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Technical Requirements and Testing Methods for Glycol-based Coolant of Cold Plate Liquid Cooling

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Foreword

This document is prepared in accordance with *GB/T 1.1-2020 Directives for Standardization—Part 1: Rules for the Structure and Drafting of Standardizing Documents*.

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Technical Requirements and Testing Methods for Glycol-based Coolant of Cold Plate Liquid Cooling

1 Scope

This document specifies the technical requirements & testing methods for glycol-based coolants of cold plate liquid cooling, as well as requirements for coolant delivery, packaging, transportation, storage, replenishment, monitoring, and recycling.

This document is primarily applicable to data center cold-plate liquid cooling secondary-side coolants, which use ethylene glycol or 1,2-propylene glycol and deionized water as the base fluid, blended with functional additives such as corrosion inhibitors and biocides.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 1040.2-2022 Plastics—Determination of tensile properties—Part 2: Test conditions for moulding and extrusion plastics

GB/T 1043.2-2018 Plastics—Determination of Charpy impact properties—Part 2: Instrumented impact test

GB/T 11446.1 Electronic grade water

GB/T 11547 Plastic - Methods of test for the determination of the effects of immersion in liquid chemicals

GB/T 14832-2008 Test methods for compatibility between hydraulic fluids and standard elastomeric materials

GB/T 15428 Cold plate design guideline for electronic equipment

GB/T 1690-2010 Rubber, vulcanized or thermoplastic - Determination of the effect of liquids

GB/T 23436 Cleaning fluids for automotive windshield

GB 29216-2012 Food Additive - Propylene Glycol

GB 29743.1-2022 Motor vehicle coolant—Part 1: Fuel vehicle engine coolant

GB 29743.2-2025 Motor vehicle coolant—Part 2: Electric vehicle coolant

GB/T 30308-2013 Fluoroelastomers—General specification and procedure of evaluation

GB/T 3190 Chemical composition of wrought aluminium and aluminium alloys

GB/T 33402-2016 Silicone rubber compound—General purpose

GB/T 37837-2019 General rules for quadrupole inductively coupled plasma mass spectrometry

GB/T 39714.2 Plastics—Polytetrafluoroethylene (PTFE) semi-finished products—Part 2

GB/T 2546.2-2022 Plastics — Polypropylene (PP) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties

GB/T 4649 Ethylene glycol for industrial use

GB/T 5231 Designation and chemical composition of wrought copper and copper alloys

GB/T 528-2009 Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties

GB/T 5750.4 Standard examination methods for drinking water — Part 4: Organoleptic and physical indices

GB/T 5750.12 Standard examination methods for drinking water—Part 12: Microbiological indices

GB/T 6031-2017 Rubber, vulcanized or thermoplastic—Determination of hardness

GB/T 6418.1-2025 Copper base brazing filler metals—Part 1: Solid brazing filler metals

GB/T 6682 Water for analytical laboratory use - Specification and test methods

GB/T 6909 Analysis of water used in boiler and cooling system—Determination of hardness

GB/T 9722-2023 Chemical reagent—General rules for the gas chromatography

GJB 1790-1993 Specification for fuel-resistant fluorosilicone rubber materials

JT/T 1230 Standard test method for determination of inorganic anions in motor vehicle engine coolant - Ion chromatography

NB/SH/T 0164 Petroleum and related products packaging, storage, transportation and acceptance of delivery rules

NB/SH/T 0828 Standard test method for determination of silicon and other elements in engine coolant by inductively coupled plasma-atomic emission spectroscopy

NB/SH/T 0967 Packaged lubricant identification general rule

SH/T 0065 Sampling of test samples of engine coolant or antirust agent and preparation of its aqueous solution

SH/T 0066 Standard test method for foaming tendencies of engine coolants in glassware

SH/T 0069 Determination method for pH value of engine antifreezing agent, antirust agent and coolant liquid

SH/T 0090 Determination of freezing point of engine coolants

SH/T 0091 Determination method for reserve alkalinity of engine coolant liquid and antirust agent

SH/T 0621 Determination method for chlorine content of engine coolant

T/CI 208 Test method for high-temperature stability and substrate compatibility of liquid cooling thermal management materials

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Liquid Cooling

A cooling method that uses liquid to carry away heat from heat-generating components. It is applicable to scenarios where computational power, energy efficiency, and deployment density need to be improved.

3.2 Cold Plate

A compact heat exchanger with internal liquid channels that allows coolant to flow through.

[Source: GB/T 15428, 3.1, with modifications]

3.3 Cold Plate Liquid Cooling

A liquid cooling technology that uses liquid as a coolant to circulate through internal flow channels of a cold plate, and cools a heat source through heat transfer via a baseplate of the cold plate.

3.4 Ethylene Glycol Coolant

A functional liquid formulated with polyester-grade ethylene glycol meeting GB/T 4649 requirements as the base fluid, along with additives such as metal corrosion inhibitors, biocides, scale inhibitors, and anti-foaming agents. It provides cooling, corrosion inhibition, and antibacterial functions, and is used in secondary-side server cooling systems of data centers, flowing through cold plates, fluid connectors, manifolds, and CDUs.

3.5 1,2-Propylene Glycol Coolant

A functional liquid formulated with 1,2-propylene glycol meeting GB 29216-2012 requirements as the base fluid, along with additives such as metal corrosion inhibitors, biocides, scale inhibitors, and anti-foaming agents. It provides cooling, corrosion inhibition, and antibacterial functions, and is used in secondary-side server cooling systems of data centers, flowing through cold plates, fluid connectors, manifolds, and CDUs.

3.6 Coolant Distribution Unit (CDU)

A thermal management device based on liquid cooling technology. It transfers heat generated in a data center to the coolant, and then dissipates the heat from the coolant through the cooling system.

4 Acronym/Abbreviation

Coolant Distribution Unit (CDU)

Colony Forming Unit (CFU)

International Rubber Hardness Degrees (IRHD)

Ethylene Propylene Diene Monomer (EPDM)

Fluoroelastomer (FKM)

Silicone Rubber (SR)

Fluorosilicone Elastomer (FVMQ)

Polytetrafluoroethylene (PTFE)

Polypropylene (PP)

Polyhexamethylene Adipamide/Nylon-66 (PA66)

5 Technical Requirements and Testing Methods

This section mainly covers the general requirements, physical and chemical performance requirements, and service performance requirements for ethylene glycol coolants and 1,2-propylene glycol coolants, as well as corresponding testing methods.

5.1 General Requirements and Testing Methods

Ethylene glycol coolants should preferably use ethylene glycol produced from polyester-grade ethylene; 1,2-propylene glycol coolants should preferably use 1,2-propylene glycol prepared by the hydration of propylene oxide with a purity greater than 99.5%. The general requirements and testing methods for coolants shall comply with the requirements in Table 1.

Table 1 General requirements and testing methods for ethylene glycol coolants and 1,2-propylene glycol coolants

Item	Quality Metrics	Testing Methods
Appearance	Clear and transparent liquid without sediment or suspended matter	Visual inspection
Color	Eye-catching color	Visual inspection
Odor	No odor	Olfactory inspection

5.2 Physical and Chemical Performance Requirements and Testing Methods

The physical and chemical performance requirements and testing methods for incoming materials of ethylene glycol coolants and 1,2-propylene glycol coolants shall comply with the requirements in Table 2.

Table 2 Physical and chemical performance requirements and testing methods for incoming materials of ethylene glycol coolants and 1,2-propylene glycol coolants

Item	Technical Specifications of Incoming Materials			Testing Methods
	Ethylene Glycol Coolant	1,2-Propylene Glycol Coolant		
		PG25	PG55	
pH value	8.0–10.0			SH/T 0069
Volume concentration [a]/%	20–25	25 ± 2	55 ± 2	GB/T 9722, SH/T 0090
Reserve alkalinity/mL	Reported value			SH/T 0091
Freezing point/°C	≤ –8.9	≤ –9.0	≤ –38.0	SH/T 0090
Conductivity (25°C), μS/cm	Reported value			Appendix A of GB 29743.2-2025
Total colonies, CFU/mL	≤ 1			GB/T 5750.12
Calcium, mg/kg	≤ 5.0			NB/SH/T 0828

Item	Technical Specifications of Incoming Materials			Testing Methods
	Ethylene Glycol Coolant	1,2-Propylene Glycol Coolant		
		PG25	PG55	
Magnesium, mg/kg	≤ 5.0			
Copper, mg/kg	≤ 0.2			NB/SH/T 0828, GB/T 37837[b]
Iron, mg/kg	≤ 0.2			
Aluminum, mg/kg	≤ 0.8			
Chlorine [c], mg/kg	≤ 10.0			SH/T 0621, JT/T 1230
Sulfate (SO_4^{2-}), mg/kg	≤ 10.0			JT/T 1230
Nitrite (NO_2^-), mg/kg	≤ 10.0			
Boron (B), mg/kg	≤ 10.0			NB/SH/T 0828
Silicate (Si), mg/kg	≤ 10.0			
Phosphate (P), mg/kg	≤ 10.0			

Notes:

a. In case of any dispute over the results, GB/T 9722 shall be used as the arbitration method.

b. When GB/T 37837 is used, sample digestion is required prior to testing: Use a pipette to transfer 5 mL of the coolant into a PTFE beaker, and evaporate it on a heating plate at 150°C for 1.0 to 1.5 hours until the coolant volume is reduced by about 0.5 mL without drying it completely. Then, add 1 mL of 70% electronic-grade nitric acid solution for digestion until no yellow gas is generated, and continue heating for 10 minutes. Add 2 mL of deionized water and continue heating for 5 minutes. After cooling, use an electronic balance to add deionized water to quantitatively adjust the test solution to a mass of 15.00 g, and shake well. Use a syringe to draw the sample and filter it through a 0.45 μm nylon 66 syringe filter for testing. When NB/SH/T 0828 is used, if the molybdenum element is present in the formulation system, the wavelengths of 237.312 nm and 394.401 nm are used for testing. In case of any dispute over the results, GB/T 37837 shall be used as the arbitration method.

c. In case of any dispute over the results, JT/T 1230 shall be used as the arbitration method.

5.3 Service Performance Requirements and Testing Methods

The service performance requirements and testing methods for ethylene glycol coolants and 1,2-propylene glycol coolants shall comply with the requirements in Table 3.

Table 3 Service performance requirements and testing methods for ethylene glycol coolants and 1,2-propylene glycol coolants

Item			Technical Specifications	Testing Methods
Static corrosion	Mass change mg/cm^2	T2 copper	± 0.2	Appendix A

Item			Technical Specifications	Testing Methods
(88°C ± 2°C, 336 h ± 2 h)		TU copper	± 0.2	
		Brass, HPb59	± 0.2	
		Copper brazing filler metal, BCu80AgP	± 0.2	
		304 stainless steel	± 0.2	
		6061 aluminum	± 0.4	
	Solution performance after test	pH value	7.5–10.0	SH/T 0069
		pH change	± 1.0	
Static corrosion (88°C ± 2°C, 1,000 h ± 2 h)	Mass change mg/cm^2	Red copper, T2 copper	± 0.4	Appendix A
		Red copper, TU copper	± 0.4	
		Brass, HPb59	± 0.4	
		Copper brazing filler metal, BCu80AgP	± 0.4	
		304 stainless steel	± 0.4	
		6061 aluminum	± 0.8	
	Solution performance after test	pH value	7.5–10.0	SH/T 0069
		pH change	± 1.0	
Compatibility with rubber materials (100°C ± 2°C, 168 h ± 2 h)	EPDM	Hardness change (IRHD)	± 10	Appendix B
		Volume change rate/%	–5 to +20	
		Tensile strength change rate upon break/%	± 50	
		Elongation change rate upon break/%	± 50	
	FKM	Hardness change (IRHD)	± 10	
		Volume change rate/%	–5 to +20	

Item			Technical Specifications	Testing Methods
		Tensile strength change rate upon break/%	± 50	
		Elongation change rate upon break/%	± 50	
	SR	Hardness change (IRHD)	± 10	
		Volume change rate/%	–5 to +20	
		Tensile strength change rate upon break/%	± 50	
		Elongation change rate upon break/%	± 50	
	FVMQ	Hardness change (IRHD)	± 10	
		Volume change rate/%	–5 to +20	
		Tensile strength change rate upon break/%	± 50	
		Elongation change rate upon break/%	± 50	
Compatibility with plastic materials (70°C ± 2°C, 168 h ± 2 h)	PTFE	Mass change rate/%	± 5	Appendix C
		Tensile strength change rate upon break/%	± 25	
		Impact strength change rate/%	± 25	
	PP	Mass change rate/%	± 5	
		Tensile strength change rate upon break/%	± 25	
		Impact strength change rate/%	± 25	
Compatibility with inorganic	Graphite/Silicon carbide	Mass change rate/%	± 2.5	T/CI 208

Item			Technical Specifications	Testing Methods
nonmetals (80°C ± 2°C, 96 h ± 2 h)		Volume change rate/%	± 2.5	
Foam tendency [a] (30°C ± 1°C, 55°C ± 1°C, and 80°C ± 1°C)	Foam volume/mL		≤ 100.0	SH/T 0066
	Foam disappearance time/s		≤ 5.0	
Stability	Low-temperature storage stability (–5°C ± 2°C, 24 h ± 2 h)	Appearance	No significant change in color, no sediment or suspension	Appendix I of GB/T 23436
	Stability at the operating temperature (55°C ± 2°C, 336 h ± 2 h)	Appearance	No significant change in color, no sediment or suspension	Appendix D of GB 29743.1-2022
	High-temperature storage stability (80°C ± 2°C, 336 h ± 2 h)	Appearance	No significant change in color, no sediment or suspension	
	Hard water resistance stability (90°C ± 2°C, 336 h ± 2 h)	Sediment volume in the solution after the test/mL	≤ 0.5	
Notes: a. The glycol-based coolant listed in the table is tested directly without being diluted.				

5.4 Technical Requirements for Coolant-Contacting Materials

5.4.1 Technical Requirements for Metal Material Selection

Carbon steel, zinc, and pure aluminum should not be used as overcurrent metal materials. It is recommended that 304 stainless steel (06Cr19Ni10), 316 stainless steel (06Cr17Ni12Mo2), TU1 pure copper, and TU2 pure copper that comply with GB/T 20878 be used. Compatibility tests for other metal materials (such as 3003 aluminum alloy and 4043 aluminum alloy) must be performed according to the testing methods and requirements in section 5.3.

5.4.2 Technical Requirements for Nonmetal Material Selection

For overcurrent nonmetals, PA66 (nylon 66) shall not be used. PTFE (meeting GB/T 39714.2-2020) is recommended. Compatibility tests for other nonmetals (such as FVMQ, FKM, EPDM rubber, and PP plastic) must be performed according to the testing methods and requirements in section 5.3. The nonmetals that require compatibility tests include but are not limited to butterfly valve sealing rings, exhaust valve sealing rings, drainage valve sealing rings, pipe filter seals, hoses, and pipe flange gaskets.

5.4.3 Technical Requirements for Joint Surfaces

The joint surface must be sealed by sealing rings. Threads and sealants are not allowed.

5.4.4 Technical Requirements for the Pipe System

The use of sealing tape for winding seals is strictly prohibited at all threaded connections in contact with secondary-side fluid.

6 Technical Requirements for Coolant Delivery

6.1 Coolant Delivery Inspection Classification

6.1.1 The inspection is classified into type inspection and factory inspection.

6.1.2 The type inspection shall be conducted in the following cases:

(a) When a new product is put into production or the product is appraised for type approval;

(b) When there are significant changes in raw materials or processes that may affect product quality;

(c) When the factory inspection or periodic inspection result differs greatly from the previous type inspection result;

(d) When the product is transferred to another factory for production;

(e) Generally, the type inspection is conducted once every two years. If the production process remains unchanged, the inspection may be postponed for two years.

6.1.3 The factory inspection is classified into batch inspection and periodic inspection. If the main raw materials and additives remain unchanged, the periodic inspection shall be conducted at least twice a year.

6.1.4 Other inspection requirements shall be determined by the supplier and customer through negotiation.

6.2 Technical Requirements for Coolant Delivery Inspection

6.2.1 The type inspection items shall include all technical requirements specified in Chapter 5.

6.2.2 The batch inspection items should include: appearance, color, odor, ethylene glycol and 1,2-propylene glycol concentration, pH value, conductivity, total bacterial count, calcium content, magnesium content, copper content, iron content, aluminum content, chlorine content, and sulfate content.

6.2.3 The periodic inspection items shall include the items specified in 6.2.2, as well as reserve alkalinity, foaming tendency, borate content, phosphate content, silicate content, nitrite content, service temperature stability, high temperature storage stability, low temperature storage stability, hard water stability, and static corrosion after 336 hours/1000 hours.

6.2.4 Other inspection items shall be determined through negotiation between the supplier and the purchaser.

6.3 Batching Requirements

Under the condition that the raw materials and process remain unchanged, each batch of product shall be produced in one tank or kettle.

6.4 Sampling Requirements

Sampling shall be performed in accordance with the provisions of SH/T 0065. The sampling quantity for each batch of product shall meet the requirements for inspection and sample retention, or samples shall

be randomly selected from the packaged product for inspection and sample retention. The sampling quantity shall meet the requirements for delivery inspection, type inspection, and sample retention.

6.5 Judgment Requirements

When the results of the delivery inspection and type inspection comply with the technical requirements specified in Chapter 5, the batch of product shall be judged as qualified.

6.6 Re-inspection Requirements

If any result of the delivery or type inspection does not comply with the technical requirements specified in Chapter 5, double the quantity of samples from the same batch of product in accordance with the provisions of SH/T 0065, and the non-conforming items shall be re-inspected. If the re-inspection results still do not comply with the technical requirements specified in Chapter 5, the batch of product shall be judged as unqualified.

7 Technical Requirements for Coolant Packaging, Transportation, and Storage

7.1 The ethylene glycol coolant and 1,2-propylene glycol coolant shall be labeled and packaged in accordance with the provisions of NB/SH/T 0164. The label shall include the following information:

(a) Product name;

(b) Coolant type;

(c) Product classification and freezing point;

(d) Production date or batch number;

(e) Usage instructions and precautions;

(f) Expiration date;

(g) Name and address of the manufacturer.

7.2 The transportation of ethylene glycol coolant and 1,2-propylene glycol coolant shall comply with the provisions of NB/SH/T 0164.

7.3 The ethylene glycol coolant and 1,2-propylene glycol coolant shall be stored in a dark, well-ventilated place at a temperature above 0°C, and shall not be exposed to direct sunlight. It shall be kept away from strong oxidants, acids, alkalies, and fire sources. The coolant storage environment shall be equipped with leakage prevention facilities and shall be kept away from precision equipment.

8 Technical Requirements for Coolant Replenishment

8.1 Technical Requirements for Coolant Replenishment

(a) When the coolant volume decreases due to leakage, the coolant of the same type as the original system shall be used, and the brand, model, and specifications of the coolant shall be identical to those of the original coolant. When the concentration increases due to water evaporation, deionized water specified in GB/T 6682 shall be added to restore the designed concentration. It is strictly prohibited to directly add undiluted corrosion inhibitors or biocides.

(b) If the coolant type needs to be changed (for example, from 1,2-propylene glycol coolant to ethylene glycol coolant), the operation shall be performed in accordance with the manufacturer's requirements.

(c) The new coolant shall be tested for key indicators such as appearance (clear and free of impurities), conductivity, pH value, and freezing point to ensure compliance with the system requirements.

(d) The coolant to be added shall be an unopened original factory product. Do not use expired or contaminated coolant.

(e) Before adding coolant, ensure that the system is under low load or shut down, and close the valve near the coolant filling port to isolate the coolant filling area.

(f) Record the current coolant level, pressure, and temperature as the reference for comparison after coolant addition.

(g) The coolant filling port and tools (such as a funnel and hose) shall be cleaned in advance to prevent dust, oil stains, and other impurities from entering the system with the coolant.

8.2 Water Quality Cleanliness Criteria for the CDU and Pipeline Ring Network System After Flushing Before Coolant Filling

The test method for the water quality cleanliness criteria for the CDU and pipeline ring network system after flushing before coolant filling shall comply with the requirements in Table 4.

Table 4 Water quality cleanliness criteria for the CDU and pipeline ring network system after flushing

Indicator	**Requirement**	**Test Method and Standard**
Filter impurities	Wipe with a dust-free cloth. Ensure that neither the filter nor the dust-free cloth has stains or visible particles.	Visual inspection
Impurities inside the stainless steel branch pipe	After wiping the filter screen with a dust-free cloth, carefully check the filter and the dust-free cloth. Ensure that neither has stains or visible particles.	Visual inspection
Turbidity/NTU	≤ 10	Turbidimeter
pH value	6.5–8.0	pH meter
Conductivity (25°C)/(μS/cm)	≤ 10	Conductivity meter
Conductivity difference before and after flushing (25°C)/(μS/cm)	≤ 2	Conductivity meter
Microorganism/(CFU/mL)	≤ 100	GB/T 5750.12
Chlorine content/(mg/kg)	≤ 20	JT/T 1230
Sulfate content/(mg/kg)	≤ 10	
Copper content/(mg/kg)	≤ 0.5	GB/T 37837
Iron content/(mg/kg)	≤ 0.5	
Aluminum content/(mg/kg)	≤ 0.5	
Total hardness/(mg/kg)	≤ 3.0	GB/T 5750.4 or GB/T 6909

Before adding coolant to the secondary side, the operator shall flush the secondary side system with deionized water. The flushing water for the secondary side system shall meet the EW-IV level or higher specified in GB/T 11446.1.

9 Technical Requirements for Coolant Monitoring

The indicators and requirements for coolant monitoring shall meet the requirements in Table 5.

Table 5 Indicators and technical requirements for coolant monitoring

<table>
<tr><th rowspan="2">Indicator</th><th colspan="3">Criteria</th><th rowspan="2">Monitoring Interval</th><th rowspan="2">Test Method</th></tr>
<tr><th>Ethylene Glycol Coolant</th><th colspan="2">1,2-Propylene Glycol Coolant</th></tr>
<tr><td>Appearance</td><td colspan="3">Obvious color</td><td>Online and real-time</td><td>Visual inspection</td></tr>
<tr><td>Volume concentration</td><td>Initial value: 20%–25%
Value for the first operation within 3–7 days: 15%–25%
Long-term operation value: 15%–25%</td><td>Initial value: 23%–27%
Value for the first operation within 3–7 days: 20%–27%
Long-term operation value: 20%–27%</td><td>Initial value: 53%–57%
Value for the first operation within 3–7 days: 50%–57%
Long-term operation value: 50%–57%</td><td>Once every three months</td><td>Onsite test: A handheld refractometer is used.
Third-party test: GB/T 9722 or SH/T 0090</td></tr>
<tr><td>pH value</td><td>Initial value: 8–10
Value for the first operation within 3–7 days: 8–10
Long-term operation value: 7–10</td><td colspan="2">Initial value: 8–10
Value for the first operation within 3–7 days: 8–10
Long-term operation value: 7.5–10.5</td><td>Once every three months</td><td>SH/T 0069</td></tr>
<tr><td>Chlorine content/(mg/kg)</td><td colspan="3">Initial value: ≤ 10
Value for the first operation within 3–7 days: ≤ 15
Long-term operation value: ≤ 25</td><td>Once every 12 months</td><td>JT/T 1230</td></tr>
<tr><td>Sulfate content (as SO^4 2-)/(mg/kg)</td><td colspan="3">Initial value: ≤ 10
Value for the first operation within 3–7 days: ≤ 20
Long-term value: ≤ 50</td><td>Once every 12 months</td><td>JT/T 1230</td></tr>
<tr><td>Calcium content/(mg/kg)</td><td colspan="3">Initial value: ≤ 5
Value for the first operation within 3–7 days: ≤ 10
Long-term value: ≤ 20</td><td>Once every 12 months</td><td>NB/SH/T 0828</td></tr>
</table>

Indicator	Criteria		Monitoring Interval	Test Method
	Ethylene Glycol Coolant	1,2-Propylene Glycol Coolant		
Magnesium content/(mg/kg)	Initial value: ≤ 5 Value for the first operation within 3–7 days: ≤ 10 Long-term value: ≤ 20		Once every 12 months	
Copper content/(mg/kg)	Initial value: ≤ 0.2 Value for the first operation within 3–7 days: ≤ 2 Long-term operation value: ≤ 5		Once every 12 months	
Iron content/(mg/kg)	Initial value: ≤ 0.2 Value after first operation within 3–7 days: ≤ 2 Long-term operation value: ≤ 5		Once every 12 months	
Aluminum content/(mg/kg)	Initial value: ≤ 0.8 Value after first operation within 3–7 days: ≤ 2 Long-term operation value: ≤ 5		Once every 12 months	
Total Bacterial Count/(CFU/mL)	Initial value: < 1 Value after first operation within 3–7 days: ≤ 100 Long-term operation value: ≤ 100		Once every three months	GB/T 5750.12

Note:

The initial values in the table are the values of the coolant delivered. If the indicators in the table are found to exceed the specified limits, the coolant shall be treated. In severe cases, the coolant shall be replaced.

10 Coolant Recycling Requirements

10.1 Coolant Recycling Principles

Coolant recycling shall comply with the principles of safety, environmental protection, and economy, ensuring that the recycling process does not cause harm to personnel, equipment, and the environment, while maximizing resource utilization.

10.2 Precautions for Coolant Recycling

During the recycling process, classify and label the coolant. Different types of coolant shall not be mixed together for recycling. The recycling container shall be clearly labeled with the coolant type, recycling date, and pollution degree (e.g., "clean and reusable" or "polluted and needs to be treated").

10.3 Technical Requirements for Coolant Reuse

The coolant that can be reused shall be filtered at multiple levels (e.g., coarse filtration to remove metal particles and fine filtration to remove micron-level impurities). The key indicators of the filtered coolant (e.g., pH value, conductivity, total bacterial count, and metal element content) shall be tested. If the indicators meet the industry or original manufacturer's standards, the coolant may be reused. If the

indicators exceed the standards, the coolant shall be regenerated or entrusted to a professional organization for disposal.

Appendix A
(Normative)
Static Corrosion Testing Method for Glycol-based Coolant of Cold Plate Liquid Cooling

A.1 Overview

Typical metal test pieces commonly used in the secondary heat management system of the data center shall be polished, cleaned, and weighed, and then assembled into a test piece bundle in the specified order. The bundle shall be placed in a glass container, and 750 mL of the coolant sample to be tested shall be poured into the container. The container shall be moved to a heating device. The test shall be conducted at a temperature of 88°C ± 2°C and an air flow rate of 100 mL/min ± 2 mL/min for 336 h ± 2 h or 1000 h ± 2 h. After the test is complete, the test piece bundle shall be removed, cleaned, and the changes in the mass of the metal test pieces and the performance of the coolant shall be verified. This method is applicable to ethylene glycol-based coolant and 1,2-propylene glycol-based coolant.

A.2 Instruments and Materials

A.2.1 Instrument

A.2.1.1 Test cup: 1000 mL, tall-form, spoutless, made of heat-resistant glass. It shall be equipped with a silicone rubber plug or glass plug, which has through holes for installing the condensation tube, gas diffusion tube, and thermometer. Figure A.1 shows the assembly of the test components.

A.2.1.2 Condensation tube: The condensation jacket is 400 mm long, and a straight-tube reflux condensation tube shall be used.

A.2.1.3 Gas diffusion tube: made of heat-resistant glass, with a length of 220 mm, an outer diameter of 8 mm, and a sand core glass diffusion head with a length of 30 mm and an outer diameter of 15 mm at the end.

A.2.1.4 Thermometer: –20°C to +150°C, with a scale division of 1°C, or an instrument with the same precision.

A.2.1.5 Heating device: liquid bath heating, capable of maintaining a temperature of 90°C ± 2°C, or an instrument with the same precision.

A.2.1.6 Air flow meter: capable of controlling the air flow rate to 100 mL/min ± 10 mL/min.

A.2.1.7 Balance: with a scale division of 0.1 mg and a maximum weighing capacity of at least 200 g.

A.2.2 Materials

A.2.2.1 Material specimens: The specimens shall meet the requirements specified in Table A.1.

Table A.1 Technical requirements for metal specimens used in the test

Material Name		**TU Copper**	**Brass**	**Copper Brazing Material**	**304 Stainless Steel**	**T2 Copper**	**Aluminum Alloy**
Compliant standards		GB/T 5231	GB/T 5231	GB/T 6418.1-2025	GB/T 20878	GB/T 5231	GB/T 3190
Material grade		TU copper	HPb59	BCu80AgP	304	T2	6061
Material dimensions/mm	Length	50.0	50.0	50.0	50.0	50.0	50.0
	Width	25.0	25.0	25.0	25.0	25.0	25.0
	Thickness	2.0	2.0	0.2	2.0	2.0	2.0
Other requirements		Through hole with a diameter of 7.0 mm					

A.2.2.2 Stainless steel bracket: made of 304 stainless steel, with dimensions of 50.0 mm × 25.0 mm × 2.0 mm. A through hole with a diameter of 7.0 mm is located at a distance of 12.5 mm from the long side and 6.5 mm from the short side.

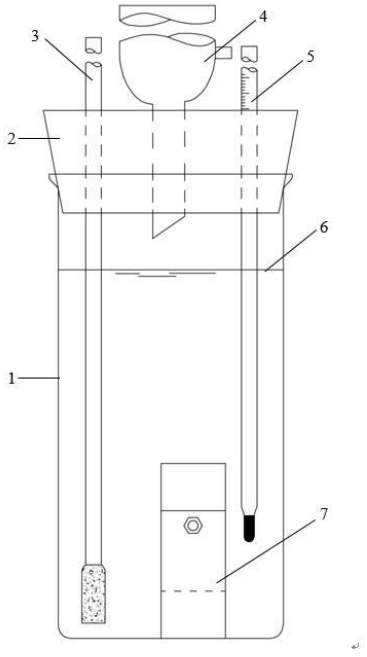
A.2.2.3 Stainless steel bolt: nominal diameter of 4.0 mm, length of 75.0 mm, and equipped with a nut and washer of the corresponding specifications.

A.2.2.4 Insulation tube: made of polytetrafluoroethylene, with an outer diameter of 6.5 mm, wall thickness of 1.0 mm, and tube length of 55 mm.

A.2.2.5 Insulation washer: made of polytetrafluoroethylene, with an outer diameter of 12.0 mm, inner diameter of 7.0 mm, and thickness of 4.5 mm.

A.2.2.6 Sandpaper: waterproof silicon carbide sandpaper with grit P320.

A.2.2.7 Brush: soft brush.



The marking sequence numbers are described as follows:

1: test cup; 5: thermometer;

2: Silicone rubber plug; 6: Liquid surface of the sample;

3: Gas diffusion tube; 7: test piece bundle

4: Condensation tube;

Figure A.1 Assembly of the test components

A.3 Reagent

A.3.1 Anhydrous ethanol: analytical grade.

A.3.2 Water: meets the requirements for grade 3 water in GB/T 6682-2008.

A.3.3 Hydrochloric acid: mass fraction of 36% to 38%, analytical grade.

A.3.4 Nitric acid: mass fraction of 65% to 68%, analytical grade.

A.3.5 Sodium sulfate: chemically pure.

A.3.6 Sodium chloride: chemically pure.

A.3.7 Sodium bicarbonate: chemically pure.

A.4 Preparations

A.4.1 Test Piece Preparation

A.4.1.1 Polishing the test piece: Use waterproof silicon carbide sandpaper with a grit size of P320 to polish the test piece along the direction parallel to the long side of the test piece, and remove burrs from the edges and through holes until the surface of the test piece is smooth and free of oxide layer.

A.4.1.2 Cleaning of the test piece: Rinse the polished test piece with water, then place it in a glass container filled with anhydrous ethanol for cleaning. After removal, dry it with dry air. The dried test piece shall not be touched directly with hands; it may be handled with clean gloves.

A.4.1.3 Weighing of the test piece: Weigh the test piece using an analytical balance to an accuracy of 0.1 mg.

A.4.1.4 Assembling of the test piece: On the stainless steel bolt fitted with an insulation tube, assemble the following components in the order given: brass support, insulation washer, T2 copper test piece, 304 stainless steel test piece, insulation washer, brass HPb59 test piece, insulation washer, TU copper test piece, copper brazing material, insulation washer, 6061 aluminum test piece, insulation washer, and brass support. Tighten the nut until the test piece is secure, ensuring good contact between each part of the test piece bundle. The assembly of the test piece bundle is shown in Figure A.2.

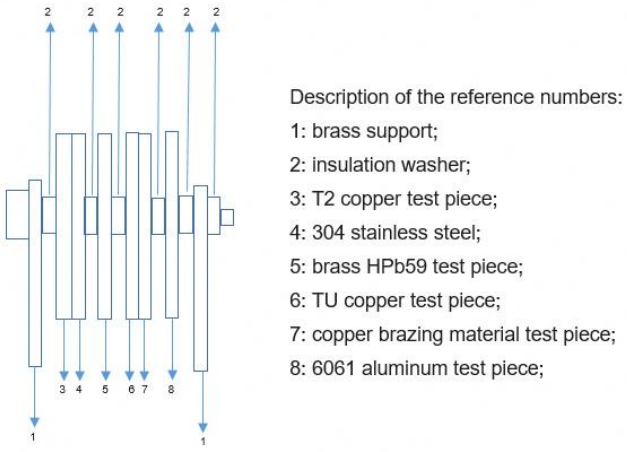


Figure A.2 Assembling the test piece bundle

A.4.2 Sample Preparation

Take the coolant of the glycol-based cold plate liquid cooling data center as the test solution (the coolant of PG55 shall not be diluted), and add 148 mg of anhydrous sodium sulfate, 165 mg of sodium chloride, and 138 mg of sodium bicarbonate to each liter of the test solution.

A.5 Test Procedure

A.5.1 Clean and dry the test cup, rubber plug, thermometer, gas diffusion tube, and condensation tube used in the test.

A.5.2 Place the three assembled test piece bundles into three test cups respectively, and pour 750 mL of the data center coolant test solution into each test cup. Assemble the silicone rubber plug, thermometer, gas diffusion tube, and condensation tube according to Figure A.2. The end of the condensation tube shall just pass through the silicone rubber plug. The diffusion head of the gas diffusion tube shall be at least 12.7 mm away from the test piece bundle, and the two shall not be in direct contact.

A.5.3 Place the test cup on the heating device and connect the condensate water line and the gas line. The test shall be performed for 336 h ± 2 h or 1000 h ± 2 h under the conditions of 88°C ± 2°C and an air flow rate of 100 mL/min ± 10 mL/min. During the test, the test conditions shall be checked daily to ensure that the test temperature, air flow rate, and liquid level meet the requirements. Water shall be added in time to compensate for the loss caused by evaporation (A.3.2).

A.5.4 After the test is completed, remove the test cup and cool it to room temperature. Remove the test piece bundle and disassemble it. Gently brush each test piece under tap water with a soft brush to remove the attached substances on the surface.

(a) Red copper and brass test pieces: In a fume hood, soak the test pieces in 100 mL of hydrochloric acid solution (prepared by mixing hydrochloric acid and water in a volume ratio of 1:1) for 15s to remove the surface film, and then brush the test pieces under tap water with a soft brush.

(b) Steel test pieces: Remove the adhered deposits with a brass scraper or brass wire brush, and then brush the test pieces with a soft brush.

(c) Aluminum alloy test pieces: In a fume hood, soak the test pieces in 100 mL of nitric acid solution (prepared by mixing nitric acid and water in a volume ratio of 4:1) for 10 min, and then brush the test pieces under tap water with a soft brush.

A.5.5 Clean the treated test pieces with anhydrous ethanol, dry them, and weigh them to an accuracy of 0.1 mg.

A.5.6 Determination of the surface area of the test piece: According to the dimensions of the metal test piece in Table A.1, calculate the total external surface area of the complete cuboid test piece, and then subtract the area of the two circular end faces with through holes. In addition, add the side area of the inner wall of the through hole cylinder to obtain the total exposed surface area of the test piece in contact with the coolant.

A.6 Calculation of Results

The total exposed surface area of the test piece is calculated according to Formula (A.1):

$$S = 2(LW + LH + WH) - 2 \times \frac{\pi d^2}{4} + \pi dH \tag{A.1}$$

Where:

S: total exposed surface area of the test piece, in square millimeters (mm^2);

L: length of the test piece, in millimeters (mm);

W: width of the test piece, in millimeters (mm);

H: thickness of the test piece, in millimeters (mm);

d: diameter of the central through hole, in millimeters (mm);

π: pi.

The mass change per unit area of the test piece is calculated according to Formula (A.2):

$$\Delta m_S = \frac{(M_1 - M_2) \times 1000}{S} \times 100 \tag{A.2}$$

Where:

Δm_s: mass change per unit area, in milligrams per square centimeter (mg/cm^2);

M_1: mass of the test piece before the test, in grams (g);

M_2: mass of the test piece after the test, in grams (g);

S: total exposed surface area of the test piece, in square millimeters (mm^2).

A.7 Result Report

A.7.1 The mass change of the test piece shall be reported. The arithmetic mean value of three parallel tests shall be used as the test results, accurate to 0.1 mg/cm^2.

Appendix B
(Normative)
Testing Method for Compatibility of Glycol-based Cold Plate Liquid Cooling Coolant with Rubber Materials

B.1 Overview

The rubber test piece is immersed in a glycol-based cold plate liquid coolant and maintained at 100°C ± 2°C for 168 h ± 2 h. Subsequently, the changes in volume, hardness, and tensile properties of the rubber test piece are checked.

B.2 Instruments, Materials, and Reagents

B.2.1 Autoclave: The shell is made of stainless steel, and the inner container is made of PTFE. It is sealed with a circular tongue-and-groove joint and fastened with manual screws. The inner diameter is approximately 70 mm ± 2 mm, the height is approximately 90 mm ± 2 mm, and the volume is approximately 400 mL ± 10 mL.

B.2.2 Oven: The temperature shall be controllable at 100°C ± 2°C.

B.2.3 Thermometer: The measuring range is –20°C to 150°C, and the scale division is 1°C.

B.2.4 Rubber hardness tester: It shall meet the requirements of method M specified in GB/T 6031-2017.

B.2.5 Balance: The scale division is 0.1 mg, and the maximum weighing capacity is not less than 200 g.

B.2.6 Tensile testing machine: The precision level is 0.5, and the maximum tensile force is not less than 500 N.

B.2.7 EPDM rubber test piece: The material shall meet the requirements of EPDM rubber specified in GB/T 14832-2008. The thickness of the test piece is 2.0 mm ± 0.2 mm. The rubber test piece used for the mass, volume, and hardness tests is a square test piece with a size of 25 mm × 25 mm. The rubber test piece used for the tensile performance test is a dumbbell-shaped test piece of type 2 specified in GB/T 528-2009.

B.2.8 SR test piece: The material shall meet the requirements of VMQ 50-G specified in GB/T 33402-2016. The thickness of the test piece is 2.0 mm ± 0.2 mm. The rubber test piece used for the mass, volume, and hardness tests is a square test piece with a size of 25 mm × 25 mm. The rubber test piece used for the tensile performance test is a dumbbell-shaped test piece of type 2 specified in GB/T 528-2009.

B.2.9 FKM test piece: The material shall meet the requirements of FKM specified in GB/T 30308-2013. The thickness of the test piece is 2.0 mm ± 0.2 mm. The rubber test piece used for the mass, volume, and hardness tests is a square test piece with a size of 25 mm × 25 mm. The rubber test piece used for the tensile performance test is a dumbbell-shaped test piece of type 2 specified in GB/T 528-2009.

B.2.10 FVMQ test piece: The material shall meet the requirements of FVMQ specified in GJB 1790-1993. The thickness of the test piece is 2.0 mm ± 0.2 mm. The rubber test piece used for the mass, volume, and hardness tests is a square test piece with a size of 25 mm × 25 mm. The rubber test piece used for the tensile performance test is a dumbbell-shaped test piece of type 2 specified in GB/T 528-2009.

B.2.11 Anhydrous ethanol (C_2H_6O): analytical grade.

B.3 Test Procedure

B.3.1 Heat the oven and control the temperature at 100°C ± 2°C. Select four autoclaves, clean them,

and dry them.

B.3.2 For each type of rubber, select three square test pieces and six dumbbell-shaped test pieces, mark them, clean them with ethanol, dry them with filter paper, wipe them clean with silk cloth, and blow them dry.

B.3.3 Square test pieces shall be measured according to the GB/T 1690 method as follows:

(a) Mass measurement: Weigh the test piece mass M_1 before the test, then weigh the test piece mass M_2 in water, with an accuracy of 0.1 mg.

(b) Hardness measurement: Measure the hardness value at three different points on the test piece. The measurement points shall be distributed, and the distance between any two points shall be at least 6 mm.

B.3.4 Select three dumbbell-shaped test pieces and measure the tensile strength and elongation at break using a tensile testing machine according to the GB/T 528 method, as the data before the test.

B.3.5 Place three square test pieces and the other three dumbbell-shaped test pieces of each type of rubber into two reaction autoclaves, respectively. Pour 300 mL of coolant into each autoclave. Ensure that the test pieces are dispersed in the autoclaves without overlapping. Cover the autoclaves and place them in an oven at a constant temperature of 100°C ± 2°C for 168 h ± 2 h.

B.3.6 After the test is complete, take out the autoclaves and cool them to room temperature. Then take out the rubber test pieces, clean them with ethanol, dry them with filter paper, wipe them clean with silk cloth, and blow them dry.

B.3.7 Measure the mass M_3 of the square test pieces after the test, then weigh the test piece mass M_4 in water, with an accuracy of 0.1 mg, and measure the hardness after the test.

B.3.8 Measure the tensile strength and elongation at break of the dumbbell-shaped test pieces after the test using a tensile testing machine.

B.4 Calculation of Results

B.4.1 The volume change rate of the rubber test pieces shall be calculated according to Formula (B.1):

$$\Delta V = \frac{[(M_3 - M_4) - (M_1 - M_2)]}{(M_1 - M_2)} \times 100\% \quad \text{(B.1)}$$

Where:

ΔV: volume change rate of the rubber test pieces, in percentage (%);

M_1: mass of the rubber test pieces before the test, in grams (g);

M_2: mass of the rubber test pieces in water before the test, in grams (g);

M_3: mass of the rubber test pieces after the test, in grams (g);

M_4: mass of the rubber test pieces in water after the test, in grams (g).

B.4.2 The change in hardness of the rubber test pieces is calculated according to Formula (B.2):

$$\Delta H = H_{后} - H_{前} \quad \text{(B.2)}$$

Where:

ΔH: change in hardness of the rubber test piece, in IRHD;

H_{before}: average hardness of the three measuring points of the rubber test piece before the test, in IRHD;

H_{after}: average hardness of the three measuring points of the rubber test piece after the test, in IRHD.

B.4.3 The change rate of the tensile strength at break of the rubber test piece is calculated according to Formula (B.3):

$$\Delta \mathrm{TS}_b = \frac{TS_{b后} - \mathrm{TS}_{b前}}{TS_{b前}} \times 100\% \quad \text{(B.3)}$$

Where:

ΔTS_b: change rate of the tensile strength at break of the rubber test piece, in percentage (%);

$TS_{b\ before}$: average tensile strength at break of three rubber test pieces before the test, in MPa;

$TS_{b\ after}$: average tensile strength at break of three other rubber test pieces after the test, in MPa.

B.4.4 The change rate of the elongation at break of the rubber test piece is calculated according to Formula (B.4):

$$\Delta E_b = \frac{E_{b后} - E_{b前}}{E_{b前}} \times 100\% \quad \text{(B.4)}$$

Where:

ΔE_b: change rate of the elongation at break of the rubber test piece, in percentage (%);

$E_{b\ before}$: average value of the elongation at break of three rubber test pieces before the test, in percentage (%);

$E_{b\ after}$: average value of the elongation at break of three other rubber test pieces after the test, in percentage (%).

B.5 Result Report

B.5.1 The arithmetic mean value of the volume change rate of the rubber test piece is reported as the test result, accurate to 0.1%.

B.5.2 The arithmetic mean value of the hardness change of the rubber test piece is reported as the test result, accurate to an integer.

B.5.3 The change rate of the tensile strength at break of the rubber test piece is reported, accurate to 0.1%.

B.5.4 The change rate of the elongation at break of the rubber test piece is reported, accurate to 0.1%.

Appendix C
(Normative)
Testing Method for Compatibility of Glycol-based Cold Plate Liquid Cooling Coolant with Plastic Materials

C.1 Overview

The plastic test piece is immersed in a glycol-based cold plate liquid cooling coolant and maintained at 70°C ± 2°C for 168 h ± 2 h. Subsequently, the changes in mass, tensile strength at break, and impact strength of the plastic test piece are checked.

C.2 Instruments, Materials, and Reagents

C.2.1 Test cup: It is made of heat-resistant glass, with an inner diameter of about 70 mm, height of about 90 mm, and volume of about 350 mL, and is equipped with a tin-plated iron lid.

C.2.2 Oven: The temperature shall be controllable at 70°C ± 2°C.

C.2.3 Thermometer: The measuring range is –20°C to 150°C, and the scale division is 1°C.

C.2.4 Balance: The scale division is 0.1 mg, and the maximum weighing capacity is not less than 200 g.

C.2.5 Tensile testing machine: The precision level is 0.5, and the maximum tensile force is not less than 500 N.

C.2.6 Charpy impact testing machine: It shall meet the requirements specified in GB/T 1043.2.

C.2.7 PTFE test piece: The material shall meet the requirements specified in GB/T 39714.2-2020. The plastic test piece used for the mass test shall meet the requirements specified in GB/T 11547. The plastic test piece used for the tensile performance test shall be a dumbbell-shaped one of type 1A as specified in GB/T 1040.2-2022. The plastic test piece used for the impact strength test shall be a type 1A notched sample as specified in GB/T 1043.

C.2.8 PP test piece: The material shall meet the requirements specified in GB/T 2546.2-2022. The plastic test piece used for the mass test shall meet the requirements specified in GB/T 11547. The plastic test piece used for the tensile performance test shall be a dumbbell-shaped one of type 1A as specified in GB/T 1040.2-2022. The plastic test piece used for the impact strength test shall be a type 1A notched sample as specified in GB/T 1043.

C.2.9 Anhydrous ethanol (C_2H_6O): analytical grade.

C.3 Test Procedure

C.3.1 Heat the oven to 70°C ± 2°C. Select four test cups, clean them, and dry them.

C.3.2 For each type of plastic, select six rectangular notched test pieces (type-A notched specimens in GB/T 1043), 10 dumbbell-shaped test pieces (type-1A specimens in GB/T 1040.2), and six square test pieces (GB/T 11547), mark them, clean them with ethanol, dry them with filter paper, wipe them clean with silk cloth, and blow them dry.

C.3.3 Select three rectangular notched test pieces and measure the impact strength using an impact testing machine according to the GB/T 1043 method.

C.3.4 Select five dumbbell-shaped test pieces and measure the tensile strength at break using a tensile testing machine according to the GB/T 1040.2 method, as the data before the test.

C.3.5 Select three square test pieces and weigh them to obtain the mass m_0 before the test, accurate to 0.1 mg.

C.3.6 Place three rectangular notched test pieces, three square test pieces, and five dumbbell-shaped test pieces of each type of plastic into three test cups, respectively. Pour 300 mL of coolant into each cup. Ensure that the test pieces are dispersed in the cups without overlapping. Cover the test cups and place them in an oven at a constant temperature of 70°C ± 2°C for 168 h ± 2 h.

C.3.7 After the test is complete, take out the test cups and cool them to room temperature. Then take out the plastic test pieces, clean them with ethanol, dry them with filter paper, wipe them clean with silk cloth, and blow them dry.

C.3.8 Measure the impact strength after the test of the rectangular notched test pieces.

C.3.9 Measure the tensile strength at break after the test of the dumbbell-shaped test pieces using a tensile testing machine.

C.3.10 Weigh the mass after the test m_1 of the square test pieces, with an accuracy of 0.1 mg.

C.4 Calculation of Results

C.4.1 The mass change rate of the plastic test pieces is calculated according to Formula (B.1):

$$\Delta W = \frac{m_1 - m_0}{m_0} \times 100\% \quad \text{.....(B.1)}$$

Where:

ΔW: mass change rate of the plastic test piece, in percentage (%);

m_0: mass of the plastic test piece before the test, in grams (g);

m_1: mass of the plastic test piece after the test, in grams (g);

C.4.2 The change rate of the tensile strength at break of the plastic test piece is calculated according to Formula (B.2):

$$\Delta \mathrm{TS}_b = \frac{TS_{b后} - \mathrm{TS}_{b前}}{TS_{b前}} \times 100\% \quad \text{.....(B.2)}$$

Where:

ΔTS_b: change rate of the tensile strength at break of the plastic test piece, in percentage (%);

$TS_{b\ before}$: average tensile strength at break of three plastic test pieces before the test, in MPa;

$TS_{b\ after}$: average tensile strength at break of three other plastic test pieces after the test, in MPa.

C.4.3 The change rate of the impact strength of the plastic test piece is calculated according to Formula (B.3):

$$\eta = \left(\frac{\frac{A_{后}}{b \cdot d} \times 10^3}{\frac{A_{前}}{b \cdot d} \times 10^3} - 1 \right) \times 100\% \quad \text{.....(B.3)}$$

Where:

η: change rate of impact strength, in percentage (%);

$A_{\ before}$: work consumed by breaking the test piece before the test, in joules (J);

A_{after}: work consumed by breaking the test piece after the test, in joules (J);

b: width of the notch in the test piece, in millimeters (mm);

d: minimum thickness of the notch in the test piece, in millimeters (mm).

C.5 Report

C.5.1 The arithmetic mean value of the mass change rate of the plastic test piece is reported as the test result, accurate to 0.1%.

C.5.2 The change rate of the tensile strength at break of the plastic test piece is reported, accurate to 0.1%.

C.5.3 The change rate of the impact strength of the plastic test piece is reported, accurate to 1%.