Measures against Outflow of Manganese from a Deep-depth Reservoir in Winter

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Introduction

Ogouchi reservoir is one of the largest reservoirs used exclusively for supplying drinking water in Japan.

In February 2010, DW (discharged water) containing high concentration of D-Mn (dissolved manganese) flowed out from the reservoir and exerted serious influence on the downstream water treatment plant.

The Bureau of Waterworks, Tokyo Metropolitan Government (hereinafter referred to as, “Tokyo Waterworks”) intended to predict the timing of the overflow of DW containing high concentration of D-Mn.

In addition, Tokyo Waterworks examined the water treatment methods by the combined use of PAC (powdered activated carbon) or SPAC (super powdered activated carbon) and chlorine.

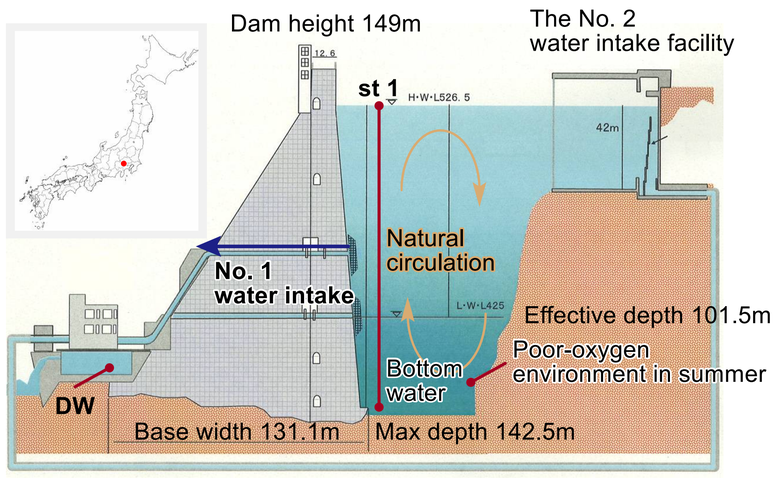

Fig. 1 Ogouchi dam

1. Investigations of the Reservoir

Material and Methods | What is the behavior of Mn ?

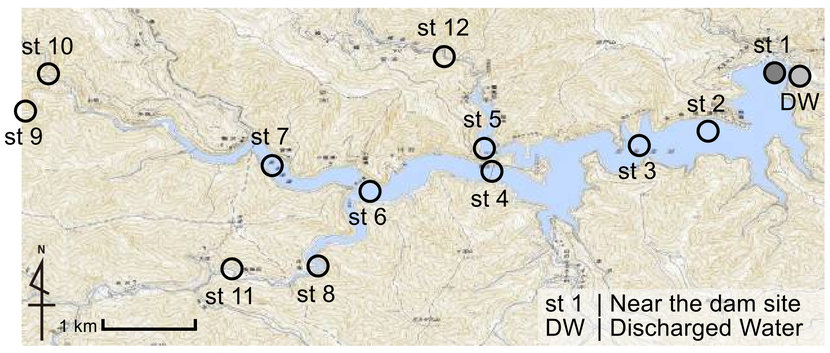

Fig. 2 Sampling points Ogouchi reservoir

Table 1 Contents of the Investigations

Investigations by depth	Measurement items	Frequency
Water Quality	General Items, Metals, etc.	1–4 / month
Sediment	General Items, Metals, etc.	1–2 / month
Elevating automatic water quality meter	WT, pH, EC, DO, etc.	Continuous * Only st 1 and DW

Results and Discussion | Flows of Mn outflow

Tokyo Waterworks considered the outflow of high concentration of D-Mn progressed in three steps.

Step 1 |

High concentration of D-Mn existed in the BW (bottom water) (Fig.3 D-Mn concentration of BW and DW at st 1).

Step 2 |

Natural total circulation started as the difference of WT between the surface layer and the bottom one disappeared (Fig. 4).

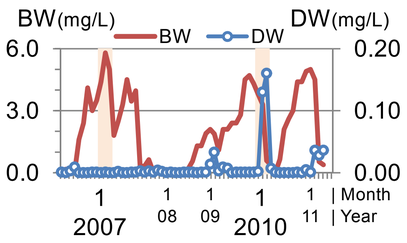

Fig. 3

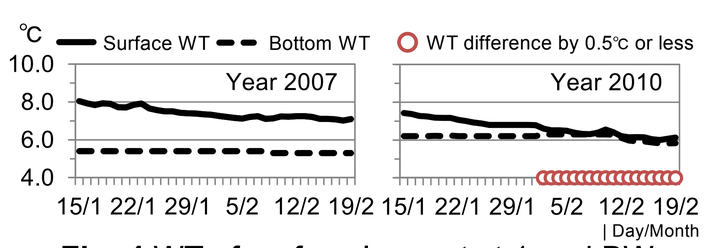

Fig. 4 WT of surface layer at st 1 and BW

Step 3 |

Upper water containing DO (dissolved oxygen) was mixed by natural total circulation, and BW diffused into all layers (Fig. 5).

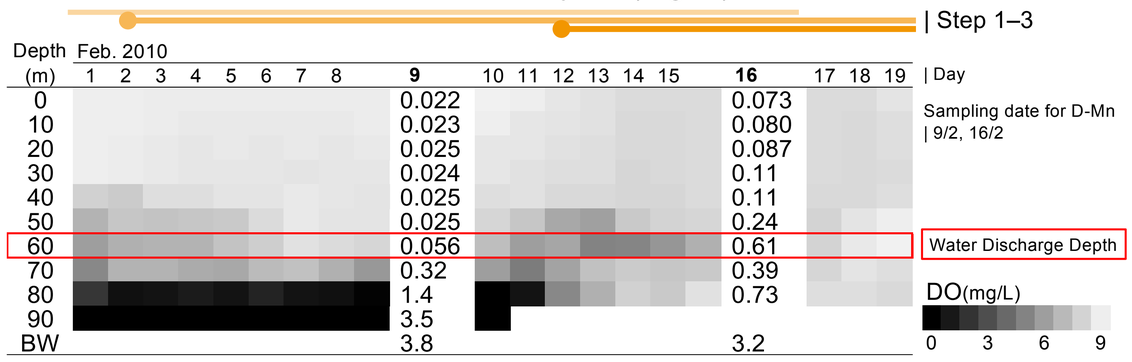

Fig. 5 Concentration (mg/L) of DO and D-Mn by depth from the surface layer at st 1

- Currently, in order to prevent similar problems, Tokyo Waterworks has been monitoring the data of WT and DO recorded by the elevating automatic water quality meter being installed at st 1.

2. Mn Removal Examinations with PAC

Material and Methods | Lab Test

Table 2 Conditions of the jar test

Contents		Conditions
Initial concentration of Mn		0.2 mg/L
Adjusted pH value		Approx. 7
PAC injection rates	PAC	0–200 mg/L
	* SPAC	0–50 mg/L
Chlorine injection rates	PAC	0, 1 and 10 mg/L
	* SPAC	1–16 mg/L
PAC contact time		30 min
Chlorine contact time		Immediately before injecting coagulant

Raw water - Preparation	PAC Chlorine	Jar test	Filtration Measurement
/ D-Mn		Rapid / 120 rpm, 2 min	MF / 0.45 μm
/ Phosphate buffer		Slow / 60 rpm, 10 min	/ 0.1 μm * SPAC
		Settling / 10 min	ICP-MS

Fig. 6 Procedure of the jar test

Results and Discussion | Can Mn be removed with PAC !?

In order to prevent D-Mn leakage from the water treatment plant, Tokyo Waterworks examined whether it is possible to use PAC injection facility introduced for countering moldy odor (2-methylisoborneol, geosmin).

Removal examination with PAC

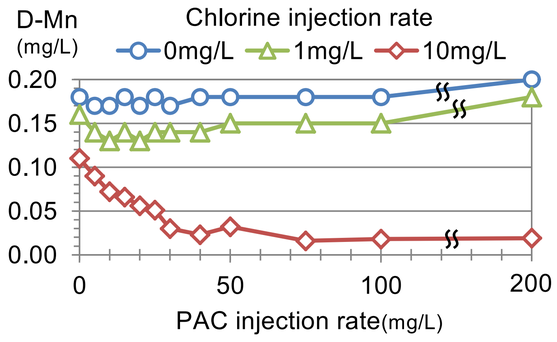

Fig. 7 Removal examination with PAC

D-Mn was hardly removed with PAC alone.

However, after injection of chlorine at the rate of 10 mg/L, the higher rates of PAC injection, the lower concentration of D-Mn will be.

Removal examination with SPAC

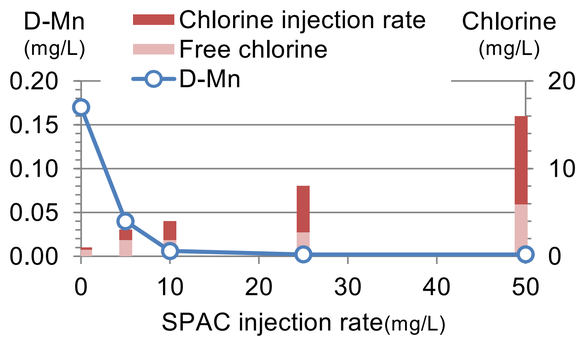

Fig. 8 Removal examination with SPAC

When SPAC was used instead of PAC, the concentration of D-Mn decreased further.

D-Mn could be reduced to a level under the Target Value for Complementary Items (0.01 mg/L) with an injection rate close to reality.

- The removal mechanism of the combination of PAC and chlorine is presumed that a trace amount of Mn adhering to PAC shows the same catalytic action as manganese sand.
- Aiming at application to actual water purification processing, Tokyo Waterworks is investigating further detailed conditions.