8. The Role of Japan in Research and Development—Internal Globalization and Technology Transfer

Having described the basic direction of research and development of environment friendly energy technologies according to international trends, stating our opinion, we would like to clarify the role that Japan should play for the sustainable development of Asian countries in the 21st century.

With a new understanding of the even higher importance of basic research in science and technology, the Japanese government decided in a Cabinet meeting in July 1996, that the government funding for science and technology would be tataling about 150 billion US Dollars for the next five years. Starting in 1996, research subsidies were available to invite public contribution at the Science and Technology Agency, the Ministry of International Trade and Industry, the Ministry of Agriculture, Forestry and Fisheries, etc. Research and development projects from small to large scale will be encouraged. A limited number of the larger projects have been opened to international research groups.

It is very likely that the trend to a multinational industrial production, sharing work horizontally across borders, will fully strengthen in the coming century. As an industrially advanced nation, Japan has a duty to take leadership in the field of research and development in the internationalization process. In the light of ever increasing international competition, it should be of importance to admit research investments up to certain levels for large projects by foreign research institutions. Through sharing research and development internationally, promoting internal globalization within Japan, we can contribute effectively to horizontal multinational production structures.

Even though we stressed the importance of internal globalizaiton, it is needless to say that technology transfer to the developing countries is also very important. Developing countries always have the tendency to buy conventional machines with a low inital cost. We strongly recommend that the developing countries would adopt advanced energy conservative technologies with very low emmissions to the environment. This will need a high initial cost, but a low running cost. As a result, the total life-span cost of the advanced machines will be lower than that of conventional machines. As we showed in the second report of IPCC, a key point in solving the climate change problem is technology transfer into developing countries. Avoiding the operation of outdated production processes, one should give the highest priority to the introduction of modern technology production processes which benefit both environment and energy economy. As a matter of course, when appropriate training is included, technology transfer can greatly contribute to solve the global environment problem.

Lead by real globalism, we should start constructing technology newworks without national boundaries.

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JSME AWARDS IN 1997

JSME Medal for Distinguished Engineers

Tomotsugu Sakai, Toyota Motor Corporation
for Studies on fastening and loosening of bolted joints and their application to joint design

Kenji Hirakawa, Kyushu University
for Evaluation and Improvement of the Strength of the Railway Wheel-Sets

JSME Medal for Outstanding Paper

Change in Residual Strain in Rat Thoracic Aorta Due to Smooth Muscle Contraction/Relaxation (Positional Variation along the Aortic Tree)
Takeo Matsumoto, Shiro Nagano and Masaaki Sato, Tohoku University

Analysis of Isolated Outer Hair Cell Motility Using Patch-Clamp Technique
Hiroshi Wada, Tohoku University, Kunihiko Satoh, Komatsu Ltd., Michiko Sugawara, Susumu Takeuchi and Katsuhisa Ikeda, Tohoku University

Proposal of Creep-Fatigue Life Evaluation Method for Ferritic Alloy Steels
Takashi Ogata and Akito Nitta, Central Research Institute of Electric Power Industry

X-Ray Stress Measurement of Aluminum Thin Films Sputtered on Silicon Wafers

Table 1. Major Specification and Performance

Vehicle Type		5 Door
Curb Weight	(kg)	1540
Seating Capacity		5
Range	(km)	215 (Japan 10·15 Mode)
Maximum Speed	(km/h)	125
Charging	On-Board (hr)	6.5 (SOC20-100%)
	Stationary (hr)	0.5 (SOC30% Recovery)
Propulsion Battery	Type	Nickel Metal Hydride
	Number of Modules	24
	Total Voltage (V)	288
	Total Weight (kg)	450
Propulsion Motor	Type	AC Synchronous
	Maximum Power (kW)	50
	Maximum Torque (Nm)	190

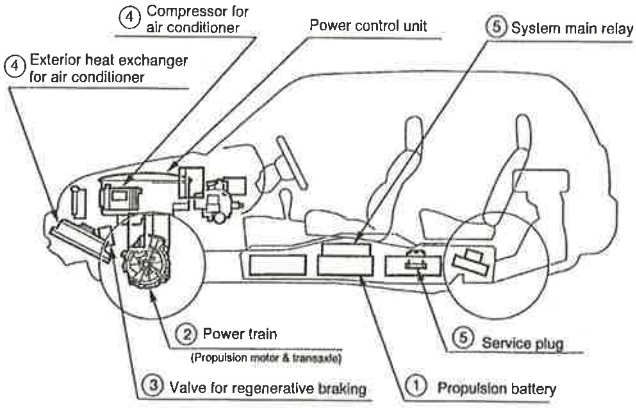


Fig. 1 Arrangement of the Major EV units

door model (photo 1) both in Japan and in the United States.

2. Technical feature

2.1 Major Specification and Performance

The major specification and performance of the RAV4 EV are shown in Table 1.

2.2 Vehicle Characteristics

The major characteristics of the vehicle are as follows.

(1) Total Balance of Vehicle Performance

The range per charge has been extended to more than 200 kilometers by using newly developed nickel metal-hydride batteries and a permanent magnet motor, as well as a high-efficient regenerative brake system. Performance is maintained at a high level constantly regardless of the state of the batteries. The quiet vehicle fits for an urban driving and a short distance inter-city highway travel.

(2) Vehicle Packaging

The RAV4 EV preserves certain advantages of the base vehicle. The cargo compartment's flat floor maximizes storage capacity, and the rear seats can be fold up to enlarge the cargo space. The wide opening rear door and lip-free door sill make loading and unloading easy.

(3) Usage and Comfort

The RAV4 EV is designed for ease of use and comfort(ability) with amenities such as power steering and air conditioning. Switches, instruments, and other control units are designed as much as possible so that drivers canfeel like those of gasoline-powered vehicles.

The on-board battery charger is provided with a one-touch connector, marking it easy to recharge the battery from any ordinary power outlet.

(4) Propulsion Batteries

Higher performance, longer life, and maintenance-free propulsion batteries have been developed.

2.3 EV Units

The arrangement of the major EV units is shown in Figure 1.

Details of the units and system are as follows.

(1) Propulsion Batteries

Toyota has developed the nickel metal-hydride batteries which provide the stable power output, approximately twice the performance and three times the product life of the lead acid batteries used heretofore in EVs. 24 batteries are installed in a battery carrier under the floor. The battery carrier is made of fiber reinforced lightweight plastics. Because batteries have a sealed structure, water refilling and other maintenance are unnecessary.

(2) Power train

By using a heat-resisting rare-earth metal magnet (neodium-iron-boron type) with high magnetic flux density in the rotor and adopting field weakening control to reduce the back electromotive force, a permanent magnet synchronous motor which covers all operating range from a low motor speed with high torque to a high motor speed with high power has been developed. Adoption of both a planetary gear transaxle with a stepped pinion gear and a permanent magnet synchronous motor which rotate on the same shaft, could make the power train more efficient, lighter, and smaller.

(3) Regenerative Brake System

When vehicle decelerates, the system operates the propulsion motor as a generator to convert the kinetic energy of the vehicle's motion into electrical energy, which is then stored in the propulsion batteries at the same time as it generates braking force. The braking system of the RAV4 EV has been developed so that the regenerative brake is primarily used at initial stage of braking. The energy recovering rate varies depending on the driving conditions, but for example, on city driving, the energy recovery reaches as much as 30%.

(4) Air condition system

A high performance gas injection type heat-pump air conditioner with scroll compressor has been developed to increase the efficiency of climate control. The ventilation system features a two-level flow that uses the cabin air effectively to reduce ventilation loss. These provide performance comparable to that of an internal combustion engine vehicle's system in a wide temperature range, even when the outside air temperature is low. To prevent damage to the ozone layer, refrigerant HFC134a is used.

(5) Safety

The vehicle's electrical system has been designed to ensure safety in all operating conditions and during maintenance and repair.

3. Conclusion

The performanced and convenience of RAV4 EV have succeeded in getting very high praise from governmental agencies and businesses both in Japan and the United States. We believe the EV has reached the point where its performance is comparable to that of a gasoline vehicle if it is used for particular purposes and within limited circumstances.

In order to gain widespread public support for EVs in the future, we are naturally striving to improve further the vehicle performance and to reduce vehicle cost, and we would paticularyly like to create a new market of EVs where the vehicle will be used in more different places and ways.

◆ Development of an NC Grinding Machine Facilitating the Production of Nonaxisymmetric Aspheric Lenses

Susumu Saito, Kouji Takahashi, Kenichi Kugai, Hitachi Koki Co., Ltd.,
Shigeo Moriyama and Akira Arimoto, Hitachi, Ltd.

1. Introduction

A new NC grinding machine, which facilitates the production of nonaxisymmetric aspheric lenses used for the scanning optics of laser beam printers, was developed. These lenses are similar to conventional toric lenses, but from the center of the lens to the respective ends, the radius in the direction perpendicular to the laser beam scanning increases continuously at different rates. This type of an aspheric lens is not axisymmetrical and therefore is difficult to be produced with conventional grinding or lapping. To overcome this problem and to facilitate the production of this type of aspheric glass lens, we were the first in the world to develop a new machine, in which two rotating motions and one linear motion are numerically and simultaneously controlled.

2. Description of the Technology

In Fig.1, the newly developed grinding machine, which facilitates the production of nonaxisymmetric aspheric glass lenses, is schematically shown. Six glass blanks are fixed on a turntable which rotates at a constant speed of 4 rpm. The radius of the turntable coincides with the radius of the lens in the laser beam scanning direction. The surfaces of the blanks are processed with a diamond grinding wheel that is

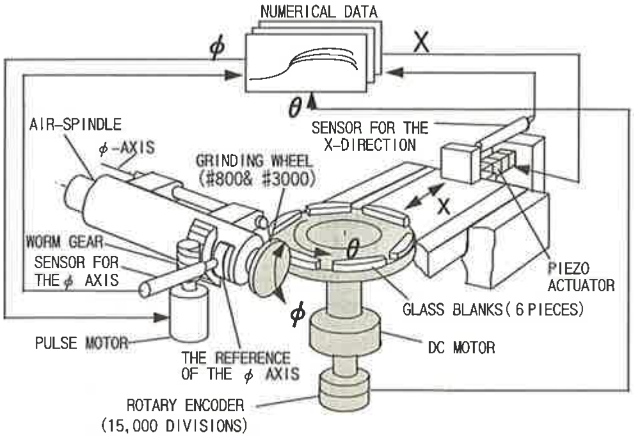


Fig. 1 Schematic diagram of the grinding machine for nonaxisymmetric aspheric lens

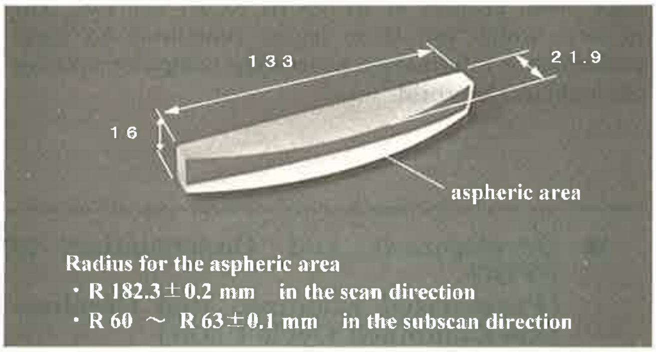


Fig. 2 An example of a processed nonaxisymmetric lens

positioned at the end of an air spindle shaft rotating at more than 7500 rpm. At every one rotation of the turntable, the blank surfaces are belt-like ground at a narrow band of about 50μm and after that, the air spindle is moved step-like in the ϕ direction by a pulse motor, and the same process is repeated.

On the other hand, corresponing to each encoder signal which detects the position of the turntable, numerical data for the aspherical surface shape, are read out from a computer and drive the piezo actuator. Thereby, the turntable is rapidly driven in the X direction and the grinding depth is controlled without time delay. The numerical data is exchanged at every step movement of the air spindle. By combining the numerically controlled movement of the turntable and the step movement of the air spindle with the grinding wheel, plural lenses with discretionary surface shapes can be manufactured at the same time.

With this machine, six aspheric surfaces with area size of 135×20 mm can be finished using a two-step grinding process, i.e., coarse and fine grinding. The processing time takes approximately 2 hours.

Figure 2 shows an example of a processed lens. It has a leading length of 133 mm and a radius of 182.3 mm in the laser beam scanning direction. In contrast, its radius in the direction perpendicular to the laser beam scanning increases continuously from 60.0 mm at the center of the lens to 62.1 mm and 62.5 mm at both the ends respectively. These values can be changed depending on the optical specification.

Even under the requirements of high resolutions and wide angle scans with a rotating polygon mirror, an optical system utilizing the above aspheric lens, in comparison with a system using conventional lenses, can easily eliminate field curvature on the scanning surface. Therefore, the newly developed machine is very effective for production of laser beam printers with high print quailty.

3. Conclusions

We were the first in the world to succeed in the development of an NC grinding machine which can produce a nonaxisymmetrical aspheric glass lens in a short processing time. The machine has been working in the optical lens manufacturing facilities for the laser beam printers at HITACHI KOKI Co. Ltd. The printers which use these lenses contribute to high-performance information processing computer systems throughout the world.

◆ Development and Construction of PFBC (Pressurized Fluidized Bed Combustion Combined Cycle Plant)

Nobuyuki Suga, Hidekazu Ishioka, Takashi Ohnishi, Hokkaido Electric Power Co., Inc.,
Shozo Kaneko and Masaaki Kinoshita, Mitsubishi Heavy Industries, Ltd.

1. Preface

In this paper we will introduce the 85MWe Tomatoh-Atsuma Unit No. 3 (Fig. 1) of the Hokkaido Electric Power Company, Inc. (HEPCO), first commercial Pressurized Fluidized Bed Combustion (PFBC) Combined Cycle Plant in Japan.

Fig. 1 Tomatoh-Atsuma Power Station No. 1, 2, 3

In recent years, coal is recognized as the most important fossil fuel for power generation, by the abundance and world-wide distribution of resources and by its economical advantages. On the other hand, superior environmental performances in particulate matters, sulfur oxides and nitrogen oxides are required and high efficiency is strongly desirable to minimize the CO_2 emission to prevent the global warming effect.

HEPCO decided to adopt PFBC Combined Cycle to its Tomatoh-Atsuma Unit NO. 3, evaluating the high efficiency and environmental superiority of PFBC C/C.

Mitsubishi Heavy Industries, Ltd. (MHI) supplied the whole system as a package, including PFBC, coal handling system, ceramic filters, steam turbine, gas turbine, heat recovery steam generator, selective catalytic reduction (SCR) system of NOx and direct digital control system.

MHI developed the ceramic filter and gas turbine technology based on its own research and development program, and to establish the final specification of the commercial plant, HEPCO and MHI did a joint R & D program since 1990.

The Tomatoh-Atsuma Unit No. 3 started its trial operation in May 1995, and finishing a variety of test programs during the trial operation, is scheduled to start its commercial operation in March, 1998.

2. Major Specification of the Unit

2.1 PFBC Island

(1) Coal/Limestone handling system

Dry feeding system of coal and limestone is adopted considering its high efficiency and reliability.

Coal is pulverized by two roller mills to 1mm average in size and supplied to the bin under the atmospheric pressure, together with ground limestone. After pressurized through lock hopper system, coal/limestone mixture is supplied to the fluidized bed boiler via distribution hopper and supply tubes.

(2) Pressurized fluidized bed boiler

The boiler is of forced circulation, reheat type with evaporation of 195 tons/hour.

Fluidized bed is separated in four cells, evaporator 1 & 2, superheater and reheater, and is operated at the bed temperature of approximately 870°C (1598°F). The change in load is controlled by the change in bed level.

(3) Dust collecting system

Dust in the flue gas from the boiler is removed in two stages. First by mechanical cyclones and secondly by ceramic filters.

Ceramic filters are operated at the temperature of approx. 850° (1562°F), and remove ash and dust to a very low level. After cleaned by the ceramic filters, hot gas enters gas turbine to generate power.

Initially, two types of ceramic elements were installed, honey comb type (20% of the total capacity) and tubular type (80% of the total capacity). Reflecting the results of operation, honey comb type was finally changed to tubular type.

2.2 Gas turbine

The gas turbine is Mitsubishi MW-151P, a single shaft machine with 3-stage turbine and 19-stage compressor. Inlet condition of gas is 0.95 MPa (138 psig) in pressure and 831° (1528°F) in temperature at rated load.

2.3 Steam turbine

The steam turbine is of reheat-regenerative condensing turbine of Mitsubishi SRT 35.4 inch with single cylinder and single exhaust flow.

Inlet steam condition is 16.6 MPa, 566/538°C.

2.4 Control System

The plant control system is Mitsubishi DIASYS direct digital control. In the main control room, CRT control panels are installed. Daily operation, start-up and shutdown are done in full automatic, by APC (Automatic Power Control System) and APS (Automatic Plant Start-up & Shutdown System).

3. Trial Operation

Trial operation was started in May 1995, starting from gas turbine spinning, followed by firing of PFBC. A variety of tests have been done since then, such as full load continuous operation test, load change tests, minimum load test, automatic start-up and shutdown tests, and tests with various coals, and confirmed satisfactory achievement of design conditions.

Official efficiency test was carried out in December, 1997 and commercial operation will start in March 9, 1998.

Operation hours up to January 1998 are; power generation hours; 6,048hrs, 100% load operation hours;
1,842hrs. Results obtained during trial operation are described in next paragraph.

4. Operation Results

4.1 Plant Performance Test

Plant performance test was carried out in Dec. 1997.

The actual gross thermal efficiency at rated load(100%) operation is 41.2% (on HHV basis). This actual thermal efficiency means 5% less CO_2 emission compared to pulverized coal fired unit with same capacity and same steam condition. Moreover all partial load thermal efficiencies are satisfied with each guaranteed values.

4.2 Environmental Performances

Emission levels of dust loading, sulfur oxides (SOx) and Nitrogen oxides (NOx) have proved to be superior to predicted values.

4.3 Load swing tests

Load change by bed level control system proved satisfactory results in both static and dynamic performance. In May and June, 1997, automatic power control adjustment was done in coordinated control mode. Load change rate of 3%/min at high load and 2%/min at lower load was successfully achieved.

4.4 Minimum Load

Stable and continuous operation was confirmed at minimum load of 30%.

Combustion, emission levels, controls were all satisfactory.

4.5 Start-up and shutdown

Full automatic start-up and shutdown by direct digital control (APS) are adopted in this unit.

Several APS tests were done for each coal and satisfactory results were obtained, ensuring automatic start-up and shutdown in commercial operation.

5. Conclusion

A variety of tests were finished in Unit No. 3 of Tomatoh-Atsuma Power Station, the first commercial PFBC combined cycle unit for utility power generation in Japan, proving the superiority in environmental performance and stable operability. In December, 1997 efficiency test was carried out and commercial operation will start in March 9, 1998.

The success in high temperature ceramic filters, will contribute to the establishment of advanced clean coal technologies.

◆ Development of the Compact High Performance Cooling Unit for Power Modules Using Boiling Heat Transfer

Masahiko Suzuki, Kiyoshi Kawaguchi, Takahide Ohara and Hiroyuki Osakabe, Denso Corporation

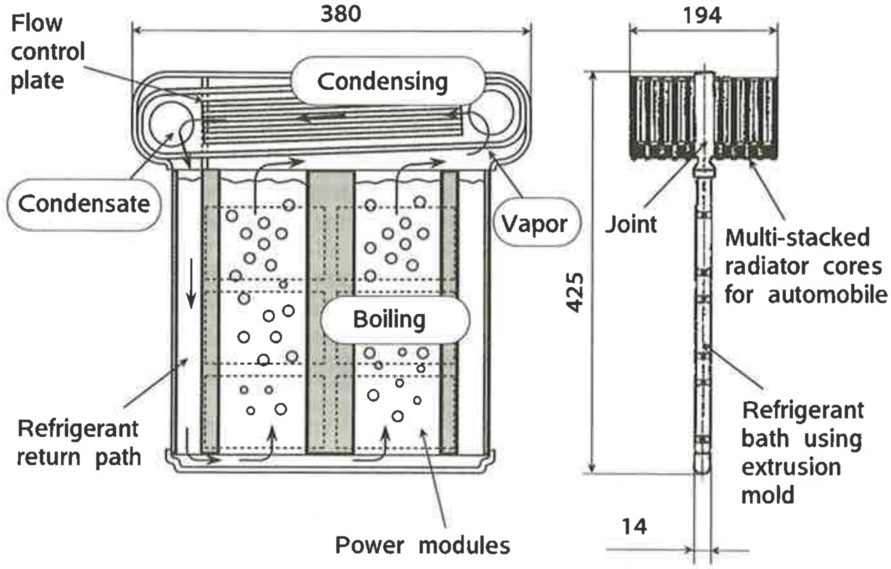
1. Overview

In recent years, power modules (semi-conductor power control elements) such as the IGBT becoming faster, more integrated, and given higher capacities. There has also been the increase in the heat load and heat flux of electronic and power control equipment, such as inverters, elevators, and uninterruptive power supplies. These developments require more compact cooling units with higher performance. In the light of this, we have developed the compact high performance cooling unit for power modules using boiling heat transfer. Since 1997, this has been available as a product for cooling industrial inverters.

2. Technical Details

Figure 1 shows the external appearance of the Compact High Performance Cooling Unit for Power Modules Using Boiling Heat Transfer. The structure of this cooling unit and its specifications are given in Figure 2. A fluorocarbon with a low boiling point and low saturated vapor pressure is used for the refrigerant. At the heat load of 2 kW, the cooling performance expressed as the temperature difference is $\Delta T=38°C$.

This cooling unit features, (1) the cooling performance that is greatly improved through the use of our own natural refrigerant flow circulation control



Items	Specifications
Cooling performance	2 kW ΔT=38℃ ΔT=Ttmax - Ta Ttmax: Max. refrigerant bath temp. Ta : Ambient temp.
Refrigerant	Perfluorocarbon
Cooling air velocity	2.4 m/s

Fig. 2 Structure of the compact high performance cooling unit and specifications

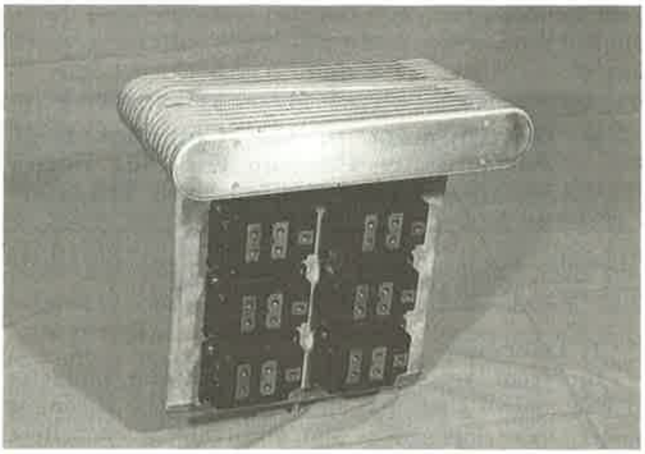


Fig. 1 External appearance of the compact high performance cooling unit

technology and, (2) an ability to accomodate itself to different heat loads and power module numbers through the use of the structure that combines multi-stacked radiator cores and an extruded refrigerant tank.

(1) Natural Refrigerant Flow Circulation Control Technology

By providing a passage for the vapor generated from boiling region and a return passage for the condensate in the extruded refrigerant tank, and by providing multi-stacked radiator cores with holes to allow the refrigerant to pass through at each end of the cores, an extremely simple circulation path is constructed. Furthermore, the cooling performance is greatly improved through the provision of a refrigerant flow control plate that allows the refrigerant to flow in only one direction in the above path, preventing interference between the vapor and the condensed liquid.

(2) Multi-stacked radiator cores and extruded refrigerant tank

Excellent air tightness is assured through the integral brazing of a condenser, formed from the multi-stacked radiator cores that utilize the high performance corrugated louver fin used for automobiles, and an thin extruded aluminium tube used as a refrigerant tank. In addition, by changing the number of multi-stacked cores and the length of the refrigerant tank it is possible to be accomodated to different heat loads and numbers of power modules.

3. Conclusion

By the above features, the present cooling unit has achieved drastic downsizing (−80%, for radiator core), weight reduction (−75%), and reduction of temperature dispersion on power modules mounting surface (−83%) when compared withe the conventional heat pipe cooling unit.

◆ Development of Non-Oxidizing Heater by High Temperature Jet Stream of Inert Gas

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1. Abstract

This Non-Oxidizing Heater, which utilizes a jet stream of high temperature inert gas, N_2 jet heater,

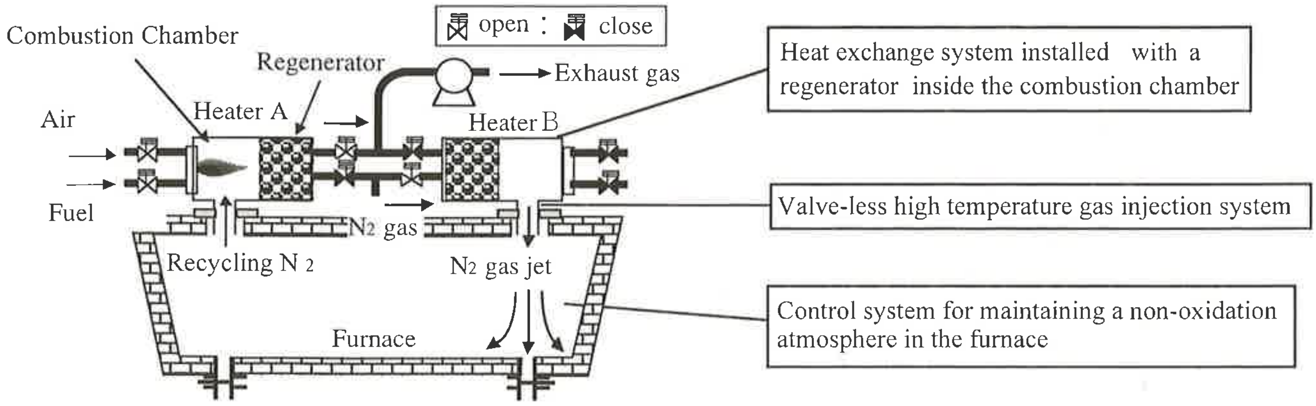

Fig. 1 Schematic diagram of N_2 Jet Heater

has been developed to heat up materials such as steel to over 1000°C under a perfect non-oxidizing atmosphere, which was almost impossible for conventional methods to achieve. Since 1995, the first manufactured equipment has been operating as the heater for the tundish-hot-cycle operation at No. 4 CC of Mizushima Works, Kawasaki Steel.

2. Description of Technology

The technical features of this technology are summarized as follows.

(1) Heat exchange system installed with a regenerator inside the combustion chamber
(2) Valve-less high temperature gas injection system.
(3) Control system for maintaining a non-oxidizing atmosphere in the furnace

One of the advantages of this system is that not only inert gas but any kind of gas can be utilized for heating up. The details of the above features are illustrated below as the case for N_2 gas.

(1) Heat exchange system installed with a regenerator inside the combustion chamber

In order to heat up N2 gas from the ambient temperature to the required high temperature and realize a high thermal efficiency, the regenerator is installed inside the combustion chamber as shown in Figure 1. This system can heat N_2 gas up to 1500°C, and can continuously supply the high temperature gas using a pair of heaters. Each heater has two modes, "Combustion mode" and "N_2 jet mode". The two modes switch over alternately every 30 to 100 seconds. During "Combustion mode", the regenerator is heated up by both combustion gas and high temperature recycling N_2 gas coming from the furnace. In "N_2 jet mode", N_2 gas is heated up passing the regenerator, and injected into the furnace. Therefore, the furnace is heated up under a perfect non-oxidizing atmosphere by the heat convection of the high temperature N_2 jet stream.

(2) Valve-less high temperature gas injection system

order to prevent combustion gas from entering into the furnace, N_2 gas used for heating up the furnace is introduced to the non-burning heater (Figure 1). This system does not require switching valve for high temperature gas. Therefore, all the problems arising from the durability of such valves are eliminated. This system also brings another advantage. Since the sensible heat of used N_2 gas is regenerated, a heat of combustion of the fuel can be transferred to the sensible heat of fresh N_2 gas at a thermal efficiency of 98%. Namely, the total thermal efficiency of this system achieves almost the same figure obtained by the direct burners.

(3) Control system maintaining a non-oxidizing atmosphere in the furnace

At the mode change of each heater, the heater is purged by recycling N_2 gas from the furnace. Furthermore, the recycling N_2 gas flow rate is controlled to maintain a certain positive pressure in the furnace through the entire operation. This system can prevent combustion gas and air from entering into the furnace.

3. Summary

This N_2 jet heater has realized to heat up materials such as steel safely to over 1000° under a perfect non-oxidizing atmosphere at a low cost, which was almost impossible for conventional methods to achieve. This developed system will be applied soon to other fields which require the material heating under a non-oxidizing atmosphere.

◆ Development of Series 500 Shinkansen Vehicle

Norihiko Yoshie, Yasuhiro Noguchi, West Japan Railway Company, Takayuki Shimomura, Railway Technical Research Institute,
Akira Hattori, Kawasaki Heavy Industreis, Ltd., and Masataka Nakamura, Hitachi, Ltd.

1. Introduction

The Series 500 vehicles run on Sanyo Shinkansen

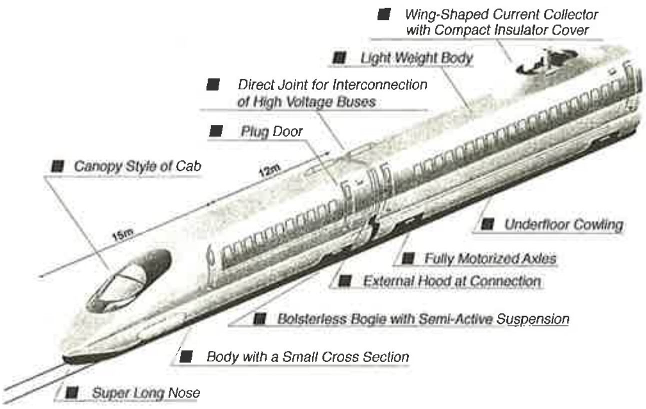

Fig. 1 Technological Features Adopted into Series 500 Vehicle

Line, first in revenue service at 300 km/h in Japan, and achieves the world speed record. To run thorough many residential areas, the vehicle is designed to have less effect on the wayside environment than conventional vehicles. It also offers better riding comfort and has achieved great cost reduction in terms of energy consumption. The service with the vehicle was inaugurated in March 1997 between Shin-Osaka and Hakata, and extended between Tokyo and Hakata in November 1997.

2. Technological Aspects of Series 500 Vehicle

Sanyo Shinkansen Line, along which the wayside population is large and half of which is covered by tunnels, projected so many technological problems on the way to achieve the speed-up: environmental matters such as wayside noise, tunnel-micro pressure waves and ground vibration, improvment of riding comfort, operational cost reduction and higher reliability. With the countermeasures of these problems, a revenue trainset of sixteen cars was built as Series 500 Shinkansen vehicle. Fig. 1 shows the vehicles technological features.

i. Wing-Shaped Current Collector

The maximum speed of the conventional vehicles on Sanyo Shinkansen Line was 270 km/h and noise level had to be suppressed as low as the conventional one despite the speed-up. Because the conventional pantographs are the major noise sources, a wing-shaped current collector is developed with a streamlined cross section. As the new current collector showed less noise, compact insulator cover is sufficient to shield noise sources on the roof.

ii. Semi-Active Suspension

Because high speed Shinkansen vehicles were thoroughly reduced their weight against ground vibration, they became sensitive to aerodynamic force and showed lateral motions easily. Dampers between car bodies and semi-active suspensions on specific cars in a trainset attained better riding comfort against the aerodynamic motions,

iii. Sharp Train Nose and Reduced Cross Sectional Area

A tunnel micro pressure wave rises between the third and tenth power of train velocity and side air pressure on the train rises in square of the velocity. To weaken them, the nose of the vehicle was lengthened to more than twice and the cross sectional area of the body, with rounded cross section, was reduced by 10% less than that of the conventional vehicle.

iv. Body Shell with Aluminum Honey Comb Panel

To lower cabin noise which grows in tunnels, brazed aluminum honey comb panels are introduced to some part of the body shell. The material contributes both to light weight and to cabin quietness.

v. Under-floor Cowling without Bolts for Maintenance

For reduction of drag force and high reliability of under-floor structure, under-floor equipment is fully covered by the car body as cowling. Under-floor equipment of conventional vehicle is inspected unedrneath; that of Series 500 is easily inspected from the sides thanks to new arrangement of the equipment and introduction of detachless ratchets. Cooling performance of the equipment is improved and the maintenance cost is reduced as a result.

Because the body surface is thoroughly smoothened for higher aerodynamic performance, the drag force of the vehicle is 35% less than that of the conventional vehicle. Together with fully motorized axles and regenerative brake system, lower energy consumption is brought about by 15% than the conventional "Nozomi" service despite the speed-up. Therefore, the vehicle can run fastest among all Shinkansen vehicles, however, it consumes electricity least.

3. Closing Remarks

The Series 500 vehicle offers the fastest train service in the world with integrated Japanese railway vehicle technology. It realizes mass-transportation, improved riding-comfort, reduced operational cost and so forth at a time, so that the vehicle satisfies the requirements of the Sanyo Shinkansen Line, such as large wayside population and many tunnels, with thoroughly improved aerodynamic performance.

JSME Young Engineers Awards

Taiji Adachi, Kobe University
for the Biomechanical Study on Structural Remodeling and Formation of Bone

Tadanobu Inoue, National Research Institute for Metals
for the Theoretical Study on Stress Field in Dissimilar Material Joints

(Fracture Mechanics to Interfacial Mechanics)

Yoshihisa Sakaida, Japan Fine Ceramics Center
for the Study on Improving the Reliability of Strength for Ceramics

Chu Sakae Kyushu University
for the Application of Fracture Mechanics to Tribology Problem

Shiro Biwa, Kyoto University
for the Studies of Bifurcation Problems Related to Cavitation in Nonlinear Elastic and Elasto-plastic Solids

Oaki Iida, Nagoya Institute of Technology
for the Studies on Turbulent Heat Transfer by Direct Numerical Simulations

Shigeharu Kobori, Tokyo Institute of Technology
for the Development of a rapid compression-expansion machine and analysis of the Diesel combustion performed by the machine

Yoshihiro Deguchi, Mitsubishi Heavy Industries, Ltd.
for the Development of Radical Detection Method in Practical Fields using Laser Diagnostics

Masahiko Fujimoto, Mazda Motor Corporation
for the Study on Combustion Characteristics of Stratified Mixture using Laser Induced Fluorescence Technique

Tomomi Uchiyama, Nagoya University
for the Research on Numerical Analysis of Gas-Liquid Two-Phase Flow in Centrifugal Pump

Masaharu Kameda, Tokyo Univ. of Agriculture and Technology
for the Research on Propagation of Shock Waves in a Liquid Containing Gas Bubbles

Takaya Kitahora, Yokohama National University
for the Research on Application of Cross-Flow Water Turbines to Low Head

Shinji Nakashima, Mitsubishi Electric Corp.
for the Investigation of Discrete Tone Noise Generated from Two-dimensional Wing

Yasuo Oshinoya, Tokai University
for the Study on Electromagnetic Levitation Control of a Thin Steel Plate

Koichi Sagawa, Tohoku University
for the Study on an Actively Controlled Stretcher for Ambulance

Ken'ichiro Nagasaka, The University of Tokyo
for the Study on Acquisition of Visually Guided Swing Motion Based on GA and NN by Two-Armed Bipedal Robot

Masahiro Watanabe, Science University of Tokyo
for the Study on Theoretical Analysis and Characteristics of Flow-Induced Vibration of a Flexible Disk Rotating in a Confined Fluid

Hiroyuki Ohta, Nagaoka University of Technology
for the Study on Vibration of Rolling Bearing

Naoto Otake, Tokyo Institute of Technology
for the Study on Gas Phase Synthesis of Ceramic Thin Films and It's Mechanical Applications

Shigeki Matsumura, Tokyo Institute of Technology
for the Study on Rotational Vibration of a Helical Gear Pair-Having Tooth Surface Deviation during Transmission of Light Load

Yoichi Uraki, Nissan Motor Co., Ltd.
for the Development of Squeeze Oil Pan for Reduction of Car Exterior Noise

Tadafumi Kanayama, Ishikawajima-Harima Heavy Industries Co., Ltd.
for the Study on the Dynamic Behavior of Container Cranes Under Strong Earthquakes

Kikuhito Kawasue, Sasebo National College of Technology
for the Development of Measuring System for Three-Dimensional Flow Using Circular Velocity bias

Katsuhiko Shoda, Mitsubishi Heavy Industries Ltd.
for the Development of Analytical Method of Vibration of Planetary Gears

Koichi Suenobu, DAC Engineering Co., Ltd.
fot the Study on On-Line Path-Planning Algorithm for Nonholonomic Mobil Robot in an Uncertain 3D World
(Evaluation of Algorithm by Partial Running and Simulation)

Takashi Harada, Shinko Kobelco Tool, Ltd.
for the Study on In-Process Error Compensation for Tooth Form Grinding Works

Katsumi Hisano, Toshiba Corporation
for the Development of Thermal Analysis Technique for Small Size Electronic Equipment

Noriyuki Hiramitsu, Nippon Steel Corporation
for the Development of Automatic Control of Furnace-Mouth Skull Remover

Takashi Miyazaki, Shibuya Kogyo Co., Ltd.
for the Development of the Capping Machine of Non-Contact Drive

Minoru Yonezawa, Toshiba Research and Development Center
for the Study on Seeking Control Optimization using Genetic Algorithm for Optical Disk Drives