Promoting grass-roots energy saving actions for facilities including purification plants and water supply stations

H. Murakami*, T. Kashiwagi, S. Furukawa*****

**Bureau of Waterworks, Tokyo Metropolitan Government, 2-10-1 Misono, Itabashi-ku, Tokyo, JP

**Bureau of Waterworks, Tokyo Metropolitan Government, 2-8-1 Nishi-Shinjuku, Shinjuku-Ku, Tokyo, JP

***Bureau of Waterworks, Tokyo Metropolitan Government, 2-8-1 Nishi-Shinjuku, Shinjuku-Ku, Tokyo, JP

Abstract: Waterworks projects of the Tokyo Metropolitan Waterworks Bureau (TMWB) consume approximately 800 million kWh of electricity annually, accounting for around 1% of the total power consumption in the nation's capital. This gargantuan energy consumption makes a great impact upon the global environment. Therefore, TMWB has been proactively pursuing efforts to improve energy efficiency by instituting the "Tokyo Waterworks 10-Year Plan for Energy Efficiency" and other policies. To achieve this goal of streamlining energy use, it is imperative for the front-line offices and facilities to employ innovative approaches and continuously accumulate efforts, while the TMWB implements overall environmental and energy measures based upon the 10-year plan. This report introduces TMWB's improved system for energy efficiency as well as cases of such actions by focusing upon initiatives at service offices that operate purification plants, water supply stations and others.

Keywords: Environment issue; purification plants; water supply stations

1. Introduction

TMWB's power consumption for its waterworks projects amounts approximately 800 million kWh annually, which is equivalent to approximately 1% of Tokyo's total electricity consumption. As a large-scale service provider, the TMWB is required to reduce energy consumption.

The breakdown of electric power consumption shows approximately 60% is used for the water transmission/distribution process, which is the largest in overall electric power consumption, followed by the purification and the water intake/conveyance process (Figure 1).

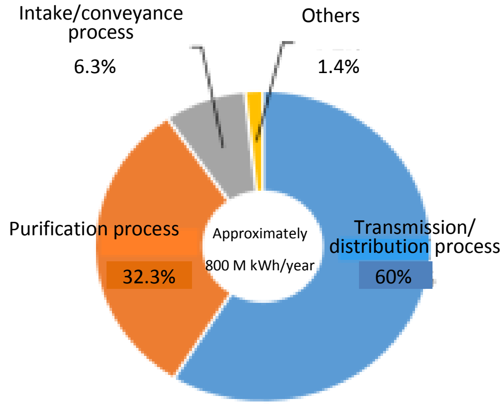

Fig. 1 Breakdown of electric power consumption

Therefore, our challenge is how to reduce electric power consumption at each level of the service process at purification plants, water supply stations and other waterworks facilities while ensuring stable water supply.

Hence, steady efforts by service offices that directly operate purification plants, water supply stations and other facilities are important. Their efforts are the key to reducing overall TMWB energy consumption.

2. TMWB's environmental and energy measures

(1) Formulating a master plan for energy efficiency

TMWB formulated the “Tokyo Waterworks 10-Year Plan for Energy Efficiency” in February 2015. It aims to minimize energy consumption while ensuring a stable supply of safe, good-tasting water. The 10-year plan clarifies specific energy measures and goals to be achieved in the mid to long-term (Fig. 2).

The target reduction figure of the TMWB’s energy consumption is set for approximately 20 percent at least by 2024 compared with 2000.

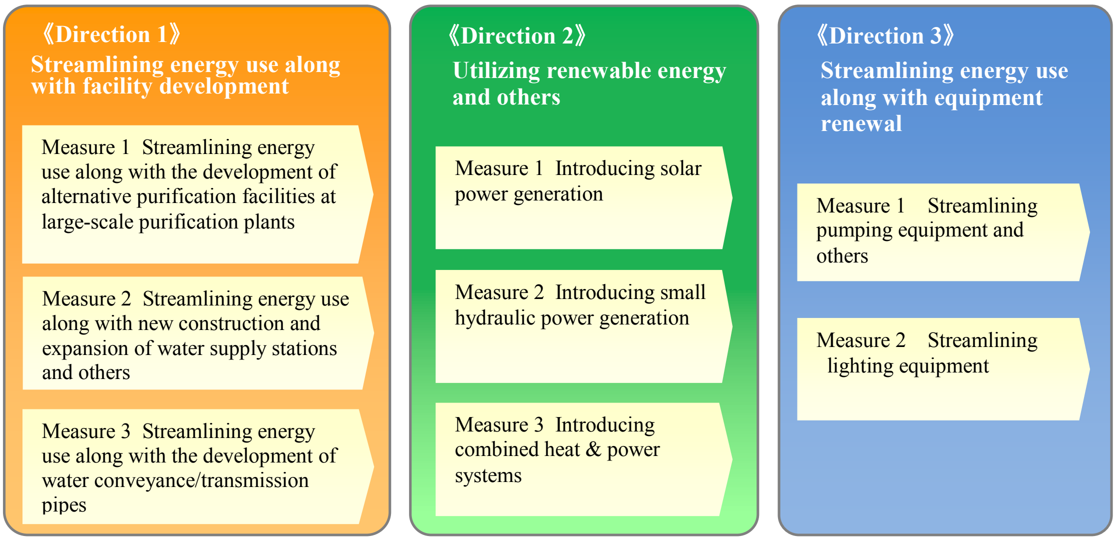

Fig. 2 Directions of measures in the Energy Efficiency 10-Year Plan

(2) Energy management system at TMWB

TMWB has made efforts to implement environmental and energy measures by building a promotion system that includes service facilities charged with planning and implementing environment and energy plans as well as energy management.

Each sector has a person in charge of promoting environmental and energy measures, and sets annual goals to reduce energy consumption and the like. The TMWB controls steps for goal achievement by collecting all facility-by-facility records of accomplishing energy efficiency goals (Fig.3).

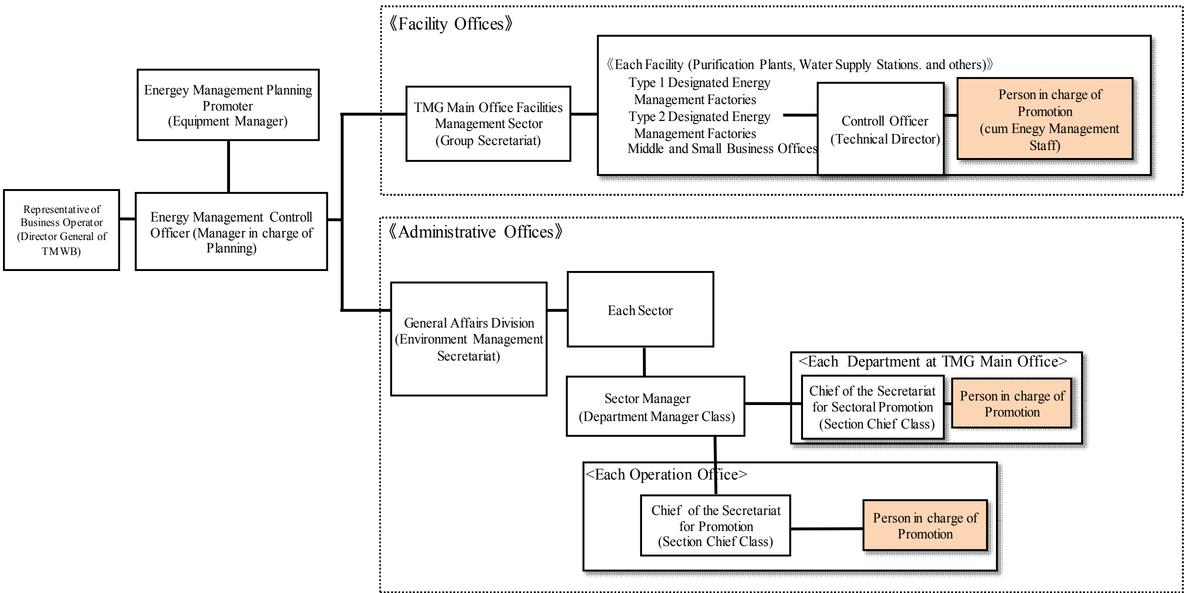

Fig. 3 Energy management system at TMWB

3. Promotion of energy-saving actions at service offices

(1) Holding information exchange meetings on energy saving

Energy-saving actions by service offices which operate water purification plants, water supply stations, and other facilities are the important to lowering energy use for the whole of TMWB.

Therefore, TMWB regularly holds information exchange meetings on energy saving. The persons in charge of promoting energy saving at respective service offices attend these meetings and share information. They also share and spread excellent cases in the energy saving measurement.

(2) Cases of energy-saving actions at service offices

The following are cases of energy-saving actions that were presented at information exchange meetings.

a. Reducing air conditioner power consumption with cooling radiating fins on outdoor units

In recent years, there is a tendency to install many electronic components in the electrical equipment of the water purification plants, such as by using combined stationary protective relays and control centers with transmission units in renewals. With such equipment, we must improve the electricity room environment by air conditioners, making the use of efficient energy a challenge.

Therefore, as an effort to reduce the power consumption of air conditioners in electricity rooms, we have improved the efficiency of air conditioners by spraying water on the radiating fins of the outdoor unit and releasing heat to the cooled outside air. (Figure 4)

The air conditioner (output 56 kW) in the electricity room consists of System 1 and System 2 (2 AC units each, 4 units in total), with a water spraying unit in the outdoor unit of System 1, but no water spraying unit in the outdoor unit of System 2. We checked the power consumption amount with accumulated watt hour meters. Conditions for carrying out the measurements were about 20 days in summer, with the water spraying apparatus operated at room temperature setting 24° C and outside air temperature of 27° C or higher. Our results showed decreased power consumption of about 3% (about 58 kWh) compared to conditions without spraying. (Fig. 5)

We expect that the reduction rate can be improved even further by improving operation of the water spray device and room temperature settings.

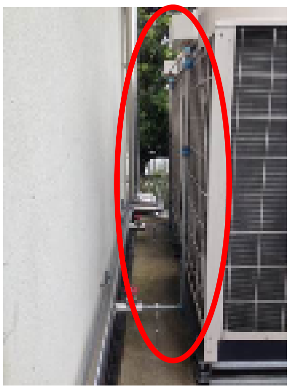

Fig. 4 Cooling Radiating Fins

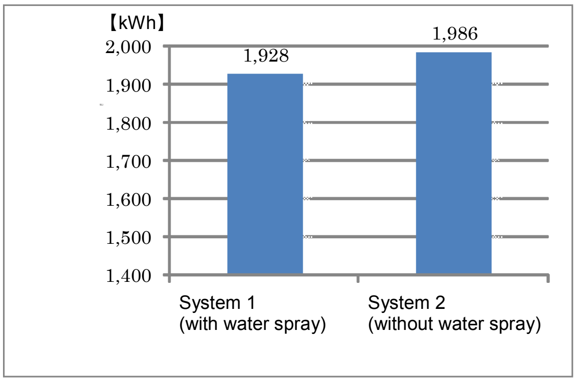

Fig. 5 Power Reduction Effect

b. Reducing power consumption by improving flocculators

In rapid filtration water purification plants, the raw water that the flocculant is added to is stirred with a flocculator to aggregate and precipitate the turbidity contained in the raw water.

Flocculators have been updated over many years due to aging and deterioration. At that time, reduced power consumption was achieved by converting from underwater bearings to a frame type.

Drive transmission of flocculators so far was primarily done by linking the shafts of several mixing blades with submerged bearings. Submerged bearings experience friction caused by silt and lowering of lubricating water. Because of this, there is more resistance on the sliding part, causing energy loss.(Fig.6)

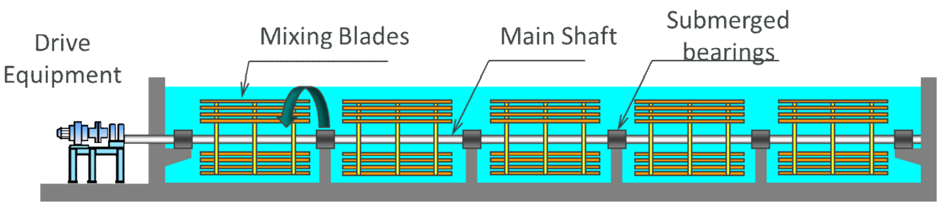

Fig. 6 Flocculators (submerged bearing type)

In contrast, the modified frame model flocculators transmit shaft power to the frame which is bonded with the mixing blades, and fixed in place with a bracing device at the end to turn it. The middle of the mixing blades is supported at regular intervals with guide rails and rollers. The sliding parts of these guide rails and rollers can adjust the buoyancy of the overall frame with floats, so we reduced their friction resistance. These revisions enabled us to remove the submerged bearings and improve maintenance manageability. (Fig.7,8)

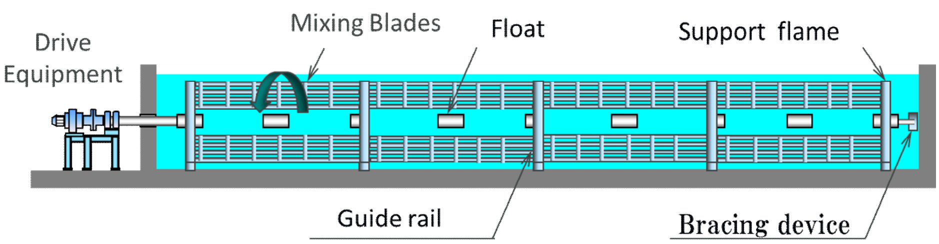

Fig. 7 Flocculators (Flame type)

As a result, it contributes to reducing electricity consumption by about 500 kWh per month compared to before improvements were made.

Fig. 8 Flocculators in the flocculation basin (Flame type)

c. Reduction of air conditioning power consumption by cooling sub-storage tank using a well water source

In water purification plants, sodium hypochlorite is used as a disinfectant indispensable for purification treatment. Yet, in order to suppress the decomposition of effective chlorine and the increase of chloric acid, long term storage must be avoided if at all possible. In addition, countermeasures are required for when the air temperature is high. For these reasons, we secure the temperature environment of the storage room with air conditioning equipment and measures to raise the liquid temperature in the sodium hypochlorite storage tank.

On the other hand, two water purification plants located in the Tama district of Tokyo have built mechanisms that can directly cool the sodium hypochlorite storage tank using well water, which has a stable water temperature throughout the year. (Fig. 9)

As a result, regardless of the outside air temperature, because it stably maintains a liquid temperature of 20 ℃ or less, these plants turned off their air conditioning equipment from May to October, when the well water temperature was lower than the outside air. As a result, it was possible for the two facilities to reduce their electricity consumption by a total of about 20,000 kWh, and achieve a CO_2 emission reduction of 8.0 tons.

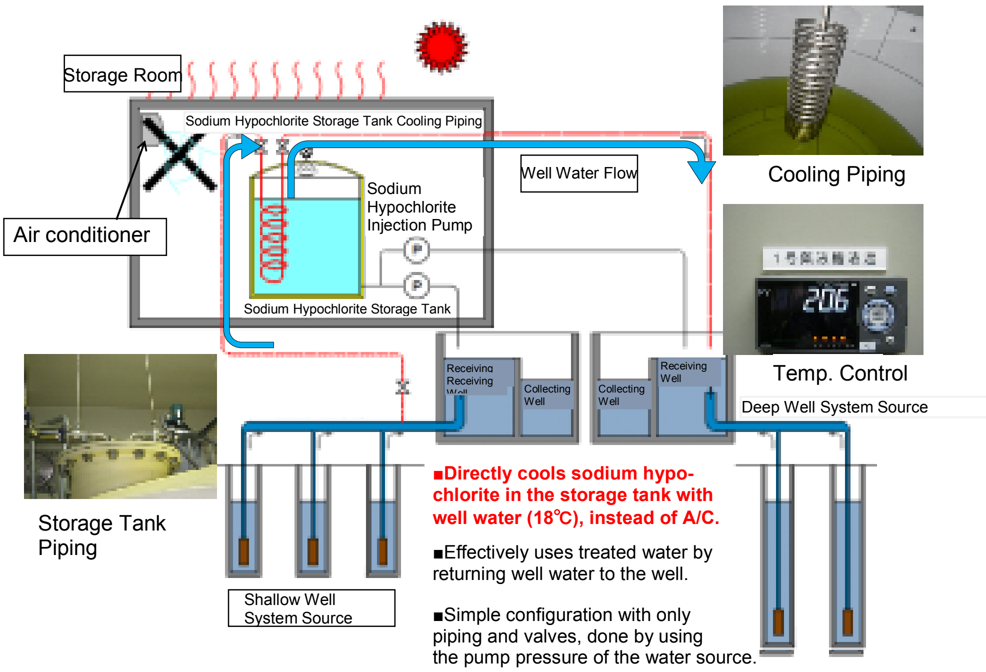

Fig. 9 Sodium Hypochlorite Storage Tank Cooling Flow

4. “Visualizing” CO2 emissions

Here we show monthly trends in total CO_2 emissions from large-scale service facilities over the past three years and cumulative total CO_2 emissions from large-scale service facilities over the past three years. (Fig. 10, Fig. 11)

Large-scale service facilities (facilities with an annual energy consumption equivalent to at least 1,500 kiloliters of crude oil) are obliged to reduce CO_2 according to the Tokyo Metropolitan Environmental Protection Ordinance.

For this reason, the TMWB visualizes data such as CO2 emissions of each service facility and the entire bureau in graph form, and notifies all bureau staff by e-mail every month.

By visualizing the reduction of CO2, we are promoting the reduction efforts of each service facility.

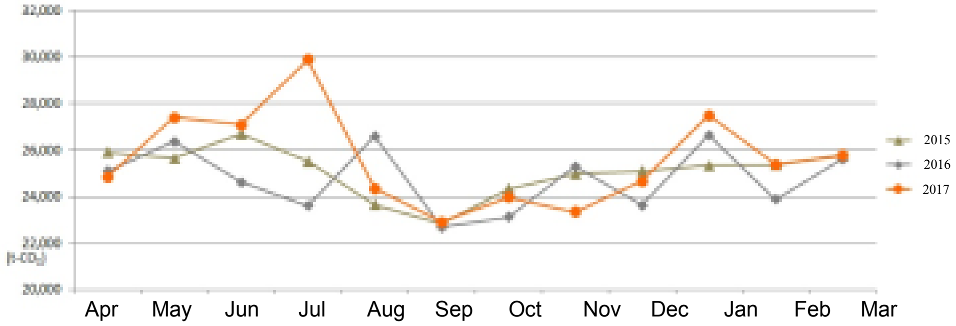

Fig.10 Monthly trends in total CO2 output at large-scale service facilities

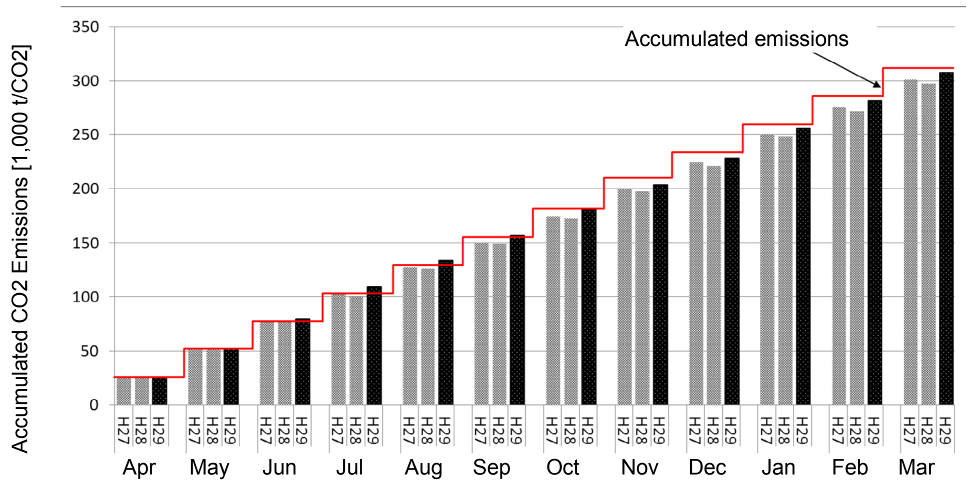

Fig.11 Accumulated CO2 emissions at large-scale service facilities by month

5. Conclusion

Waterworks projects have mission to supply safe and tasty water, but they also consume an enormous amount of energy in the processes of purifying, sending, and distributing water.

In order to realize further reduce energy consumption, TMWB shall continue to promote environmental and energy measures based on plans it has formulated, and steadily make innovative efforts in the field which will serve to support energy efficiency.

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