Manufacturing Techniques Contributing to Eco-Friendliness throughout Product Lifecycles

—Design, Procurement, and Production of Inverters

Embodied in Fuji Electric's Corporate Philosophy is our pledge to continue to be an eco-friendly company comprised of responsible corporate citizens in a global society.

By accomplishing this goal, we hope to contribute to environmental preservation through the lifecycles of our various products. In this special feature, we will present some of the initiatives being introduced throughout the lifecycle of our mainstay inverter products, which are a key component for realizing energy savings in industrial fields.

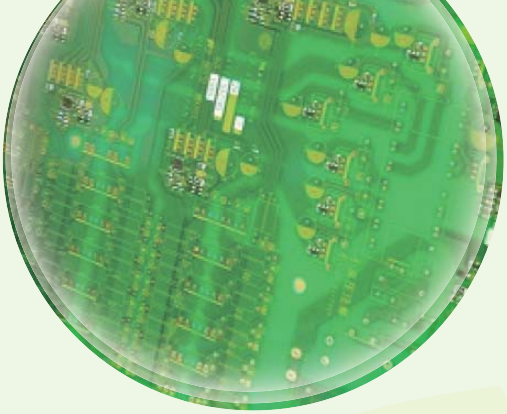
Design

Pursing Longer-Lasting, More-Durable Products

Inverters are combined with motors and are widely used in industrial and social infrastructure, including air conditioner fans, water circulating pumps, cranes, and elevators. By adjusting motor output and optimizing rotation frequency according to use, inverters are able to contribute to energy savings.

The Company's inverter design and development divisions are pursuing energy savings and working to extend product lifespan with the aim of reducing the environmental impact of these products. Extending product lifespan is a particularly important theme to be addressed as a part of the product's lifecycle due to the contributions that longer-lasting products can make to effective resource utilization. In addition to increasing lifespan, we are also designing and developing inverters to be more durable, as they are central components in a variety of equipment and machinery and must be used continuously over long periods of time.

Design and development efforts in the pursuit of energy savings and extended product lifespans



Doubling Product Lifespans to Reduce Resource Usage

The Japan Electrical Manufacturers' Association (JEMA) has not formulated standards for inverter lifespan. Rather, the Company has established its own product lifecycle standards, based on which it targets lifespans of 15 years. These standards were established with the aim of enabling customers to use our products with peace of mind for as long as possible.

For inverter components that must be replaced, such as condensers and cooling fans*, we take a number of steps to ensure that these components are also long-lasting. Carefully re-evaluating each step of the manufacturing processes for these components, we stringently select materials, revise the designs of printed wiring boards (PWBs), and improve soldering equipment. Through these efforts, we have successful developed components with lifespans of approximately 10 years, whereas their predecessors only lasted 5 years. These longer-lasting components help reduce resource usage as well as free customers from the hassle of frequent replacements.

In our constant quest to improve the durability of Fuji Electric inverters, we test them under high-temperature and high-humidity environments, while frequently stopping and starting testing apparatuses. We feel that these testings are a necessary step in ensuring satisfactory levels of durability.

Furthermore, the Company aims to reduce the environmental impact of its inverters when they are disposed of. To this end, coordination with quality assurance and procurement divisions is pursued to develop product designs that do not contain hazardous substances, and are compliant with the European Union's Restriction of Hazardous Substances (RoHS) Directive and other environmental regulations.

In these ways, we are targeting environmental impact reductions throughout the lifecycle of our products and remain conscientious of this goal throughout our design and development activities.

* The standard replacement term is five years for condensers used in inverters and two to three years for cooling fans.

VOICE Equating Long Lifespans with Quality in Product Designs

Were an inverter to cease functioning due to one of its components wearing out, it could bring a factory's production line to a halt. For this reason, long lifespans are incredibly important for inverter components.

In particular, condensers are critical to the durability of our inverters as they play an important role in filtering electrical interference. Bearing this in mind, we have compared the condensers of various manufacturers, inspecting their materials as well. For use in our inverters, we have selected those condensers that, through these comparisons, proved to be exceptionally heat resistant and capable of handling significant loads while also matching the operating conditions of all Fuji Electric inverters.

Temperatures surrounding inverters greatly affect lifespan, thus making cooling fans vital to longevity. Therefore, we selected optimal fans based on the results of airflow simulations conducted from various angles, and have also redesigned the structure of our inverters to increase the cooling effect gained from fans.

Due to such improvements, the inverters we currently sell have lifespans as long as 10 years. Going forward, we will continue to target higher levels of customer satisfaction by developing inverter designs that equate long lifespans with quality.

(Left)
Yuhei Suzuki
Standard Drive Development Section
Development Department

(Right)
Takanori Shintani
Global Drive Development Section
Development Department

Procurement

Compiling Databases of Chemical Substances Contained in Components

Inverters are created by assembling over 500 different components, including fan motors, cooling units, electric components, power semiconductors (insulated gate bipolar transistor modules (IGBTs)), and plastic cases. In making its inverters, the Company procures a number of these components from other manufacturers.

The procurement division of the Suzuka Factory in Japan, where the Company's inverters are produced, selects suppliers based on the Fuji Electric Green Procurement Guideline*, which set standards for procuring components with low environmental impact. The division also carefully manages each component to ensure that they do not contain any substances prohibited by these standards. In this way, we are reducing environmental impacts across the entire supply chain.

Specifically, we require suppliers to submit a certificate showing that prohibited substances are not used or contained in their products. Furthermore, Fuji Electric compiles databases on the chemical substances contained in the various components it uses, and shares this information throughout the Company. This information sharing enables the Company to reduce the burden of conducting environmental impact studies relating to itself and its suppliers. Moreover, with the aim of promoting compliance with environmental regulations, we periodically hold explanatory forums for suppliers to verse them on the Company's procurement policies.

Suppliers were called to the Suzuka Factory to discuss means of reducing component numbers

Fuji Electric conducts annual environmental audits investigating manufacturing subcontractors to ensure that they adhere to our procurement policies. As part of this process, we visit the factories of subcontractors to ensure that they are taking care to manage and prevent usage of prohibited substances. If any issues are detected, we promptly instruct the concerned party to implement improvements.

* This material procurement guideline outlines standards for evaluating suppliers based on three areas: measures for environmental preservation, measures for construction of management systems for chemical substances contained in products, and measures for content of chemical substances for supplied materials.

VOICE Sharing a Spirit of Environmental Preservation

My company is a press and sheet metal processing company founded in 1971. In an effort to reduce the environmental footprint of the surrounding community and contribute to environmental preservation, we have acquired ISO 14001 certification and have also established environmental goals. Our efforts toward meetings these goals are accelerating every year.

We supply Fuji Electric's Suzuka Factory with sheet metal and pressed products for use in inverters and motors. The factory orders components from us when they are needed, and we deliver these using the "milk run" method. As we receive orders on a daily basis, production volumes are stable and we are able to keep our inventories low.

We share a mutual goal of environmental preservation with Fuji Electric, and are working together to implement initiatives that help protect the environment.

Masahiko Maeda
President
Maeda Technica Co., Ltd.

Reducing CO_2 Emissions through the "Milk Run" Method

Procurement divisions are working to reduce CO_2 emissions associated with the transportations of products.

One way we are realizing such reductions is through a logistics method known as the "milk run" method. In this method, one large-scale truck collects components from various different suppliers. We have operated one such route since fiscal 2010.

Previously, deliveries along this route entailed several trucks making roundtrips between the Company's factory and one of six component manufacturers. However, we now use only one large-scale truck to collect deliveries from all six manufacturers. This has resulted in annual CO_2 emissions reductions of 4.5 tons.

Further, Wuxi Fuji Electric FA Co., Ltd., a subsidiary located in China that manufactures inverters, is actively procuring components locally. By purchasing components from local manufacturers rather than have them delivered from Japan, the Company is reducing the CO_2 emitted when transporting these components. This company procures approximately 80% of components locally, with the principle exception being the core IGBTs that are produced by Fuji Electric's Matsumoto Factory in Japan.

Logistics truck on a "milk run"

VOICE Promoting Indispensable Cooperation with Partner Companies

In procurement divisions, our efforts to reduce environmental impacts can be divided into two main categories: selecting eco-friendly components and reducing logistics-related CO_2 emissions. For the former, we work in close coordination with design and development divisions to ensure that they consider environmental impact reduction when selecting components to be used in drawing up designs. For the latter, we are considering expanding the scope of the logistics initiative involving the "milk run" method that was implemented in fiscal 2010, as this initiative has proven to be highly effective. Also, Wuxi Fuji Electric is increasing the amount of components it procures locally.

Cooperation with partner companies is absolutely essential to the success of such efforts by procurement divisions. Going forward, we will continue to work together with suppliers and subcontractors as we vigorously pursue improved product quality and environmental preservation.

(Left)
Tatsuya Suzuki
Inverter and Servo System Design Section
Design Department

(Right)
Hiroshi Furuichi
Purchasing Section
Purchasing Department

Production

Reforming Production Processes to Minimize Chemical Use

At Fuji Electric factories, we are striving to develop manufacturing processes that not only guarantee the high levels of quality and functionality that customers expect but that are also eco-friendly.

To this end, we are implementing ongoing improvements throughout all areas of production sites. These include the development of new production technologies that reduce resource usage and waste production during manufacturing and the introduction of production facilities that improve electricity and fuel efficiency.

Inverter production begins with the creation of circuit boards. In mounting IGBTs, condensers, and other electronic components to these boards, chemicals such as solder, flux, and cleaning agents are used. In order to minimize the use of these chemicals, we analyze production line processes while sending boards down the line at different angles and speeds and measuring the chemical usage and remaining stock volumes. This information is applied to the development of production processes that use lower volumes of chemicals. Furthermore, we aim to prevent over usage of chemicals or unnecessary release into the atmosphere stemming from deterioration or malfunction of production equipment. In this pursuit, we utilize data collected by analyzing each piece of equipment to inspect and improve facilities, while also preventing waste.

Going forward, we plan to begin production of circuit boards at our production bases in China. To reduce the environmental footprint of our overseas production bases, we will implement the chemical-reduction initiatives that we have put in place in Japan.

Circuit board production equipment

VOICE Achieving Both Improved Productivity and Lower Environment Impact

With the aim of making our manufacturing operations eco-friendly, we have continued to inspect various production facilities used for soldering processes in search of ones that required lower volumes of chemicals. Based on these inspections, we chose to introduce tabletop selective soldering system to replace the previously used inclined wave soldering system.

Previously used facilities enabled solder to be applied to several electronic components at once by submersing them in a solder basin. However, this required flux—a substance used to facilitate this process—to be applied to the entire board, thus resulting in wasted chemicals. Furthermore, this process requires the use of large amounts of nitrogen, as it is effective in limiting the oxidation of solder. The introduction of the selective soldering system has enabled us to realize substantial reductions in flux and nitrogen, with flux usage down 97% and nitrogen usage down 94%.

In this manner, we believe that ideas for reducing chemical usage are often inspired by daily productivity improvement efforts. In the future, we will continue to pursue greater reductions in environmental impact through such straightforward and diligent efforts.

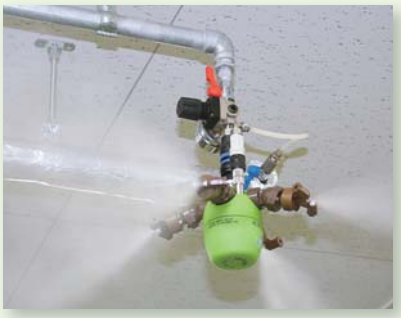
Yasuhiro Shiramizu
Manufacturing Engineering Section
Manufacturing Department

Reevaluating Production Facilities to Reduce Energy Usage

When replacing or introducing new production facilities, we make sure to select those that feature low energy usage.

In fiscal 2011, we confirmed the energy usage levels of all our production facilities. This was a move inspired by the significant pressure that was placed on the supply and demand balance for electricity at the time, a result of the Great East Japan Earthquake which occurred in March 2011. Production lines for circuit boards must be equipped with means of preventing the accumulation of static electricity by controlling levels of humidity. The steam-based humidifiers that were used previously successfully raised humidity levels, but a large amount of electricity was required for heating the water this equipment used. For this reason, we decided to switch to more energy-efficient equipment. Dry fog humidifiers, which do not require heating, were judged to be capable of maintaining sufficient levels of humidity for the operation of circuit board production lines, and their introduction helped realize substantial levels of energy consumption reduction, reducing energy usage by 97% when compared to previous facilities and leading to a year-on-year decrease of 47 tons in CO_2 emissions.

We have also implemented other measures to reduce our environmental impact through lower electricity and fuel usage, including introducing LED lighting and electric forklifts.



Humidity-adjusting dry fog

Lowering CO_2 Emissions at IGBT Production Bases

The IGBT power semiconductor modules mounted on circuit boards are a core element of inverters as they optimize electricity control for the entire device. IGBTs are produced at Fuji Electric's Matsumoto Factory, Fuji Electric (Malaysia) Sdn. Bhd., and four other sites inside and outside of Japan.

IGBT production requires a significant amount of electricity as they must be manufactured by large-scale equipment inside clean rooms that are completely free of dust and other potentially disruptive particles. To reduce its environmental footprint while still meeting this substantial electricity demand, the Matsumoto Factory has introduced cogeneration systems.

Cogeneration systems are a type of in-house generator that utilizes city gas as a fuel source to generate electricity and heat energy. The generation efficiency (ratio of energy used in generation that is converted into electricity) of a standard generator is around 40%. Cogeneration systems, however, utilize exhaust heat in a highly efficient manner, enabling these systems to realize generation efficiency of closer to 80%. Since 2002, the Matsumoto Factory has introduced three such cogeneration systems, which supply approximately 80% of the energy used by the factory. These systems have also enabled the factory to cut CO_2 emissions by approximately 26% compared with previous levels.

IGBT

Cogeneration System Unit 3