Topic [1]

Development toward Waste Power Generation and Heat Supply Facility

The Company has been involved with the joint stock enterprise nationwide, in the fields of waste treatment and power generation/heat supply businesses and as our eighth project, Ichihara New Energy Co. (Ichihara City, Chiba Prefecture) was established.

Ichihara New Energy Co. was launched with the aim of jointly conducting a waste power generation and heat supply business by four organizations; namely the facility was initiated by Takuma and Sugita Kenzai Co., Ltd., a waste processor, while having Takeei Co., Ltd. and Takatoshi Co., Ltd., both of which are also waste processors, as the two main pillars of facility users.

Its field erection work commenced in September 2006 and construction was completed in October 2007. The facility commenced commercial operation after being authorized to run a waste treatment business by Chiba prefectural authorities.

Three New Approaches

In this project, we will promote three new approaches in the waste treatment industry, aiming to establish a business scheme which could be a model for the next-generation waste treatment business.

1 High Efficiency Heat Utilization by Waste Cogeneration (Prevention of Global Warming)

This project targets high efficiency power generation, with power generation efficiency of 15%, as well as highly efficient heat utilization by waste cogeneration, providing a heat supply through heated water recovery by low temperature heat waste, which was never previously utilized for industrial waste incineration plants in the private sector.

2 The Joint Stock Enterprise by Environmental Facility Manufacturers and Waste-Discharging Enterprises (Establishment of a Recycle-oriented Society)

In this project, thermal recovery (note: refer to the glossary) is proactively implemented using combustible residue, which is generated after the material recycling of construction waste into waste fuel. The project is promoted as a joint stock enterprise conducted by four parties, utilizing individual areas of specialty for each respective party; namely the two industrial waste disposers (Takeei Co., Ltd. and Takatoshi Co., Ltd.), which discharge combustible residue, participate as facility users, while a further disposer (Sugita Kenzai Co., Ltd.) and environmental facility manufacturer (Takuma) also join the project.

3 Co-existence with the Local Community

The heat supply destination is a neighboring farming greenhouse which engages in the hydroponic cultivation of Japanese gingers and we contribute to developing local industry by heat supply while also employing workers on light duties from neighboring welfare institutions and the community. We aim to establish a win-win project with the community by creating jobs.

Full view of the facility
(Left-hand photo: The heat supply destination-farming greenhouse)

Project Overview

1 Processing Object

Recycled combustible residue after shredded and sorted from construction waste used as main processing object, a wide variety of industrial waste such as hospital waste and liquid waste have been processed as incineration disposal.

2 Facility Description

The incineration capacity is 96 tons per day (4 tons/h X 24h/day) with an incinerator, waste heat boiler, exhaust gas treatment facility, steam turbine power facility, and heat supply facility.

3 Waste Power Generation and Off-site Heat Supply

High efficiency power generation is implemented with a rated output of 1,950kW (a final generating efficiency of 15.3%) with a steam turbine generator by generating steam from the heat produced by waste disposal using a waste heat boiler. Surplus power of 1,450kW is also generated after the on-site power supply. This surplus power is sold to PPS (Power Producers and Suppliers) (note: refer to the glossary).

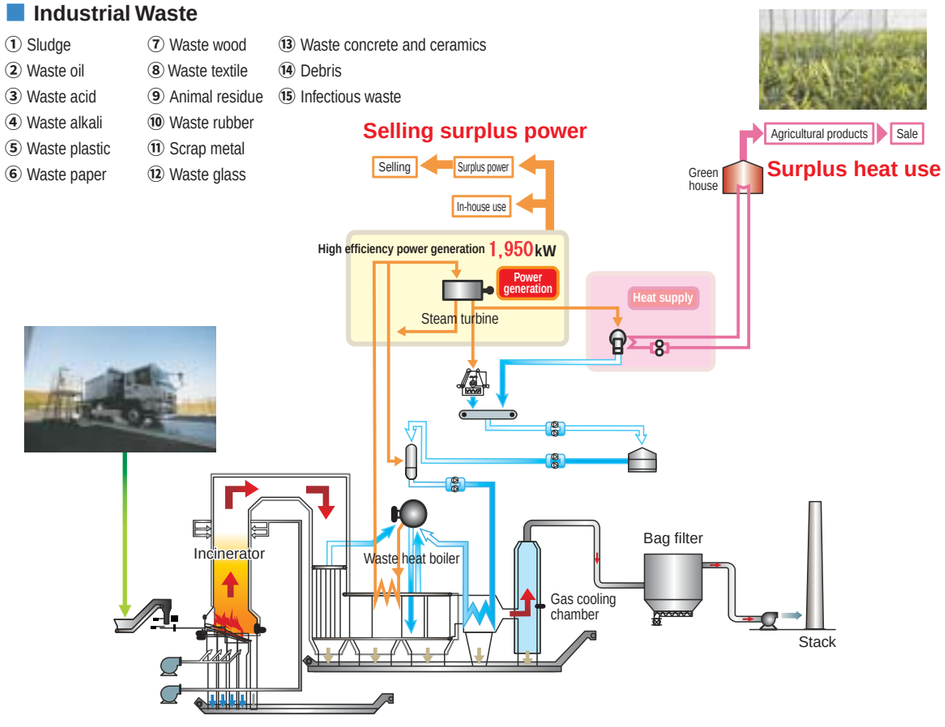
Since waste biomass, including waste wood, wastepaper, waste textiles, and animal and plant residues represents new energy, the facility is authorized as an RPS (Renewable Portfolio Standard) facility (note: refer to the glossary) and corresponding power such as new energy is also sold.

As for the further surplus heat use, in this project, heated water is generated from heat recovery through a turbine exhaust. The heated water is supplied to a farming greenhouse built on adjacent land (a hydroponic cultivation facility for Japanese gingers, operated by Sugita Kenzai Co., Ltd., with an area of approximately 1 hectare) as a heat resource for heating during the winter free of charge. The heat supply capability peaks at around 7.0GJ/h and the annual planned heat supply is approximately 9,000GJ.

Flow Sheet

Industrial Waste

① Sludge
② Waste oil
③ Waste acid
④ Waste alkali
⑤ Waste plastic
⑥ Waste paper
⑦ Waste wood
⑧ Waste textile
⑨ Animal residue
⑩ Waste rubber
⑪ Scrap metal
⑫ Waste glass
⑬ Waste concrete and ceramics
⑭ Debris
⑮ Infectious waste



Our Approaches to Global Warming Countermeasures

1 The Global Warming Countermeasures by Thermal Recovery

In this project, waste power generation is conducted by using unused energy, namely waste heat generated by waste incineration; therefore it significantly contributes to reducing fossil fuel consumption by an electric company during the process of thermal power generation and will consequently help reduce corresponding CO_2 emissions.

In addition, heat supply from the generation of heated water, using waste heat, helps reduce fossil fuels as well as CO_2 emissions for the corresponding amount of heat as well as power.

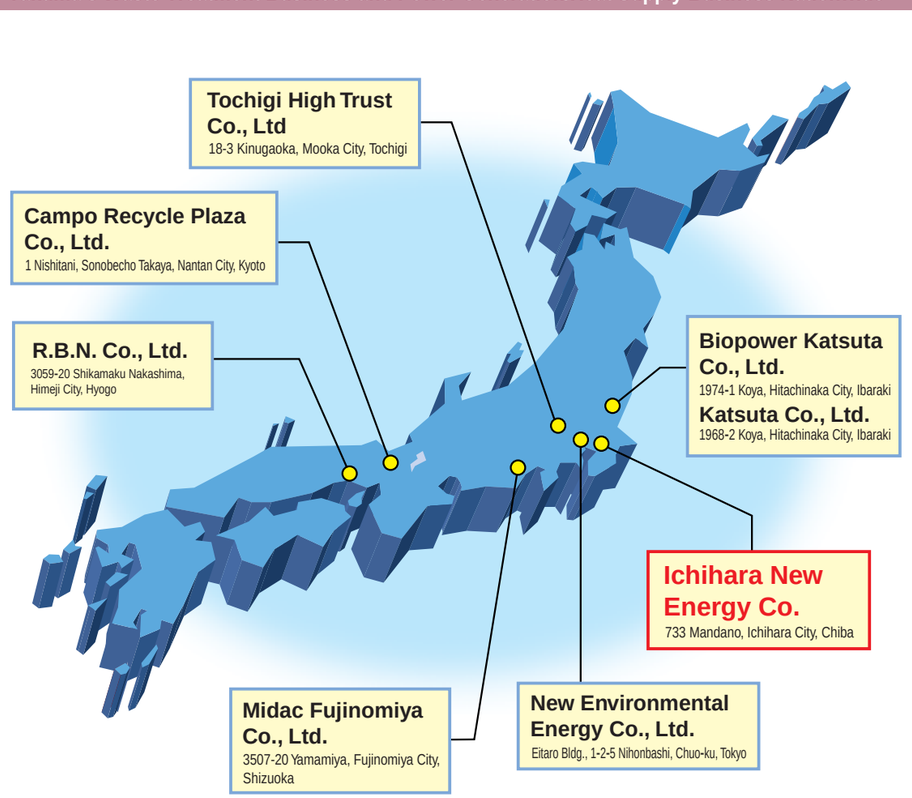
As thermal recovery in the waste incinerator contributes to reducing CO_2, which is a greenhouse effect gas, the project advantage is recognized and a subsidy was successfully obtained (Ministry of the Environment: a project on global warming countermeasures in waste treatment facilities) to cover part of the construction cost from the national government.

2 CO_2 Reduction Effect and Oil Substitution Effect

In this project, it is effective for a CO_2 reduction of approximately 3,900 tons per year and oil substitution of approximately 2,500 kL (crude oil equivalent) compared to the previous waste incinerator (approximately 5% of the power generation efficiency) via the implementation of waste power generation as well as the off-set heat supply.

Adding a function of "reducing CO_2 by thermal recovery" to the waste incinerator, we came to play a social role, contributing to global warming countermeasures through waste treatment.

Takuma's Waste Treatment Business and Power Generation/Heat Supply Business Nationwide



Outlook for Waste Incineration

Recently, various measures related to energy conservation and/or global warming have been achieving successful outcomes, while the social consequences of escalating crude oil price have simultaneously arisen, resulting the rapid acceleration of waste fuel utilization.

However, there are still considered to be numerous forms of combustible waste processed via simple incineration and landfill without the ability to exploit them as fuels in the country. With this in mind, we consider promoting thermal recovery, via such incineration disposal, to be effective as a global warming countermeasure. The Company has a track record of previously achieving seven projects nationwide in the fields of the waste treatment business as well as power generation/heat supply projects and this Ichihara New Energy is eighth project of the kind. We will continue to proactively expand the joint stock enterprise of the same in this field.

Being Engaged in the Waste Power Generation/Heat Supply Project

Hiroyuki Adachi
Manager, Project Planning Section, Business Development Department

Ichihara New Energy is a joint stock enterprise, established with the aim of implementing a waste power generation/heat supply project as a private business. I have been engaged in this project from the planning phase, which was a new challenge for me, getting involved in various fields such as power generation and agriculture related business of the heat supply destination rather than simply handling business in the waste treatment field in which I was previously involved and I thus encountered unfamiliar scenes and made some mistakes. However, working with people from different fields was most rewarding and I enjoyed myself very much.

I strongly believe that thanks only to the efforts of related company staff and the support of those outside the company, the construction of this waste power generation/heat supply facility was completed and the project launch enabled safe and sound. I would like to take this opportunity to express my gratitude for such people.

I sincerely hope that this project will continue to run smoothly and that the number of similar projects will increase in future.

Thermal recovery

A term synonymous with thermal recycling

PPS (Power Producer and Supplier)

Due to the recent reform of the electric utility system, newcomers other than electric utilities became able to supply electric power. Consequently, new retail sales companies emerged; entering into the electricity industry in addition to traditional electric utilities. PPS represents an organization having reported its plan to run an electricity business of a specified scale. (Electricity Enterprise Law, second clause of Article 1, Section 8)

Authorized RPS facility

In order to promote the utilization of new energy, in the "Law concerning Special Measures to promote the Use of New Energy, etc. by the Electric Power Industry" (RPS: Renewables Portfolio Standard) proclaimed in June 2002, the use of electricity generated through the use of more than a certain amount of new energy is mandated for the electric power industry. To be authorized as new energy, the power generation facility is required to meet specified standards and be authorized by the Minister of Economy, Trade and Industry.

Topic [2]

Fuel gas taken from sewage sludge and applied for power generation

The Development of a System of Sewage Sludge Gasification and Power Generation

Achieved a national first: 2000 hours of continuous operation of the gasification system

The Company has been promoting the project — the system of sewage sludge gasification and power generation — which targets high efficiency power generation by transducing sewage sludge, never previously used as energy, into fuel gas and we have successfully achieved a national first by continuously operating the gasification system for 90 days or 2000 hours during the period from the end of September 2007 to the end of December. Consequently, the stable running performance of the system was proved.

Development Background

As sewage sludge is collected at the sewage treatment facility via the sewage system, it is positioned as biomass with improved infrastructure; however, it had previously remained unused as an energy resource. Moreover, a huge amount of electricity was consumed within the sewage treatment site.

The Company has thus been promoting the development of the gasification and power generation system, utilizing sewage sludge as fuel for the power generation facility as a joint project with Tokyo Gas Co., Ltd. Subsequently, since fiscal 2004, the project has progressed as joint research: "Demonstration Test for the Utilization of Unused Energy such as Biomass" with the NEDO (New Energy and Industrial Technology Development Organization of Japan) and we have been tackling the need to accumulate data and know-how with the practical application of the system in mind.

The external appearance of the demonstration sludge gasification and power generation plant

Being Engaged in the Development of a System of Sewage Sludge Gasification and Power Generation

Keiji Tatsumi
Energy & Environmental Development Department

I have been engaged in the "development of the system of sewage sludge gasification and power generation", since the initial phase of constructing the demonstration plant in fiscal 2004. I have been involved in the project as a development assistant leader, mainly responsible for field-work management, relating to the demonstration procedure, including the test plan, operational management and data reduction of the test results.

Although the system required the development of various elements, during the demonstration performed in fiscal 2007, we successfully achieved a national first with its continuous operation for 2000 hours. I believe this achievement is the fruits of motivation and passion toward the challenges of those engaged in the development, as well as our technical capabilities.

In terms of the effective utilization of biomass energy, which is highly regarded recently, we have delivered a number of accomplishments, including biomass boilers and biomass power plants. We also view the sewage sludge as an important biomass energy resource; hence, I would be delighted if I could play a part toward the establishment of a recycle-oriented society via the practical application of our developed gasification technology.

The Features of the Takuma System of Sewage Sludge Gasification and Power Generation

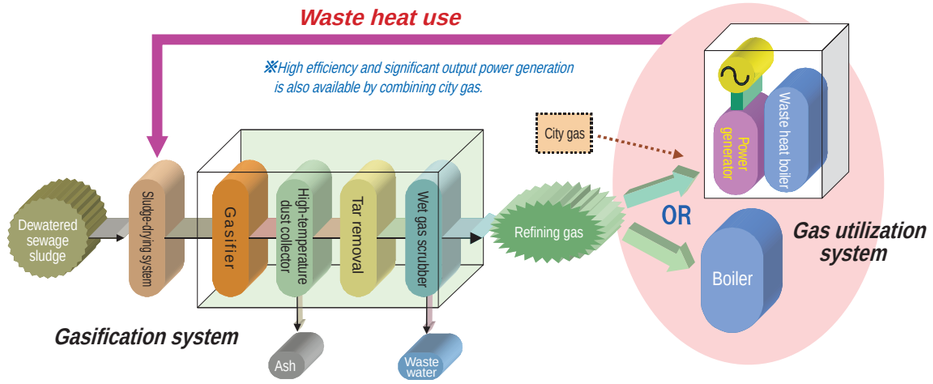
The system is designed to extract combustible gases, such as hydrogen and carbon monoxide, from sludge by drying it with a moisture content of 75 to 80% and partially burning the sludge to obtain a temperature of approximately 800℃. Electricity is generated by pumping this combustible gas into the gas engine, as well as recovering steam from the waste heat generated from the gas engine during the process of power generation and utilizing its heat.

In addition, the system adopted a circulating fluidized bed gasification furnace in order to efficiently transduce sludge into combustible gas, while also introducing our own developed technology, including high temperature dust collection by ceramic filter, and a tar decomposition catalyst, which efficiently decomposes the tar generated during the process of gasification.

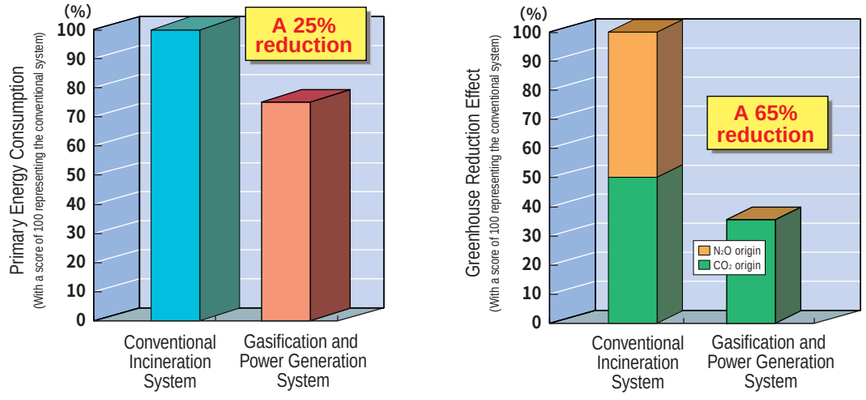
Thus, the system contributes to reducing CO_2 emissions due to its efficient energy utilization by recovering electricity and heat. Moreover, as it discharges no nitrous oxide (N_2O), which has a more significant impact on global warming than CO_2 generated during the process with conventional sludge incineration disposal, the system is anticipated to further contribute to the prevention of global warming.

Three key phrases for sludge gasification:

- **Efficient utilization of sludge energy** → Efficiently extract and utilize sludge energy from gasification
- **Contribution to the prevention of global warming** → Without discharging N_2O, while reducing CO_2 emissions, contributing to reducing global warming gas
- **Treatment for the excess sludge reduction of sewage sludge** → Sludge reduction is available equivalent to sludge incineration disposal



[System Flow Diagram]



[Primary energy consumption and greenhouse gas reduction effect in comparison with the conventional incineration system]

Topic [3]

Toward the effective utilization of unused biomass energy

The Development of a High Efficiency Energy Recovery (Hydrogen-Methane Fermentation of Shochu Distillation Lees) System from shochu (distilled spirit) lees

Achieved a 20% increased energy recovery rate via hydrogen-methane fermentation

The Company developed a simple system which efficiently recovers energy by microbial decomposition without burning biomass containing moisture, such as raw garbage. An operational demonstration, featuring this system applied to shochu distillation lees, is underway and we aim to promote the market expansion to encourage the utilization of a greater variety of biomass.

Development Background

During the manufacturing process of otsurui type shochu (so-called authentic shochu), "shochu lees" containing organic substances is produced as part of the process of distillation. Shochu lees used to be discharged into the ocean and was never effectively exploited. On the other hand, there is a distillation process for producing shochu, where fossil fuel had been used.

The Company has been promoting the development of a system to efficiently recover combustible biogas generated from the shochu lees using hydrogen-methane fermentation technology and transducing it into heat energy (steam) with boilers, achieving savings in terms of fossil fuel, which had previously been used in the production process. In order to demonstrate the effectiveness of the system, we have been addressing a demonstration project in collaboration with the New Energy and Industrial Technology Development Organization of Japan (NEDO) and achieving significant results.

Demonstration Plant for Hydrogen and Methane of Shochu Lees

The Features of Takuma's Hydrogen-Methane Fermentation System

There are mainly two-stage microbial reactions: solubilization, the hydrogen & acid production stage and the methane production stage during the decomposition process by methane fermentation.

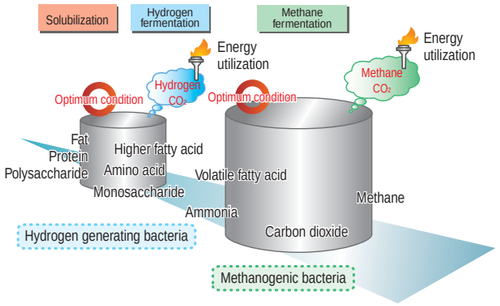
Thus, it enables relatively high overall fermentation efficiency by dividing each stage into two tanks; each of which is fermented under optimum conditions. The system is compact and with the two dual-tank fermentation technology, the energy recovery rate is increased compared to the conventional method with single tank methane fermentation, as well as accelerating the solubilization and production of organic acid, which helps reduce fermentation time. In addition, the plant is formed with a simple system structure, without adopting incidental equipment, which could potentially cause trouble.

As well as shochu lees, the technology is also applicable for highly efficient energy recovery from waste with high moisture content, generated from food manufacturing plants such as bean curd refuse and juice strained lees, as well as night soil and sludge.

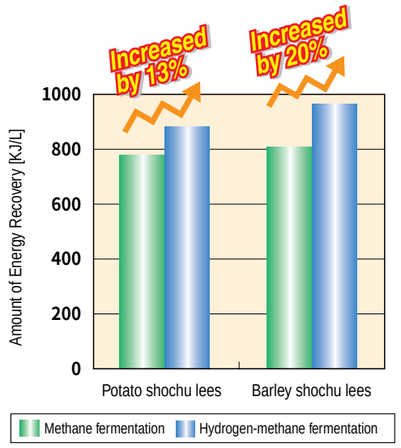
The Company hopes to contribute to the prevention of global warming, using this technology.

Three key phrases for Takuma's hydrogen and methane fermentation:

- **The effective utilization of biomass with high moisture content** → Potential recovery of 70% and above of energy with organic substances
- **Contribution to the prevention of global warming** → Biogas can be effectively used as an alternative to fossil fuels
- **Simple system structure** → It requires less care; thus minimizing the items to be monitored on a daily basis, as well as maintenance



[Conceptual Rendering of Takuma's Hydrogen-Methane Fermentation]



[Comparison of the amount of energy recovery between methane fermentation and hydrogen-methane fermentation]

Being Engaged in the Development of Hydrogen-Methane Fermentation Technology

Katsushi Wada
Energy & Environmenta Development Department

I have been engaged in the project since fiscal 2003, the second year since the commencement of the development of "hydrogen-methane fermentation technology". At the beginning of the project, its laboratory scale was so small, with a treatment capacity of just a few liters a day and experiments were performed with simulated waste. Currently, however, facilities have been upgraded to perform demonstration tests, treating dozens of tons of actual waste, namely "shochu lees", on a daily basis. To date, we have been implementing demonstration tests for two years and experienced unexpected events on a laboratory scale, facing hardship; however, with the advice of people around, I have been able to accumulate successful results without any serious problem.

Currently, global warming caused by the consumption of fossil fuels has been highly publicized and I believe that energy recovery from waste, which has previously been unused as introduced in this technology, is very meaningful. I would like to continue to promote efforts toward further enhancing the efficiency of technology and creating better products to launch onto the market, contributing to society.

Topic [4]

For the benefit of the global environment — Activities of the Group Company: Nippon Thermoener Co., Ltd.

Development of a Hybrid Hot Water System (For preheating)

Successfully achieved a significant reduction in CO_2 emissions compared to conventional systems

Development Background

Our vacuum-type hot water heater "vacotin heater", has long been adopted in the industrial water heater market. Although we offer efficient product lines featuring the latest models, with thermal efficiency of 92 to 93%, and based on the combustion type principle, efficacy can never exceed 100%, meaning the limit under present circumstances has been reached and achieving further energy conservation is likely to be fairly difficult.

Conversely, in terms of the water heater market for consumer use, the use of heat pump water heaters, as typified by the energy-efficient "EcoCute" line, has been increasing year after year. In the market for industrial use water heaters; however, the widespread use of heat pump water heaters remains very sluggish and the combustion type is still the mainstream option.

This is because the usage of hot-water supply for industrial use tends to vary day by day and when corresponding solely to the thermal storage type of EcoCute, there is a need to equip the water heater with maximum capacity for the hot-water supply and prepare the maximum volume of such equipment, thus presenting a problem in terms of the initial cost and installation site.

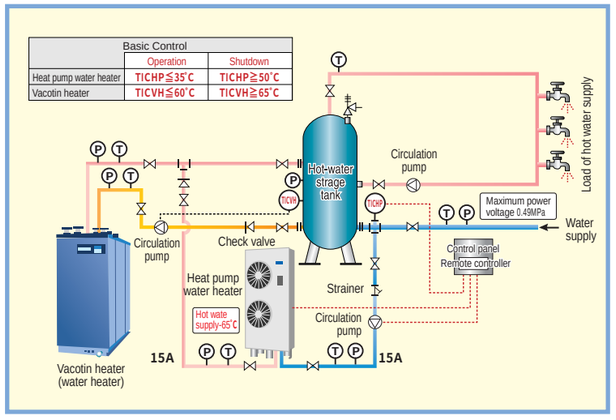
With such issues in mind, the Company developed a hybrid hot water system (for preheating) which optimally exploits the mutual advantages by combining an energy-efficient heat pump water heater, with excellent ecological properties as well as economic efficiency, alongside a combustion type water heater, compact and with high heating capacity, into a single unit.

System Overview

A hybrid hot water system (for preheating) is created by combining an average industrial combustion type hot water system with a heat pump water heater.

Its control method involves installing a temperature sensor for the heat pump water heater on the water inlet, which is placed at the bottom section of the hot-water storage tank, as well as installing a temperature sensor for combustion type water heaters in the middle section of the hot-water storage tank. The system is very simple, with operation control of the heat pump water heater and combustion type water heater implemented by detecting the temperature of each temperature sensor.

When hot water is supplied, water is replaced at the bottom section of the hot-water storage tank based on the precise quantity of water used. Subsequently, the heat pump water heater is operated preferentially to heat the water. If heating via a heat pump water heater only cannot maintain a sufficient level, there is insufficient hot water to keep the hot-water storage tank half-full, whereupon the combustion type water heater commences a backup operation, while the heat pump water heater is also running in parallel. The fundamental operation is performed by the heat pump water heater and only if the relevant quantity of water is used, does the combustion type water heater offer a back-up. With this method, a hot water system that is both energy-saving and user-friendly can be achieved.

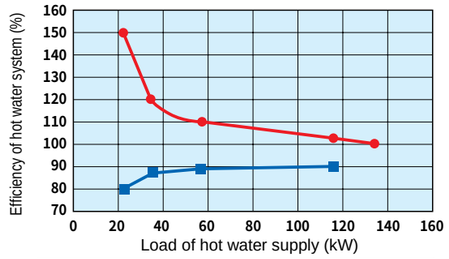


[Hybrid Hot Water System (For preheating)]

The Basic System Specification

The observation result of a single water heater and preheating hot water system is shown in the following diagram.

The efficiency of the single hot water system (thermal capability of 116kW, efficiency 90%) of a water heater was up to 90%, while the preheating hot water system, which combines a dedicated heat pump water heater (thermal capability of 18kW, COP4.0) with the same water heater, is available to boost the efficiency of the hot water system by 100 to 150%.



[Efficiency of hot water system of water heater with single application and preheating hot water system]

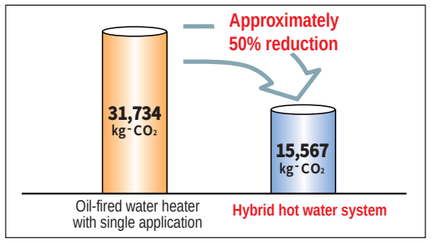
Estimation of the Amount of CO_2 emission reductions

The estimated result is shown under the conditions of an operation time of 12 hours a day and use on a 365 days a year basis, with one unit of heat pump water heater. Consequently, the introduction of a hybrid hot water system enables CO_2 emissions to be reduced by approximately 50% compared to a single conventional oil water heater (kerosene).

Comparative Table of Running Costs and CO_2 emissions

Item	Oil water heaterwith single application	Hybrid hot water system
Load of hot water supply on a daily basis (amount of thermal dose of heat pump water heater)	**300kWh** (216kWh: 18kW x 12 hours)	
Type of energy	Kerosene	Electricity + kerosene
Energy unit price	**¥85/L**	**¥11/kWh＋¥85/L**
Heat source equipment	**0.9**	**COP4.0＋0.9**
Consumption (per day)	**34.9L**	**54kWh＋9.8L**
Running costs (per day)	**¥2,967**	**¥594＋¥833**
Running costs (per year)	**¥1,082,955**	**¥520,855**
Running merits (per year)	—	Potential of reducing ¥562,100 a year
CO_2 emissions (per year)	**31,734kg-CO_2**	**15,567kg-CO_2**
Reduction of CO_2 emissions (per year)	—	Potential of reducing 16,167kg-CO_2 a year

Note : 1 COP of a heat pump water heater as indicated on a yearly average basis
2 Boiler efficiency and energy units are approximate values
3 Specific consumption of CO_2 emissions is incorporated from the actual record for fiscal 2005 by the Tokyo Electric Power Company, as well as references from the emission calculation for greenhouse gases, Reports and mandated announcements on the website by the Ministry of the Environment and the Ministry of Economy, Trade and Industry.



[Comparative diagram of CO_2 emissions]

Delivery Record and Case Example

In fiscal 2006, we launched the full-fledged sale of hybrid hot water systems and the delivery record is as shown below.

This system is adopted by a wide variety of industries, including welfare institutions, accommodation facilities, hot bath facilities, hospitals, golf courses, and plant facilities.

Delivery Record

F Y	FY 2006	FY 2007
Number of delivered systems	**22**	**61**
Number of delivered units (heat pumps)	**57**	**125**

Accommodation with hot spring in Kyoto City
(Delivered 4 units of heat pump water heater)

Being Engaged in the Development of Hybrid Hot Water Systems

Akio Morita
Section Chief, Element Engineering Department, Engineering Division
Nippon Thermoener Co., Ltd

To further respond to the requirements of customers and measures toward the global environment, I would like to contribute to improving the global environment as a pioneer of the new system of combining heat pump water heaters and water heaters/boilers based on long accumulated experience and know-how as a manufacturer of industrial water heaters.

In fiscal 2008, the launch of the "Cool Earth Promotion Team", which is a team specializing in hybrid hot water systems, is scheduled. I will continue to strive with the aim of promoting the further widespread penetration of hybrid hot water systems.