The 16th session of the Conference of the Parties of the United Nations Framework Convention on Climate Change (COP16) was held in Cancun, Mexico, from November 29 to December 10, 2010. Like other recent rounds of this annual conference, one of the key agendas at COP16 was to create a framework that would replace the Kyoto Protocol, which was agreed upon at COP3 held in Kyoto in 1997 (effective from 2005) and will see the end of its commitment period in 2012. The Kyoto Protocol set clear greenhouse gas emission reduction targets for developed countries over the five years from 2008 to 2012: 6% for Japan, 7% for the United States (non-signatory), and 8% jointly for the European Union, as compared to 1990 emission levels. Total emissions in Japan had remained high even after the Kyoto Protocol went into effect, but began to decrease after peaking at 1,371 million tons in fiscal 2007. In fiscal 2009, total emissions decreased by 5.7% compared to the previous year to 1,209 million tons (preliminary figure), representing a 4.1% decrease compared to those of the base year of 1999 and coming within range of the 6% reduction target.

At the recent COP16, the proposal for a simple extension of the Kyoto Protocol commitment period to 2013 and beyond gathered momentum. Japan voiced a strong objection, which can certainly be considered fair. One is naturally forced to question the viability of the current system, wherein the world’s two largest greenhouse gas-emitting countries – China and the United States – are not obliged to reduce such emissions. Furthermore, it is not only developed countries who are the primary sources of greenhouse gas emissions, as emerging and developing counties are now experiencing economic growth. Sure enough, the task of creating a framework to combat global warming in 2013 or thereafter has been deferred until COP17, which is scheduled to take place in South Africa toward the end of 2011. This begs the question as to whether the world is truly facing up to this urgent problem that involves factors that threaten not only the natural environment, but the very future of humanity itself. International society has set for itself the goal of cutting the world’s greenhouse gases in half by 2050. If Japan is to be an “environmentally advanced country” in terms of both engineering and awareness, it will be required to persistently pursue negotiations with China, the United States, and emerging and developing countries toward the creation of a fair and viable international framework.

*1 The Kyoto Protocol’s emission reduction targets cover carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).
Reducing CO2 by Introducing High-efficiency, Energy-saving Circulating Fluidized Bed Incinerators

While countries across the globe are discussing measures to prevent global warming through international diplomatic measures such as those represented by the COPs, a variety of grass-roots initiatives are taking place throughout the world in pursuit of this common cause. Japan is no exception, as the bitter experiences of social problems caused by pollution during its rapid economic growth period have prompted both the public and private sectors of the country to take positive approaches toward solving environmental issues. Addressing the problem of global warming, not only governments and enterprises, but other groups and organizations as well are making steady efforts to reduce greenhouse gases. The country’s local governments, too, are proactively tackling this issue, and Shizuoka Prefecture’s Hamamatsu City is one such “environmentally advanced” city in Japan.

Overlooking the Sea of Enshu and known for its mild climate, Hamamatsu is an ordinance-designated city with a population of more than 800,000 people. Of the many environmental conservation projects that this city has undertaken so far, one that is drawing considerable attention is “Operation kotsu-kotsu in Japanese, meaning ‘little by little’ Diet,” an action plan for combating global warming that was launched in 2008. The municipal government has a wide range of business activities, which include not only clerical and reception work but also waste disposal management, water supply and sewage work, and management of schools, fire stations, hospitals, and the like. This makes it one of the largest sources of CO2 emissions generated by a single business operator in the city. The project was started to reduce the CO2 emissions produced by the local government.

“[This project] aims to help reduce CO2 emissions throughout the city by implementing measures to reduce greenhouse gases. In addition, we are encouraging residents and businesses to take every opportunity to reduce their CO2 emissions by setting a model for them to follow.” (Motoi Nasu, Director, Sewerage Construction Division, Water Services Department, Hamamatsu City)

With that objective in mind, city officials took note of the sewage sludge incinerator at its Chubu Sewage Treatment Center, which was responsible for the largest amount of CO2 emissions among the facilities managed by the city (9,356 t/year in FY2005, or 9.2% of the total of all city facilities). At sewage treatment plants, sewage is separated into water and sludge, the latter of which is burned up by a sewage sludge incinerator after the condensation and dewatering processes. The sewage treatment process at the facility in Hamamatsu – and every facility of its kind, for that matter – emits a large amount of CO2 throughout the treatment process. With the spread of sewage systems, this discharge increased by some 54% between 1990 and 2006, making reduction of CO2 discharged from sewage treatment a policy agenda on the national level. As such, the Japanese government took up reduction of CO2 and other greenhouse gases through promotion of energy conservation, and compact size. Because its combustion efficiency is higher than that of conventional incinerators and a higher combustion load (caloric value within the combustion chamber) may be tolerated, the incinerator can be made more compact. Also, thanks to the low air power requirements necessary for sand circulation, flow power requirements have been substantially reduced. High fuel efficiency has also been achieved by collecting high-temperature combustion air from the incinerator exhaust gas.

At the time, sewage sludge incinerators in Hamamatsu City were undergoing a replacement period. Due to the need to respond to higher-calorie sludge, the introduction of circulating fluidized bed incinerators was considered. In fact, however, there were some who questioned the adoption of such incinerators. There were still only a few local governments across the country that had introduced them, thus giving rise to serious concerns over the risk of treatment of rainwater drainage and domestic wastewater in recent years, the ratio of organic substances coming from inflow sources has increased, thus creating “calorie-rich” wastewater. In addition, the shift from lime polymer coagulant as a dewatering aid has tended to add more calories to dewatered sludge. In response, demand was high for an incinerator capable of burning up such sludge with greater speed, using less energy, and generating less CO2.

The circulating fluidized bed incinerator uses high-temperature circulating sand as a heat medium for the instant dispersal and drying of sludge for incineration. This incinerator is characterized by improved efficiency, energy conservation, and compact size. Because its combustion efficiency is higher than that of conventional incinerators and a higher combustion load (caloric value within the combustion chamber) may be tolerated, the incinerator can be made more compact. Also, thanks to the low air power requirements necessary for sand circulation, flow power requirements have been substantially reduced. High fuel efficiency has also been achieved by collecting high-temperature combustion air from the incinerator exhaust gas.

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Fuel Switchover from Kerosene to Natural Gas – Meeting Needs Promptly and with Precision

In 2008, Hamamatsu City set a clear target: reducing FY2010 CO₂ emissions at its Chubu Sewage Treatment Center by 19.2% compared to the levels in FY2005. The trigger for this decision was a price hike of crude oil, the primary fuel source of the incinerator. At that time, oil prices soared to US$140 per barrel, which in turn pushed up the price of the kerosene that was used for their sewage sludge incinerator. Something had to be done to trim fuel costs. It was then that Hamamatsu City came up with the idea of switching the incinerator’s fuel from kerosene to natural gas, which sounded like a brilliant idea as it would not only stabilize costs, but also reduce CO₂ emissions. However, there had been no precedent for a fuel conversion from kerosene to natural gas. And so, they turned to Kubota for technical consultation.

Subsequently Kubota began construction of the incinerator in 2002. The incinerator was put into operation in 2005, making it possible to incinerate 60 tons of sludge daily. From the perspective of the fight against global warming, it should be noted that the introduction of circulating fluidized bed incinerators is remarkable in that it not only drastically reduced N₂O generation, but as an energy-conserving facility it also helps to reduce CO₂ emissions. Compared to 2005 levels, CO₂ was successively reduced by 4.48%, 7.78%, and 9.19% in the following three years.

In simple terms, fuel conversion from kerosene to natural gas involves an attempt to replace the burner running on kerosene with one that runs on natural gas. To make this project a success, it was necessary to reduce costs and shorten the construction period. Members of a cross-sectional team put their heads together to work out the design, etc., but what proved most effective were clever improvements to the burners themselves. The incinerator uses two burners: a main burner used at startup only and a gun burner employed for constant use (Fig. 1). Originally, conversion to natural gas was intended for both types of burners; however, since the Chubu Sewage Treatment Center runs almost constantly, it was suggested that kerosene be used for the main burner, which is used during startup only. In other words, the incinerator would feature “hybrid burners” using both kerosene and natural gas. This helped to compress the volume of construction work, and thus made it possible to meet the Hamamatsu municipal government’s requests for cost reduction and a shorter construction period. This idea also involved technical issues, such as fulfilling gas supply conditions, checking whether legal regulations on the burners to be used would be applied to the circulating fluidized bed incinerator, selecting burners in accordance with gas pressure, and checking the usage characteristics of the burners and incinerator. As they managed to resolve these issues one by one, they hit upon the idea of installing a natural gas supply facility while still keeping the kerosene-powered burner. However, those who were involved in the operation of the facility did not unanimously welcome each and every one of Kubota’s proposals and ideas. Apparently, some had concerns stemming from the fact that such an attempt had never been made before. It goes without saying that it is essential for sewage sludge incinerators to operate stably.

“The worst nightmare of anyone involved in the operation of such a facility is incinerator shutdown. We could not deny the possibility of suspension of operations due to fuel conversion work being extended,...
Milestone in the Fight against Global Warming

which would result in irreparable consequences. Even if the construction work was to be completed as scheduled and operations began, I must admit that those involved in the facility had no small amount of anxiety as to whether the incinerator would really run without a hitch. (Masaki Saito, Director, Sewerage Facilities Division, Water Service Department, Hamamatsu City)

Cutting costs, shortening the construction period, and offering solutions to technical issues were certainly all important, but what was equally or even more essential to making the fuel changeover a reality was gaining the understanding and consent of people working at the facility. Such being the case, the closest attention was paid to ensuring a complete understanding among those concerned by providing the most detailed explanations kind. They listened earnestly to any concerns that we had. Thanks to their accurate understanding of our needs and quick responses, we were able to achieve this fuel conversion. We believe that being able to use both kerosene and natural gas is not only cost efficient, but also highly effective in hedging potential risks involved in natural disasters and other catastrophes. (Hideyuki Tsuboi, Assistant Director, Sewerage Construction Division, Water Service Department, Hamamatsu City)

In August 2009, the renovated sewage sludge incinerator resumed operations, and the fuel conversion certainly did achieve a significant reduction in CO2 emissions. In FY2009, CO2 emissions from the incinerator were reduced by 39.38% compared to FY2005 levels. As a result, emissions from the Chubu Sewage Treatment Water Purification Center also declined overall by 21.17%, thus contributing significantly to "Operation CO2 - CO2 Diet."

Renewable Energy Supplied from Sewage Treatment Plants

Hamamatsu City's project to combat global warming has been expanded to include all sorts of programs, such as the introduction of new energy equipment to its public facilities, use of low-emission vehicles (hybrid cars, natural gas cars, etc.) as official city vehicles, subsidies for home-use photovoltaic power generation systems, etc., opening of the Hamamatsu City eco model house, and widespread utilization of biomass organic resources made from forest resources, raw garbage, scrap wood from construction sites, etc., which are in plentiful supply. Meanwhile, its sewage sludge incinerator has small amount of inherent issues, and these are not unique to Hamamatsu City, but are shared by every sewage sludge treatment plant in Japan. One of these issues involves recycling. Incinerated ash generated by burning sewage sludge is recycled into cement and other construction materials, and its recycling ratio has reached approximately 77% (FY2007 national average). However, the sustainability of recycling such incinerated ash into raw materials for cement – currently the most prevalent use of such recycled materials – is not without its concerns, since cement companies do not always take them, as cement demands fluctuate with the economy. Making aggregate concrete or bricks, on the other hand, can incur a large amount of costs, and so demand has yet to become stabilized. Going forward, it will be necessary to diversify and expand recycling applications, including, for example, using such materials as compost for green farms.

Another pioneering initiative is also underway. In order to realize flexible power generation, low-carbon society.

At Hamamatsu City, "preparations are being made so that action can be taken at any time." (Motoi Nasu) Ongoing efforts to fuel conversion:" and “fuel conversion” represent a successful example in this regard. This is not the end of their journey, however. Hamamatsu and other local governments will accelerate their drive to prevent global warming through new approaches by shedding new light on sewage system facilities in their entirety, as they continue to broaden their perspective even further.