

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.

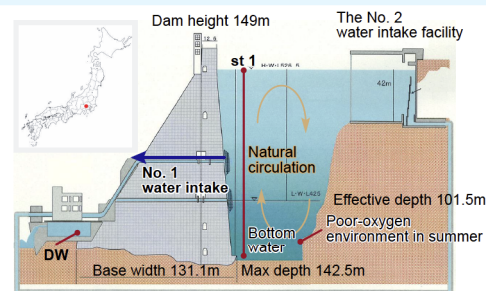


Fig. 1 Ogouchi dam

1. Investigations of the Reservoir

Material and Methods | What is the behavior of Mn ?

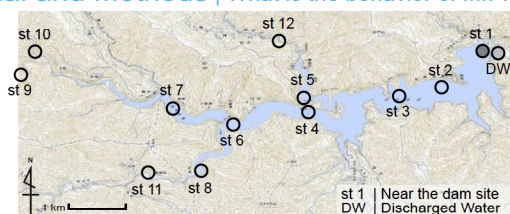


Fig. 2 Sampling points Ogouchi reservoir

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).

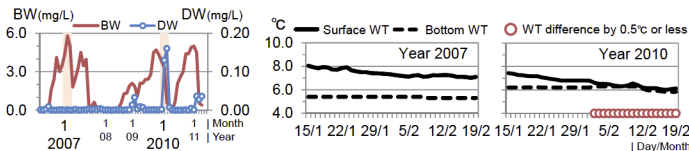


Fig. 3

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).

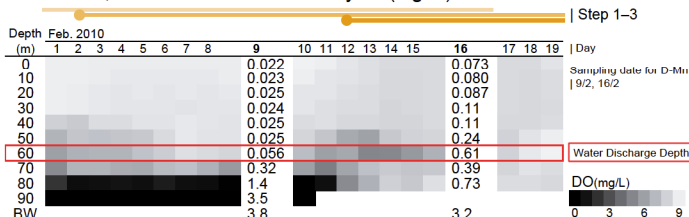


Fig. 5 Concentration (mg/L) of DO and D-Mn by depth from the surface layer at st 1

- 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 |

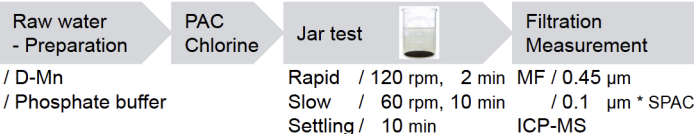


Fig. 6 Procedure of the jar test

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

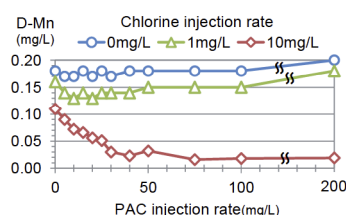


Fig. 7 Removal examination with PAC

Removal examination with SPAC

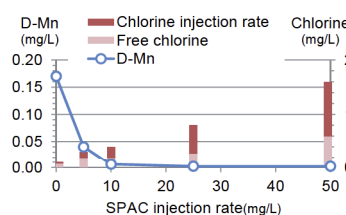


Fig. 8 Removal examination with SPAC

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.

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.