ICS 13.020.40
J 88
Record No.: 51914-2015

JB

Standards for Machinery Industry of the People's Republic of China

JB/T 12579-2015

Multi-function high-efficient aerator

多功能高效曝气装置

（报批稿）

Implementation date:2016-03-01

Issue date:2015-10-01

Issued by Ministry of Industry and Information Technology of the People's Republic of China

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Contents

Foreword

CMIF/TC 7 is in charge of this English translation. In case of any doubt about the contents of this English translation, the Chinese original shall be considered authoritative

This document is drafted in accordance with the rules of GB/T 1.1-2020.

This document is proposed by China Machinery Industry Federation (CMIF).

This document is centrally administered by the Machinery Industry Environmental Protection Machinery Standardization Committee (CMIF/TC7).

This document was prepared by CMIF/TC 7 on the Machinery Industry Environmental Protection Machinery Standardization Technical Committee.

This document was issued as first edition.

Multi-function High-efficient Aerator

1 Scope

This document specifies the terms and definitions, models and specifications, technical requirements, test methods, inspection rules, sign, packaging, transport and storage of the multi-function and high-efficiency aerator.

This document is applicable to the multi-function high-efficient aerator driven by motors and reducers in the aerobic biochemical water treatment process.

2 Normative References

The following documents are essential for the application of this document. For dated referenced documents, only the dated version applies to this document. For undated referenced documents, the latest version (including all amendments) is applicable to this document.

GB/T 191 *Packaging –pictorial marking for handling of goods*

GB/T 307.3 *Rolling bearings - General technical regulations*

GB/T 3077 *Alloy structure steels*

GB/T 3098.1 *Mechanical properties of fasteners - Bolts, screws and studs*

GB/T 3480.5 *Calculation of load capacity of spur and helical gears-Part 5: Strength and quality of materials*

GB/T 3797 *Electrical control assemblies*

GB/T 6404.1 *Acceptance code forg gear units-Part 1: Test code for airborne sound*

GB/T 7324 *General purpose lithium lubricating grease*

GB/T 7631.7 *Lubricants and related products (Class L) - Classification - Part 7: famioly C (gears)*

GB/T 9239.1 *Mechanical vibration –Balance quality requirements for rotors in a constant (rigid) state-Part 1:Specification and verification of balance tolerances*

GB/T 9969 *General principles for preparation of instructions for use of industrial products*

GB/T 10095.1 *Cylindrical gears- System of accuracy - Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

GB/T 10095.2 *Cylindrical gears- System of accuracy - Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information*

GB/T 13306 *Plates*

GB/T 13384 *General specifications for packing of mechanical and electrical product*

GB 18613 *Minimum allowable values of energy efficiency and energy efficiency grades for small and middiumthree-phase asynchronous motors*

GB/T 28742 *Sewage treatment equipment for prevention and treatment of water pollution*

JB/T8680 *Specification for Y2 Series (IP54) Three-phase asynchronous motors (Frame No. 63 ~ 355)*

JB/T10447 *Specification for Y3 series (IP55) Three-phase induction nmotors (Frame No. 63 ~ 355)*

NB/T 47003.1 *Steel welded atmospheric pressure vessel*

CJ/T 475-2015 *Measurement of oxygen mass transfer in clean water for fine bubble diffuser*

3 Terms and definitions

The following terms and definitions are applied to this document.

3.1 multi-function high-efficient aerator

the invention relates to an aeration device which is applied in biochemical aerobic sewage treatment process and has the functions of water drawing and lifting and air suction, and provides a 2-step aeration by mixing the air, water and solid and ejecting the mixture into water body.

Note: The multi-function high-efficient aerator is mainly composed of a motor, a transmission mechanism and a multifunctional impeller (i.e. Hydraulic components, hereinafter referred to as impellers) and an electrical control cabinet. The theoretical power efficiency is not less than 3.12kg/(kW • h), and the energy efficiency ratio is not less than 2.5kg/(kW • h).

3.2 theoretical power efficiency

[Ep]

for the impeller of multi-function high-efficient aerator, under standard test conditions, the ratio of the amount of oxygen transferred to clean water with zero dissolved oxygen per unit time to the useful work of driving the impeller, i.e. The amount of oxygen/useful work, is measured in kilogram of oxygen per kilowatt-hour [kg/(kW • h)]. It is a technical index to evaluate the aeration performance of impeller.

3.3 energy efficiency ratio

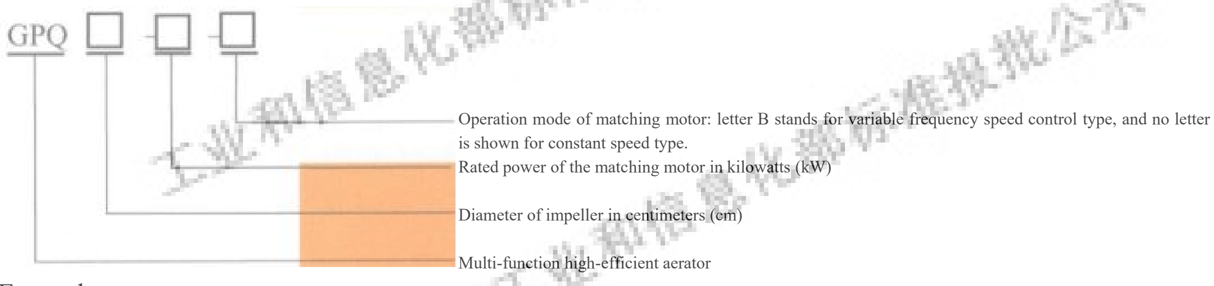
[$E_{\text{efficiency}}$]

for the multi-function high-efficient aerator, under standard test conditions, the ratio of the amount of oxygen transferred to clean water with zero dissolved oxygen per unit time to the total power consumption of the complete machine, i.e. the amount of oxygen/total power consumption, is measured in kilogram of oxygen per kilowatt-hour [kg/(kW • h)]. It is an economical index to evaluate the multi-function high-efficient aerator, that is, the amount of oxygen transferred to the water per 1 kWh of electricity consumed by the aeration device.

4 Model codingand Specification

4.1 Model

The model of a multi-function high-efficient aerator is represented by Chinese phonetic alphabet and Arabic numerals.



Example:

GPQ325-55-B Multi-function high-efficient aerator：

A multi-function high-efficient aerator with the diameter of the impeller of 325cm, the rated power of the motor of 55kW, and with a variable frequency control motor.

GPQ400-132 Multi-function high-efficient aerator：

The diameter of the impeller of 400cm, the rated power of the motor of 132kW, and with a constant motor.

4.2 Specification

Specifications of the multi-function high-efficient aerators are provided in Table 1 according to the power of the motor and the diameter of the impeller.

Table 1 Specifications and models of multi-function high-efficient aerator

Specifications and models	Impeller diameter in cm	Motor power in kW
GPQ80-3 (or 4)	80	3 or 4
GPQ100-5. 5 (or 7.5)	100	5.5 or 7.5
GPQ125-11	125	11
GPQ165-15 (or 18.5)	165	15 or 18.5

Table 1 Specifications and models of multi-function high-efficient aerator (continued)

Specifications and models	Impeller diameter in cm	Motor power in kW
GPQ200-18. 5 (or 22)	200	18.5 or 22
GPQ225-22 (or 30)	225	22 or 30
GPQ250-30	250	30
GPQ275-37	275	37
GPQ300-45	300	45
GPQ325-55	325	55
GPQ325-75	350	75
GPQ375-90 (or 110)	375	90 or 110
GPQ400-110 (or 132)	400	110 or 132
GPQ450-160	450	160

5 Technical Requirements

5.1 Working environment requirements

The multi-function high-efficient aerator should be able to operate normally under the following conditions:

a) Altitude should be below 1000 m; when the altitude exceeds 1000 m, appropriate motor and lubricating oil should be selected.

b) The operating ambient temperature is-20 °C ~ 65 °C.

c) Medium temperature is 0 °C ~ 45 °C.

d) When the pH value of the medium is 6.5 ~ 8.5, the impeller should be made of low alloy high strength structural steel; When the pH value of the medium exceeds this range, the impeller shall be made of stainless steel.

e) The density of the medium shall not exceed 1150 kg/m^3.

5.2 Basic requirements

5.2.1 The multi-function high-efficient aerator shall meet the requirements specified in this Standard and shall be manufactured according to the drawings and technical documents approved by the specified procedures.

5.2.2 Motor components and electrical control equipment

a) The motor matched with the multi-function high-efficient aerator shall be a high-efficiency standard motor, and the allowable values of energy efficiency and energy efficiency grades of the selected motor shall conform to Grade 1 specified in GB 18613.

b) The selected motor shall conform to the requirements of JB/T 8680 and JB/T 10447.

c) When the motor is running on load, the current difference of the three-phase line is within 8%.

d) The insulation grade of the selected outdoor motor shall be no lower than F and the protection grade shall be IP55.

e) When the operation mode is of speed control, the standard variable frequency motor shall be selected, and the common motor with variable frequency device is not recommended.

f) The electrical control equipment shall comply with the provisions of GB/T 3797.

g) Electrical control equipment and motors shall be provided with a good grounding network.

5.2.3 Transmission

a) When designing and selecting reducers, it shall be determined according to continuous operation conditions and other conditions, and the safety factor of the reducer shall not be less than 1.75.

b) The gear material of the reducer shall not be lower than those of 20CrMnTi or 42CrMo alloy steel. The material and mechanical properties shall meet the requirements of GB/T3077. The heat treatment of the gear material shall conform to the requirements of GB/T 3480.5.

c) The machining accuracy grade of the cylindrical gear of the reducer shall not be lower than Grade 7 of

GB/T 10095.1 and GB/T 10095.2.

d) The selection of gear lubricating oil for reducer shall be carried out in accordance with the provisions of GB/T 7631.7.

e) The sound pressure level of the reducer shall be less than 80 dB (A).

f) The reducer shall operate smoothly, free from impact, vibration and abnormal noise caused by abnormal meshing; There shall be no oil leakage at all matching surfaces and joints.

g) The bearing shall be designed and selected on the premise that the life factor is determined by the expected life of 100000h under the 24h continuous operation.

h) The rotation accuracy grade of the selected bearing shall not be lower than Grade 6 of GB/T 307.3.

i) Bearing grease shall be selected in accordance with the provisions of GB/T 7324.

j) After the transmission shaft is connected with the reducer, the radial runout at the matching end of the transmission shaft and the impeller shall be less than 0.1 mm.

5.2.4 Impeller

a) The radial runout of the impeller body, blades and other parts shall be less than 0.1% of the diameter of the impeller.

b) The axial runout of the impeller shall be less than 0.1% of the diameter of the impeller.

c) The symmetry error of the blades on the impeller body shall be less than 5 '.

d) Static balance test shall be carried out for the impeller, and its allowable balance quality grade shall be G6.3 in GB/T 9239.1.

e) The impeller can be made of stainless steel or low alloy high strength structural steel; If it is made of low alloy high strength structural steel, the surface shall be coated with anti-corrosive coating.

5.3 Complete machine requirements

5.3.1 Fasteners in direct contact with water shall be made of stainless steel.

5.3.2 The mechanical property grade of bolts and screws used for fastening shall not be lower than Grade 8.8 in GB/T 3098.1.

5.3.3 Signs indicating impeller rotation direction shall be provided on visible positions of the multi-function high-efficient aerator.

5.3.4 Current fluctuation value of operating line:

a) When the motor power is < 30kW, the fluctuation value should be less than 10%;

b) When the motor power is ≥ 30 kW, the fluctuation value shall be less than 5%.

5.3.5 The service life of the complete machine shall not be less than 8 years.

5.3.6 The sound pressure level of noise generated by the multi-function high-efficient aerator during operation shall be less than 85 dB (A).

5.3.7 Thickness of anti-corrosive coating for surface anti-corrosive treatment:

a) The thickness of the part directly in contact with water shall be ≥ 0.25 mm;

b) The thickness of the part not in direct contact with water shall be between 0.15 mm ~ 0.2 mm.

5.3.8 The safety technical requirements of the complete machine shall meet the provisions of GB/T 28742.

5.4 Performance requirements

5.4.1 Under the specified test conditions, the multi-function high-efficient aerator shall meet the following requirements:

a) The multi-function high-efficient aerator with Grade 1 energy efficiency: theoretical power efficiency is $\geq$4.25 kg/(kW • h), and energy efficiency ratio is$\geq$3.4kg/(kW•h);

b) The multi-function high-efficient aerator with Grade 2 energy efficiency: theoretical power efficiency is $\geq$4.0kg/ (kW•h), and energy efficiency ratio is $\geq$3.2kg/(kW•h);

c) The multi-function high-efficient aerator with Grade 3 energy efficiency: theoretical power efficiency is$\geq$3.125kg/ (kW•h), and energy efficiency ratio is $\geq$2.5kg/ (kW•h).

5.4.2 The suitable effective water depth of multi-function high-efficient aerator is 4.5 m ~ 6.5 m.

6 Test Methods

6.1 The three-phase line current value of the motorunder load operation shall be measured by clamp ammeter.

6.2 The noise test of the reducer shall be carried out in accordance with the provisions of GB/T 6404.1.

6.3 Tightness and operation detection of the reducer: Start idle operation for 1h ~ 2h, and observe whether there is any abnormality or leakage.

6.4 Standard measuring tools for dimensional inspection of impellers and transmission shafts; Geometric tolerances shall be tested in accordance with Appendix A.

6.5 Static balance detection of impeller: Place the impeller on a balance frame and balance it by adding or removing mass on a non-working face.

6.6 The weld quality inspection of impeller shall be in carried out accordance with the provisions of NB/T 47003.1.

6.7 The test of working performance requirements shall be conducted out according to Appendix B.

7 Inspection Rules

The inspection is divided into delivery inspection and type inspection.

7.1 Delivery inspection

7.1.1 Each multi-function high-efficient aerator can only leave the factory after passing the inspection.

7.1.2 Check the appearance quality and dimensions of the transmission and impeller, which shall comply with the provisions of 5.2.3 j), 5.2.4 a), 5.2.4 b) and 5.2.4 c) .

7.1.3 Give the device a test run for 1h ~ 2h, and check:

a) The sound of the complete machine when it is running, which shall comply with the provisions of 5.3.6.

b) Oil leakage of reducer, which shall comply with the provisions of 5.2.3 f).

c) Motor three-phase line current difference, which shall comply with the provisions of 5.2.2 c) and 5.3.4.

7.1.4 The impeller rotation direction identification and surface anti-corrosion treatment, which shall comply with the provisions of 5.3.3 and 5.3.7.

7.2 Type test

7.2.1 Type tests must be carried out when one of the following conditions occurs:

a) Types of new products and products of new specifications need to be finalized, or old products are produced in a different factory.

b) The structure, process and main materials of a product have changed greatly, which may affect the performance of the product.

c) Production is resumed after continuous shutdown for more than one year;

d) The production has been normal for three years;

e) The national quality supervision authority requires type tests to be done.

7.2.2 Type test sampling and test items:

a) Sampling method. Take samples randomly from the products that pass the delivery inspection, and the number of sample in each batch shall be 1.

b) Type test items. The test items shall include those specified in 7.1.2, 7.1.3 and 7.1.4, and shall also include the following ones:

1) The performance test of multi-function high-efficient aerator, which shall comply with the provisions of 5.4;

2) Type tests of motor and reducer: The type test reports of motor and reducer shall be provided by the producer and the supplier.

7.2.3 Judgment rules.

If any item is found to be unacceptable in the spot check, the sample is determined to be unacceptable.

8 Markings, Packaging, Transportation and Storage

8.1 Markings

The product shall be provided with markings on obvious parts. The markings shall comply with the provisions of GB/T13306. The following contents shall be indicated on the nameplate:

a) Product name and model.

b) Main technical parameters:

1) Rated frequency in hertz (Hz);

2) Rated voltage in volts (V);

3) Rated current in amperes (A);

4) Rated power in kilowatts (kW);

5) Diameter of impeller in centimeters (cm)

6) Constant rotational speed in revolutions per minute (r/min);

7) Aerated oxygen quantity

c) Factory number and production date.

d) Name of manufacturer.

e) Number of the implemented standard for the product.

8.2 Packaging

8.2.1 The packing shall comply with the provisions of GB/T 13384.

8.2.2 Packing, storage and transportation signs shall comply with the provisions of GB/T191.

8.2.3 The following documents shall be attached to the packing box:

a) Packing list;

b) Product certificate;

c) Product instruction manual (shall comply with the provisions of GB/T 9969).

d) Equipment installation foundation diagram and electrical schematic diagram.

e) As-built drawings of equipment and list of vulnerable parts.

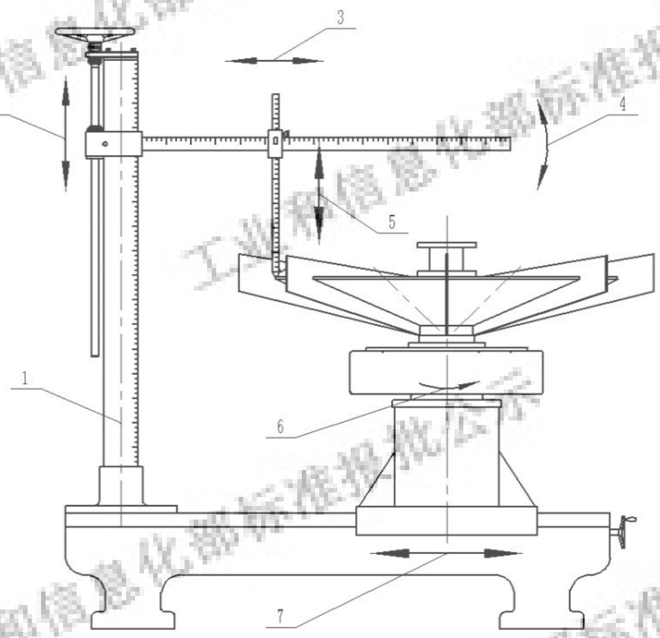
8.3 Transportation and storage

During transportation and storage, measures such as anti-corrosion, damage prevention, rain prevention, moisture prevention shall be taken for the products. The products shall not be stored in the open air.

Annex A
(Normative)
Detection of Shape and Position Deviation of Impeller

A.1 Detection of shape and position deviations of impeller body and blades

A.1.1 As shown in Fig. A.1, the impeller is fixed on a CMM or a self-made measuring device based on the rotation center of the impeller.



Description of index serial number

1——Axis A

2——Move up and down

3——Move left and right

4——Rotate around axis A

5——Move up and down

6——360°rotary table

7——Slide left and right

Fig. A.1 Schematic diagram of form and position deviation detection

A.1.2 Measuring steps:

a)Adjust the scale to make the measuring head contact the impeller edge or blade edge, lock the vertical scale and record the horizontal scale reading X_1.

b)Rotate the impeller, measure another impeller edge or another blade edge and record the horizontal scale reading X_2.

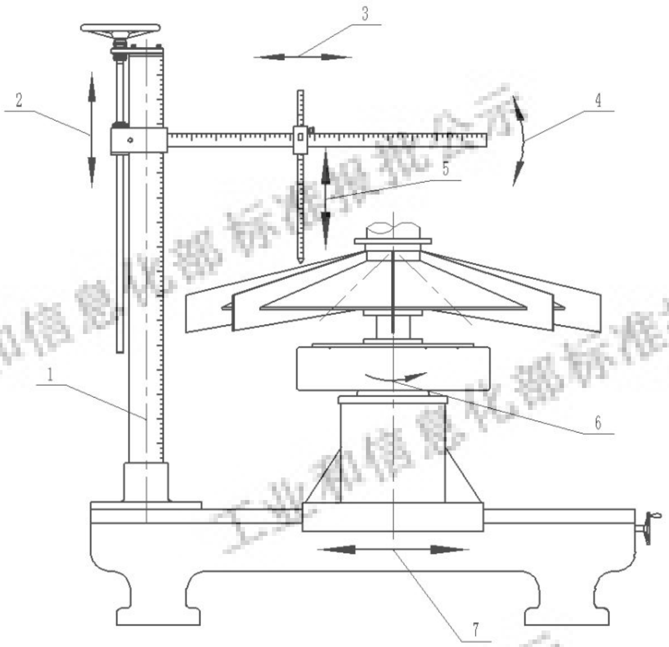
c)Repeat step b) to measure other impeller edges or other blade edges in sequence, and record horizontal scale readings X_3 and X_4.

d) Determine the maximum value X_{max} and the minimum value X_{min} of the horizontal scale readings of impeller edges or blade edge points respectively to calculate the eccentricity ($\Delta R=X_{max}-X_{min}$), then the actual deviation of the impeller edge or blade edge is 2ΔR.

e)If the actual deviation 2ΔR<0.1%D, the index is acceptable.

A.2 Test of axial circular runouts of impeller body and blades

A.2.1 As shown in Fig.A.1 and Fig. A.2, the impeller is fixed on a CMM or a self-made measuring device based on the rotation center of the impeller. Test the axial circular runouts on the water surface and air surface of the impeller or blades respectively.



Description of index serial number

1──Axis A

2──Move up and down

3──Move left and right

4──Rotate around axis A

5──Move up and down

6──360°rotary table

7──Slide left and right

Fig. A.2 Schematic diagram of axial circular runout detection

A.2.2 Measuring steps:

a) Based on the diameter of the impeller, equally divide the impeller into 3 - 5 concentric circles from the center to the outside.

b) Adjust the scale to make the measuring head detect a measuring point on the impeller or blade on the first concentric circle circumference, fix the measuring scale on the transverse scale, and record the measuring scale reading Y_1.

c) Rotate the impeller, measure the corresponding position point on another impeller or blade on the same concentric circle circumference, and record the measuring scale reading Y_2.

d) Repeat step c) to measure other points at corresponding positions on the impeller or blade on the same concentric circle circumference in turn, and record the measuring scale readings Y_3, Y_4..

e) Determine the maximum value $Y_{\max}$ and the minimum value $Y_{\min}$ of the measuring points on the impeller or the blade respectively, and calculate the axial circular runout$\Delta Y_1=Y_{max}-Y_{min}$, that is, the actual axial circular runout of the impeller or the blade on the concentric circle circumference.

f) Repeat steps b) ~ e), measure each corresponding point on other concentric circles in turn, and calculate Y_2, Y_3..., namely the axial circle runout of the corresponding point on each concentric circle circumference.

g) Determine the maximum value $\Delta Y_{max}$of axial circle runout of corresponding points on each concentric circle circumference; If ΔY_{max}< 0.1% D, the index is acceptable.

Annex B
(Normative)
Test Method for Theoretical Power Efficiency and Energy Efficiency Ratio

B.1 Test conditions

A square aeration tank or a Carrousel aeration tank is used in the test, and the wall of the tank is smooth. The ratio of impeller diameter to aeration tank width is greater than 1:5; the effective water depth of the aeration tank is greater than 4.5 m.

B.2 Measuring steps:

Refer to CJ/T475-2015.

B.3 Total oxygen transfer coefficient K_{La}

In aeration and oxygenation, gas molecules are transferred from the gas phase to the liquid phase. Oxygen must pass through the gas-liquid interface. If there are gas film and liquid film on both sides of this interface, the transfer process of oxygen through these two films can be explained by the double-film theory.

According to the double-film theory, the diffusion rate can be calculated as Equation (B.1).

$$\frac{\mathrm{d}C}{dt} = K_{La}(C_S - C) \quad \text{(B.1)}$$

In Equation (B.1), the oxygen transfer coefficient K_{La} represents the total transmission of oxygen during aeration and oxygenation, which is related to the multi-function high-efficient aerator and reflects the properties of the multi-function high-efficient aerator. The Equation (B.2) can be obtained by integrating Equation (B.11).

$$\int_{C_0}^{C_s} \frac{dC}{dt} = \int_{C_0}^{C_S} K_{La}(C_S - C) \quad \text{(B.2)}$$

$$C = C_S - (C_S - C_0)\exp(-K_{La}t)$$

Where:

C- Dissolved oxygen concentration in milligrams per liter (mg/L);

C_s- Saturated dissolved oxygen concentration in milligrams per liter (mg/L);

C_0- The value of concentration C when time t is 0, in milligrams per liter (mg/L);

t- Time in seconds (s), minutes (min), or hours (h).

The primary purpose of performance testing of multi-function high-efficient aerator is to measure its oxygen transfer coefficient K_{La}. According to the nonlinear least square method, write a program to calculate the oxygen transfer coefficient K_{La}. Nonlinear least square method can also be called nonlinear regression method. For Equation (B.2), when Cs and C0 are unknown, the equation is a typical nonlinear equation. For this reason, the nonlinear least square method can be applied, and its theoretical curve Equation is Equation (B.3).

$$\mathrm{f}(t; C_S, C_0, K_{La}) = C_S - (C_S - C_0)\exp(-K_{La}t) \quad \text{(B.3)}$$

According to the measured *C-t* data, using the least squares method to obtain the parameters, and then derive the nonlinear least squares problem in Equation B.4.

$$Q(C_S^*, C_0^*, K_{La}^*) = \sum_{i=1}^{n}\left[f(t_i; C_S^*, C_0^*, K_{La}^*) - C_i\right]^2 = \min \sum_{i=1}^{n}\left[f(t_i; C_S^*, C_0^*, K_{La}^*) - C_i\right]^2 (i = 1,2, \dots n) \quad \text{(B.4)}$$

The nonlinear least squares problem cannot be directly solved, and the iterative method is generally adopted. The steps are as follows: first estimate a set of (C_S^0, C_0^0, K_{La}^0), then make Taylor expansion of formula (B.3) at this point, and omit second or higher power ofvariables. The obtained linear function approximately replaces $f(t_i;$ C_s, C_0, $K_{La})$. For the approximate substitution function$f(t_i;$ C_s, C_0, $K_{La})$, obtain (ΔC_s, ΔC_0, ΔK_{La} by linear least square method, and then solve by Equation (B.5).

$$(\Delta C_S, \Delta C_0, \Delta K_{La}) = (C_S^1, C_0^1, K_{La}^1) - (C_S^0, C_0^0, K_{La}^0) \quad \text{(B.5)}$$

Obtain (C_S^1, C_0^1, K_{La}^1); Then, have Taylor expansion of formula (B.3) at the point (C_S^1, C_0^1, K_{La}^1) , and repeat the previous steps to obtain (C_S^2, C_0^2, K_{La}^2), and repeat the iteration. Formula (B.6) represents the calculation accuracy.

$$\Delta j = \left|\frac{b^j - b^{j-1}}{b^j}\right| (\text{b分别为} C_S, C_0, K_{La}) (j = 1,2,\cdots,n) \quad \text{(B.6)}$$

Where:

Calculation accuracy, used to control the number of iterations.

This method regards Cs as an unknown number, and can reduce the dependence of linear regression method on C_s to a certain extent. Using this method, accurate K_{La} can be obtained only if the measured Cs is not less than 98% of the real value. It is easier to control in the actual determination process.

B.4 Standard oxygen transfer rate (SOTR)

Standard oxygen transfer rate (SOTR) refers to the amount of oxygen transferred to clear water without dissolved oxygen per unit time by the multi-function high-efficient aerator under the standard state (1atm, 20 ℃, the same below) test conditions (mainly referring to oxygen volume). In essence, SOTR is a rate, that is, the rate at which oxygen is transferred. Equation (B.7) represents SOTR.

$$SOTR = K_{La20}VC_{S20}) \quad \text{(B.7)}$$

Where:

SOTR- The SOTR of the multi-function high-efficient aerator under the standard state, and the unit is kilograms of oxygen per hour (kgO_2/h);

V- The volume of water in the inspection tank (tower) is in cubic meters (m^3);

C_{s20}- The saturated dissolved oxygen concentration of water under the standard state is 9.08 mg/L.

B.5 Total power consumed P_{total}

When the aerator operates at power frequency, the total power consumed Ptotal is measured by athree-phase power meter.

B.6 Theoretical power efficiency [*E*p]

Theoretical dynamic efficiency [*E*p] relates to impeller, which is the hydraulic component of the multi-function high-efficient aerator. It refers to the ratio of the amount of oxygen transferred to clean water without dissolved oxygen per unit time to the useful work (kW•h) driving the impeller under the standard state test conditions. It is in kilograms of oxygen per kilowatt-hour [kg/(kW•h)]. The calculation is shown in Equation (B.8).

$$E_P = \frac{SOTR}{P} \quad \text{(B.8)}$$

Where:

E_P - Theoretical dynamic efficiency of impeller under standard state. It is in kilograms of oxygen per kilowatt-hour [kg/(kW•h)];

P- The useful work driving the impeller. It is in kilowatt hours (kW•h).

B.7 Energy efficiency ratio

Energy efficiency ratio [$E_{efficiency}$] refers to the ratio of the amount of oxygen transferred to clean water without dissolved oxygen per unit time to the total electric power (kW•h) consumed by the multi-function high-efficient aerator under the standard state test conditions. It is in kilograms of oxygen per kilowatt-hour [kgO_2/(kW•h)]. The calculation is shown in Equation (B.9).

$$E_{efficiency} = \frac{SOTR}{P_{total}} \quad \text{(B.9)}$$

Where:

$E_{efficiency}$The energy efficiency ratio of the multi-function high-efficient aerator under the standard state, and the unit is kilograms of oxygen per hour (kg/h);

P_{total}The total electric power consumed by the aerator. It is in kilowatt hours (kW•h).

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