impact on the global environment. In addition, Toyota Industries is directing its recycling design efforts toward increasing the life of its products as a means of reducing their environmental impact.

In FY 2002, Toyota Industries revised its in-house recycling design guidelines in order to continue to promote recycling design. In addition, the company carried out surveys used to monitor the disposal of its products. The survey results were used to guide product development efforts within the company.

■ Revised Recycling Design Guidelines

Toyota Industries published its original Recyclable Design Guidelines in March 2001, in order to promote recyclable design on a company-wide basis. The company revised the Guidelines in FY 2002 in response to new ISO standards, which came about as a result of the European Union's adoption of the ELV directive. The ELV directive sets minimum standards for recyclability in vehicles sold in Europe starting from 2005.

The revisions to the company's Recyclable Design Guidelines led to several new efforts during FY 2002. For example, the company set about reducing its reliance on PVCs that are known to release toxic gases during incineration. Toyota Industries also began to label its plastic and rubber parts to indicate the material composition for the purpose of recyclability calculations.

■ Automotive Wrecking Survey

Based on the recent introduction of Japanese regulations such as the Automobile Recycling Law and the Fluorocarbons Recovery and Destruction Law, Toyota Industries continued to conduct field surveys regarding the disposal of automobiles, which it first began surveying in FY 2001, and confirmed methods for the reclamation of hydrofluorocarbons (HFCs) from car air-conditioners and the disassembly and recycling of airbag systems from cars.

Toyota Industries also conducted a field survey regarding the scrapping and disassembly of forklift trucks. The results from this survey helped to reinforce the importance of recycling design.

Disassembly of Automobile

■ Extended Life Forklift Survey

In FY 2002, Toyota Industries conducted a field survey of its G3 automatic looms, which were originally introduced in 1961 and are still being used today. In FY 2002, the company conducted a field survey on the 5LR forklift truck, which was originally introduced in 1967.

Recycling design requires an optimal balance of cost reduction, safety and durability in a product. These characteristics are all found in the 5LR forklift truck. Toyota Industries is committed to promoting extended-life products as part of its activities to incorporate recyclable design into its products.

Toyota Industries 5LR Forklift Truck (Manufactured in 1967)

Future Activities

Toyota Industries will create an environmental data system starting from FY 2003. The system will be used for calculating the recyclability of its products, and for determining the amounts of substances of concern used in these products. The system will also assist in the conducting of life cycle assessments and recyclability evaluations in a precise and rapid manner. The creation of an environmental data system will also help Toyota Industries to continue to develop environmentally conscious products for the long term.

Subsidiary Spotlight

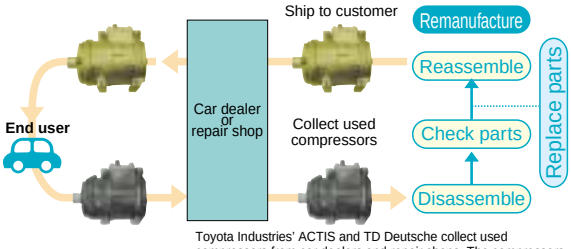
Remanufacturing Car Air-Conditioning Compressors

In the U.S. and Europe, demand is increasing for reconditioned or remanufactured automotive components, reflecting social and environmental needs for more efficient utilization of parts and resources. In response to this trend, ACTIS Manufacturing, Ltd. LLC in North America and TD Deutche Kilmakompressor GmbH in Europe have begun remanufacturing car air-conditioning compressors. The two companies disassemble used compressors, replace worn parts with new ones, then reassemble the units for sale as remanufactured compressors.

In 2002, the two subsidiaries sold approximately 50,000 compressors to the U.S. and European aftermarkets.

Toyota Industries is committed to making contributions to resource conservation by increasing the number of remanufactured products it sells in the future.

Remanufacturing Process



Toyota Industries' ACTIS and TD Deutsche collect used compressors from car dealers and repair shops. The compressors are remanufactured and later resold to dealers and repair shops.

Environmentally Conscious Products

Toyota Industries is incorporating environmentally conscious designs in all of its products.

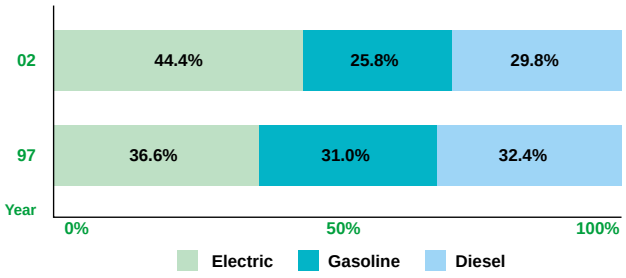
■ Environmentally Conscious Forklift Trucks

The forklift truck manufacturing industries has continued to witness growing demand for environmentally conscious forklift trucks and electric forklift trucks that produce less vibration, noise and exhaust gas emissions. Toyota Industries recently developed the new GENEO-E (7FBE outside Japan) forklift truck, as part of its best-selling GENEO series (7 series) of forklift trucks. The GENEO-E forklift truck is a three-wheel, electric counterbalanced forklift that is designed to meet a wide range of needs. The GENEO-E was released in January 2003 and is equipped with the SAS-AC*1 system, a combined safety system, and an AC (alternating current) power system.

In addition, Toyota Industries expanded its line of GENEO-B electric counterbalanced forklift trucks (7FB outside Japan) by adding 3.5-4.5 ton capacity units. The company also added a new 0.9 ton capacity unit to the GENEO-R series of electric reach trucks (7FBR outside Japan). All of the above models were released together in the Japanese market in December 2002.

Toyota Industries also enhanced its line of gas-powered forklift trucks by reducing exhaust gas emissions and adding versions that run on compressed natural gas (CNG). The CNG-powered forklift trucks help to reduce the CO_2 emissions that contribute to global warming, and have almost completely eliminated SOx emissions, which can cause acid rain.

Domestic Forklift Truck Sales by Engine Type Data from the Japan Industrial Vehicles Association (JIVA)



GENEO-B
Electric Counterbalanced
Forklift Truck
(7FB outside Japan)

GENEO-E
Three-Wheel Electric
Counterbalanced
Forklift Truck
(7FBE outside Japan)

■ Development of Low Emission*2 Diesel Engine

Diesel engines operate at a high thermal efficiency for better fuel efficiency, which makes them effective in preventing global warming. However, increasingly strict regulations are being placed on exhaust gas emissions from diesel engines, which has prompted Toyota Industries to place great emphasis on achieving regulatory compliance with exhaust gas emission standards as part of its development efforts for diesel engines.

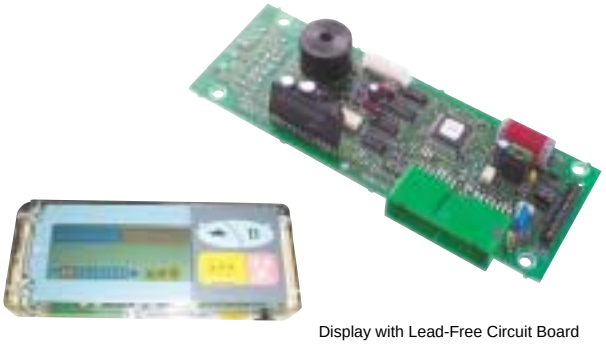
Toyota Industries recently redesigned its 2Z direct injection diesel engine in order to comply with Japanese 2003 exhaust gas emission standards for forklift trucks and other special vehicles. The 2Z diesel engine is used in the company's GENEO series (7 series outside Japan) of diesel forklift trucks, which are available in capacities ranging from 2.0 to 3.5 tons. The redesigned 2Z engine uses an improved injection pump that delivers optimal injection timing performance and secondary injection suppression, as well as an improved injection nozzle that offers fine misting performance. As a result of these changes, the redesigned 2Z diesel engine delivers reduced traces of NOx, total hydrocarbon (THC) and particulate matter (PM) emissions in exhaust gas emissions.

2Z Direct Injection Diesel Engine

■ Lead-Free Circuit Boards

Lead contained in solder used in circuit boards has been noted for polluting the environment when it is not properly disposed of. Consequently, Toyota Industries is trying to switch to lead-free solder in its circuit boards for its industrial machinery, automobiles and textile machinery products.

When designing circuit boards with lead-free solder, Toyota Industries had to overcome various issues such as the high melting point of lead-free solder, which made it difficult to control soldering temperatures while ensuring that parts could stand the heat. However, Toyota Industries was successful in overcoming these issues and in January 2003 began producing lead-free circuit boards for use in the displays for one of its electric reach truck models.



Display with Lead-Free Circuit Board

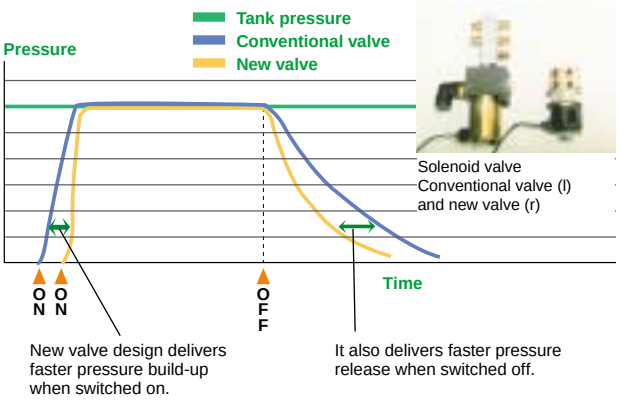
*1 SAS-AC System of Active Stability and AC Power Control: A safety system that uses an electric-hydraulic control system to prevent operating errors and lateral tipping during rapid maneuvering.
*2 Low emission: Indicates exhaust gas emissions low in CO, NOx and particulate matter (PM).

■ Energy Conservation

Textile machinery has a tendency to consume large amounts of energy during operation. When Toyota Industries set about developing an environmentally conscious air jet loom, the company had to reduce the consumption of air used to insert weft yarn. Toyota Industries was eventually successful in developing the new JAT710 Air Jet Loom, which boasts greater energy efficiency and 20% less air consumption. The new air jet loom was made possible by the company's development of a new air solenoid valve* that is smaller and offers faster pressure build-up and better release performance than its predecessors.

JAT710 Air Jet Loom

Pressure Characteristics of New Air Solenoid Valve



Subsidiary Spotlight

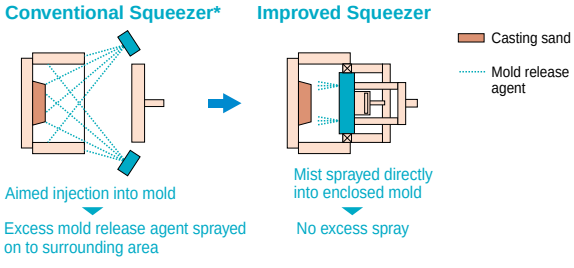
Tokyu Co., Ltd.

New Flaskless Molding Machine Consumes 20% Less Power and Is 10 dB Quieter than Conventional Machines

Tokyu Co., Ltd. develops and manufactures forging machinery. Since acquiring ISO 14001 certification in November 2001, Tokyu has been actively working to reduce the environmental impact of its manufacturing activities. In addition, the company has also taken steps to reduce the environmental impact of its products.

One area that Tokyu is involved in is the design and manufacturing of flaskless molding machines. In FY 2002, the company released the new AMF V flaskless molding machine, which is 10 dB quieter and consumes 20% less power than conventional machines. The reduced power consumption was achieved by redesigning the sand feed system and using a new injection method for mold release agents. The latter change helped to reduce the power consumption in the hydraulic unit and the amount of air consumed by the machine. Noise reduction was achieved by decreasing the size of the hydraulic pump and by improving the air blow system.

Improved Injection Method for Mold Release Agents



*Squeezer: Device used to squeeze casting sand into mold

New AMF V Flaskless Molding Machine

Advanced Logistics Solutions Co., Ltd.

Subsidiary Specializes in Logistics Solutions that Combine Logistics Efficiency and Environmental Efficiency

In March 2002, Toyota Industries established a new subsidiary, Advanced Logistics Solutions Co., Ltd. (ALSO), which plans overall logistics operations (including distribution) and operates distribution centers. We aim to respond to increasing market needs for streamlined logistics by utilizing our longstanding experience in the production and sale of materials handling equipment, such as forklift trucks and automated storage and retrieval systems.

ALSO seeks to provide logistics solutions that are both logistically efficient and environmentally conscious. The company's expertise is rooted in the Toyota Production System, which was originally formulated by Toyota Motor Corporation. ALSO applies these concepts to logistics operations to reduce overburden, waste, and unevenness existing in operations, and consequently helping preserve the environment.

ALSO currently manages both a parts distribution center for industrial vehicles that is located in Toyota Industries' Takahama Plant, and distribution centers for pharmaceutical products and convenience store products providing efficient logistics solutions. The company will seek further growth by providing optimized logistics solutions for a wide range of firms involved in manufacturing food, distribution, and other business areas.

*Solenoid valve: A direction control valve used to control the flow of air or hydraulic fluid. When a current is supplied to the internal magnetic coil, the valve is operated using magnetic force.

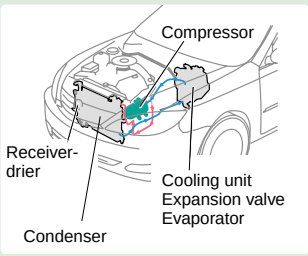
Spotlight **Car Air-Conditioning Compressors**

Toyota Industries continues to lead the industry through its efforts to reduce the environmental impact of car air-conditioning compressors.

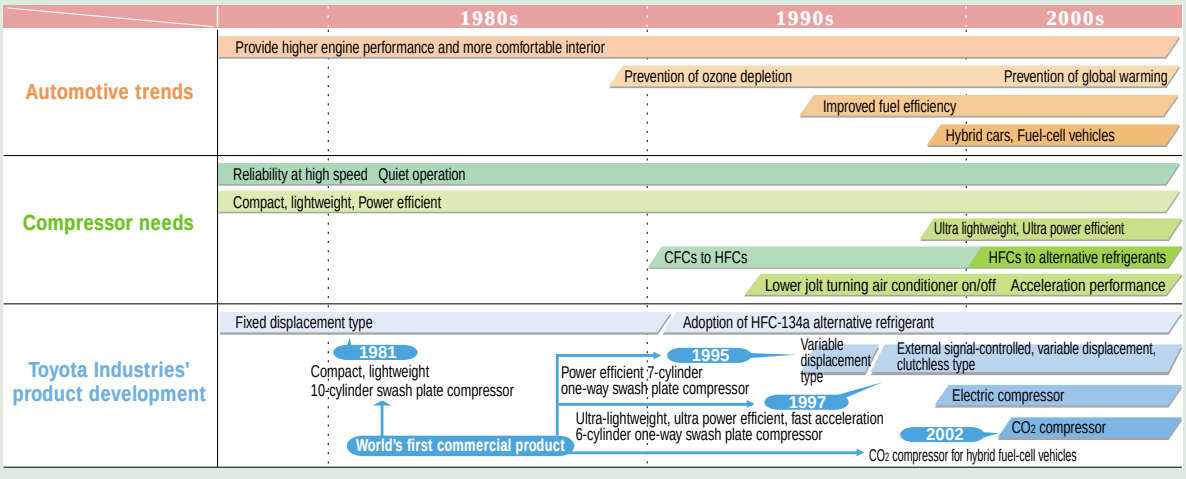
The company has made its compressors lighter to improve fuel efficiency and is exploring the use of natural refrigerants for its compressors.

In December 2002, the Japanese government took delivery of four revolutionary hydrogen-powered fuel-cell hybrid vehicles developed by Toyota Motor Corporation. These cars were equipped with an electrically driven CO_2 compressor that Toyota Industries jointly developed with DENSO Corporation. CO_2 is a natural refrigerant.

In addition to offering outstanding cooling performance and durability, the new compressor is ideally positioned for use in the next generation of vehicles, since it contributes to protect ozone layer depletion and to slow down global warming. Major technological leaps in compressor technology have always been triggered by society's increasing concern for the environment.



Automotive Trends and Toyota Industries' Compressor Product Development



●Improving Fuel Efficiency

Since the 1990s, Toyota Industries has continually sought to improve the fuel efficiency of its compressor products in an attempt to minimize air pollution and prevent global warming. The company's efforts have been focused on reducing weight and improving the efficiency of its compressors.

■ Weight Savings Made Possible by Advanced Technologies

Toyota Industries has led the compressor industry through its aggressive efforts to incorporate aluminum in its compressor products. Aluminum is lighter than other materials but also lacks strength. Toyota Industries has succeeded in reducing the weight of its compressors by carefully selecting appropriate materials that are shaped for optimum performance. This same expertise was also used in the development of the company's CO_2 compressor.

■ World's First Variable Displacement Compressor with One-Way Swash Plate

Toyota Industries developed the world's first variable displacement compressor with a one-way swash plate. This compressor delivers a variable output displacement in response to external variables such as the outside temperature, sunlight and driving speed. Toyota Industries developed this compressor based on the need for improved cabin comfort, faster acceleration and improved fuel efficiency.

In response to the increasing interest in environmental conservation and fuel efficiency, Toyota Industries developed an external signal-controlled, variable displacement, clutchless compressor. This compressor offers dramatically improved fuel efficiency for air conditioners by incorporating sensors that detect changes in engine acceleration and other external variables.

Future Activities

Toyota Industries will continue its efforts to improve the fuel efficiency of its compressor products by focusing on its proprietary weight reduction technology and external signal-controlled, variable displacement compressor technology. The company will also expand its line of variable displacement compressors in order to offer environmentally conscious compressors for all applications. Furthermore, Toyota Industries will develop new compressors that offer outstanding fuel economy for use in hybrid and fuel-cell vehicles.

●Switching Refrigerants

In 1991, in response to concerns over ozone depletion, Toyota Industries began switching from CFC-12 chlorofluorocarbon-based refrigerants to HFC-134a hydrofluorocarbon-based refrigerants for use in its car air-conditioning compressors. Since then, research has indicated that the global warming potential (GWP) of HFC-134a is still 1,300 times greater than CO_2, which has led the company to explore new refrigerants that are friendlier to the environment. Toyota Industries is actively working to develop compressors that use alternative refrigerants.

■ Lubricants and Sealing Materials

As a byproduct of its successful development of hydrofluorocarbon-based compressors, Toyota Industries has succeeded in developing lubricants and sealing materials that are free of chlorofluorocarbons.

Future Activities

Experts are currently predicting that the natural refrigerant CO_2 will eventually become the refrigerant of choice for car air-conditioning compressors. However, CO_2 has several drawbacks, such as a low molecular weight allowing easy passage through rubber and other sealing materials, and a high operating pressure that requires greater component strength than was needed before.

Toyota Industries is confident that its successful attempts to develop an electrically driven CO_2 compressor for Toyota's fuel-cell hybrid vehicle will also lead to the development of a similar CO_2 compressor to be used in standard engine vehicles.

Electrically Driven CO_2 Compressor