CLAIMS

1. A water treatment apparatus that aerates, with air, treatment target water that flows into a bioreactor tank through an inlet, performs biological reaction treatment, and drains the treatment target water out of the bioreactor tank through a drain port, the water treatment apparatus comprising:

a first aeration unit and a second aeration unit to aerate the treatment target water with the air;

an aeration rate calculation unit to calculate a first setting value and a second setting value, the first setting value being a setting value of an aeration rate of the first aeration unit, and the second setting value being a setting value of an aeration rate of the second aeration unit, to provide control to make the aeration rate of the first aeration unit equal to the first setting value, and to provide control to make the aeration rate of the second aeration unit equal to the second setting value; and

an effluent pollutant concentration measurement unit to measure an effluent pollutant concentration of the treatment target water, wherein

the first aeration unit is disposed at a position less distant from the inlet than the second aeration unit in the bioreactor tank,

the first setting value, denoted by G_1, is calculated using an equation below:

$G_1=k_{12}\cdot(G_P+G_I+G_D)+k_{13}$, and

the second setting value, denoted by G_2, is calculated using an equation below:

$G_2=k_{22}\cdot(G_P+G_I+G_D)+k_{23}$,

wherein G_P represents an amount of proportional control based on a difference between the effluent pollutant concentration measured by the effluent pollutant concentration measurement unit and an effluent pollutant concentration target value, G_I represents an amount of integral control based on the difference, G_D represents an amount of derivative control based on the difference, k_{12} and k_{22} are predetermined coefficients, and k_{13} and k_{23} are predetermined constants.

2. The water treatment apparatus according to claim 1, wherein the effluent pollutant concentration measurement unit is installed upstream of an outlet at a downstream end in the bioreactor tank.

3. A water treatment apparatus that aerates, with air, treatment target water that flows into a bioreactor tank through an inlet, performs biological reaction treatment, and drains the treatment target water out of the bioreactor tank through a drain port, the water treatment apparatus comprising:

a first aeration unit and a second aeration unit to aerate the treatment target water with the air;

an aeration rate calculation unit to calculate a first setting value and a second setting value, the first setting value being a setting value of an aeration rate of the first aeration unit, and the second setting value being a setting value of an aeration rate of the second aeration unit, to provide control to make the aeration rate of the first aeration unit equal to the first setting value, and to provide control to make the aeration rate of the second aeration unit equal to the second setting value; and

an influent load measurement unit to measure an influent pollutant concentration S_{IN} and a flow rate Q_{IN} of the treatment target water that flows into the bioreactor tank, wherein

the first aeration unit is disposed at a position less distant from the inlet than the second aeration unit in the bioreactor tank,

the first setting value, denoted by G_1, is calculated using an equation below:

$G_1=k_{11}\cdot S_{IN}\cdot Q_{IN}+k_{13}$, and

the second setting value, denoted by G_2, is calculated using an equation below:

$G_2=k_{21}\cdot S_{IN}\cdot Q_{IN}+k_{23}$

wherein k_{11} and k_{21} are predetermined coefficients, and k_{13} and k_{23} are predetermined constants.

4. The water treatment apparatus according to claim 3, wherein the influent load measurement unit is installed at a position selected, based on use, from a position in a pipe or in a water conduit through which the treatment target water flows into the bioreactor tank, and a position nearer to an entry of an aerobic zone, corresponding to the first aeration unit, in the bioreactor tank.

5. A water treatment method to be used in a water treatment apparatus that aerates, with air, treatment target water that flows into a bioreactor tank through an inlet, performs biological reaction treatment, and drains the treatment target water out of the bioreactor tank through a drain port, the water treatment method comprising:

a step of measuring an effluent pollutant concentration of the treatment target water; and

a step of calculating a first setting value and a second setting value, the first setting value being a setting value of an aeration rate of a first aeration unit that aerates the treatment target water with the air, and the second setting value being a setting value of an aeration rate of a second aeration unit that aerates the treatment target water with the air, of providing control to make the aeration rate of the first aeration unit equal to the first setting value, and of providing control to make the aeration rate of the second aeration unit equal to the second setting value, wherein

the first aeration unit is disposed at a position less distant from the inlet than the second aeration unit in the bioreactor tank,

the first setting value, denoted by G_1, is calculated using an equation below:

$$G_1=k_{12}\cdot(G_P+G_I+G_D)+k_{13}, \text{ and}$$

the second setting value, denoted by G_2, is calculated using an equation below:

$$G_2=k_{22}\cdot(G_P+G_I+G_D)+k_{23},$$

wherein G_P represents an amount of proportional control based on a difference between the effluent pollutant concentration measured and an effluent pollutant concentration target value, G_I represents an amount of integral control based on the difference, G_D represents an amount of derivative control based on the difference, k_{12} and k_{22} are predetermined coefficients, and k_{13} and k_{23} are predetermined constants.

6. A water treatment method to be used in a water treatment apparatus that aerates, with air, treatment target water that flows into a bioreactor tank through an inlet, performs biological reaction treatment, and drains the treatment target water out of the bioreactor tank through a drain port, the water treatment method comprising:

a step of measuring an influent pollutant concentration S_{IN} and a flow rate Q_{IN} of the treatment target water that flows into the bioreactor tank; and

a step of calculating a first setting value and a second setting value, the first setting value being a setting value of an aeration rate of a first aeration unit that aerates the treatment target water with the air, and the second setting value being a setting value of an aeration rate of a second aeration unit that aerates the treatment target water with the air, of providing control to make the aeration rate of the first aeration unit equal to the first setting value, and of providing control to make the aeration rate of the second aeration unit equal to the second setting value, wherein

the first aeration unit is disposed at a position less distant from the inlet than the second aeration unit in the bioreactor tank,

the first setting value, denoted by G_1, is calculated using an equation below:

$$G_1=k_{11}\cdot S_{IN}\cdot Q_{IN}+k_{13}, \text{ and}$$

the second setting value, denoted by G_2, is calculated using an equation below:

$$G_2=k_{21}\cdot S_{IN}\cdot Q_{IN}+k_{23}$$

wherein k_{11} and k_{21} are predetermined coefficients, and k_{13} and k_{23} are predetermined constants.