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Heat treating fluids

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japan Metal Working Fluids Association (JMFA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS K 2242:2006** is replaced with this Standard.

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Heat treating fluids

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 6743-14** published in 1994 and the first edition of **ISO 9950** published in 1995 with some modifications of the technical contents to meet the actual situation in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standards have been modified. A list of modifications with the explanation is given in Annex JA.

1 Scope

This Standard specifies heat treating fluids composed mainly of mineral oils (hereafter referred to as “heat treating oils”) among heat treating fluids which are to be used for heat treatment of iron and steel or other metals.

For the water soluble heat treating fluids (hereafter referred to as “water soluble quenching liquids”), only the testing method of cooling performance is specified in Annex A.

NOTE : The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 6743-14:1994 *Lubricants, industrial oils and related products (class L)—Classification—Part 14: Family U (Heat treatment)*

ISO 9950:1995 *Industrial quenching oils—Determination of cooling characteristics—Nickel-alloy probe test method* (overall evaluation: MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

Warning: Persons carrying out tests based on this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7410 *Liquid-in-glass thermometers for testing of petroleum product*

JIS C 1602 *Thermocouples*

JIS C 1605 *Mineral insulated thermocouples*

JIS C 4003 *Electrical insulation—Thermal evaluation and designation*

JIS G 0201 Glossary of terms used in iron and steel (Heat treatment)

JIS K 0114 General rules for gas chromatography

JIS K 2001 Industrial liquid lubricants—ISO viscosity classification

NOTE : Corresponding International Standard: ISO 3448:1992 *Industrial liquid lubricants—ISO viscosity classification* (MOD)

JIS K 2251 Crude petroleum and petroleum products—Sampling

JIS K 2265-4 Determination of flash points—Part 4: Cleveland open cup method

NOTE : Corresponding International Standard: ISO 2592:2000 *Determination of flash and fire points—Cleveland open cup method* (MOD)

JIS K 2270-1 Crude petroleum and petroleum products—Determination of carbon residue—Part 1: Conradson method

JIS K 2275 Crude oil and petroleum products—Determination of water content

JIS K 2283 Crude petroleum and petroleum products—Determination of kinematic viscosity and calculation of viscosity index from kinematic viscosity

NOTE : Corresponding International Standards: ISO 2909:1981 *Petroleum products—Calculation of viscosity index from kinematic viscosity* and ISO 3104:1994 *Petroleum products—Transparent and opaque liquids—Determination of kinematic viscosity and calculation of dynamic viscosity* (overall evaluation: MOD)

JIS K 2514 Lubricating oils—Determination of oxidation stability

JIS K 6751-1 Testing methods for phthalic esters—Part 1: General

JIS K 8150 Sodium chloride (Reagent)

JIS K 8550 Silver nitrate (Reagent)

JIS R 1402 Non-metallic insulating tubes for thermocouples

JIS R 3503 Glass apparatus for chemical analysis

JIS R 6252 Abrasive papers

JIS Z 8401 Guide to the rounding of numbers

JIS Z 8402-6 Accuracy (trueness and precision) of measurement methods and results—Part 6: Use in practice of accuracy values

JIS Z 8704 Temperature measurement—Electrical methods

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS G 0201**, and the following terms and definitions apply.

3.1 quenching

heat treatment of hardening where steels are to become the martensitic structure by the rapid cooling from the austenitizing temperature

3.2 quenching in hot bath

quenching carried out in the hot bath of about 120 °C to 160 °C

3.3 tempering

heat treatment where steels of martensitic structure are heated again in the hot bath, maintained for a definite time, then taken out from the hot bath and cooled

3.4 steam film stage

cooling stage due to the film cooling in the cooling process of quenching

A gentle cooling is carried out by the thermal insulation effect of the steam film.

3.5 boiling stage

cooling stage due to the nucleate boiling in the cooling process of quenching

Steels are rapidly cooled by steam bubbles.

3.6 characteristic temperature

one of the scales indicating the cooling performance of heat treating fluids and the temperature at the time changing from the steam film stage to the boiling stage in the cooling process

NOTE : In the heat treatment such as quenching, the steam film stage is firstly present followed by the boiling stage in the cooling process.

4 Classification

Heat treating oils are classified as shown in table 1 according to their applications.

Table 1 Classification

Classification		Application	Common name (reference)	Corresponding ISO symbol
Class 1	No. 1	For quenching of material easy to be quenched ^{a)}	Cold oil	UHA
	No. 2	For quenching of material hard to be quenched ^{b)}	Cold oil	UHB
Class 2	No. 1	For hot-bath quenching at around 120 °C	Semi-hot oil	UHC, UHD
	No. 2	For hot-bath quenching at around 160 °C	Hot oil	UHE, UHF
Class 3	No. 1	For tempering at around 150 °C in oil temperature	—	UHE, UHF
	No. 2	For tempering at around 200 °C in oil temperature	—	UHG, UHH
Notes ^{a)} Materials such as alloy steels.				
^{b)} Materials such as carbon steels.				

5 Quality and property

When tested according to clause 6, heat treating oils shall comply with the specifications in table 2.

Table 2 Quality and property

Classification			Cooling performance						Stability		
			Oil temperature 80 °C		Oil temperature 120 °C		Oil temperature 160 °C				
			Charac- teristic tempera- ture	Cooling duration from 800 °C to 400 °C	Charac- teristic tempera- ture	Cooling duration from 800 °C to 400 °C	Charac- teristic tempera- ture	Cooling duration from 800 °C to 400 °C	Viscosity ratio	Incre- ment of carbon residue	
			°C	s	°C	s	°C	s		Mass %	
Heat treating oils	Class 1	No. 1	480 min.	5.0 max.	—	—	—	—	1.5 max.	1.5 max.	
		No. 2	580 min.	4.0 max.						2.0 max.	
	Class 2	No. 1	—	—	500 min.	5.0 max.	600 min.	6.0 max.		1.4 max.	1.5 max.
		No. 2			—	—					
	Class 3	No. 1				—	—				
		No. 2									
Testing method			6.2						6.3		
Classification			Kinematic viscosity		Flush point	Burning point	Water content				
			40 °C	100 °C							
			mm ² /s	mm ² /s	°C	°C	Mass %				
Heat treating oils	Class 1	No. 1	30 max.	—	180 min.	200 min.	0.05 max.				
		No. 2	26 max.		170 min.	190 min.					
	Class 2	No. 1	—	20 max.	200 min.	220 min.	0.1 max.				
		No. 2		35 max.	250 min.	280 min.					
	Class 3	No. 1		30 max.	230 min.	250 min.					
		No. 2		50 max.	280 min.	310 min.					
Testing method			6.4		6.5	6.5	6.6				

6 Testing methods

6.1 Sampling method

Samples are taken according to the sampling method of primary sample specified in clause 7 of JIS K 2251.

6.2 Testing method for cooling performance (Method A: surface temperature measuring method)

6.2.1 Principle of testing method

A silver rod is heated and quickly put into the sample, and the cooling curve is plotted by setting the temperature change of the silver rod as the function of duration. As for the temperature change, the surface temperature of a silver rod is measured by means of a silver-alumel thermocouple.

The apparatus and implements are such that an electric furnace for heating, silver rod, sample container, recorder, etc. are assembled in a unit, and each of them are as follows. An example is shown in figure 1.

- The silver wire and the alumel wire are as follows.

-
- The diagram illustrates a vacuum furnace system. It includes two rectangular components on the left, labeled 1 and 2, which are connected to a central control unit. This unit features a switch labeled 3 and a series of electrical contacts or sensors labeled 4. A vertical cylindrical component, labeled 5, is positioned within a larger rectangular chamber labeled 6. The chamber 6 has a central opening where the cylinder 5 is located. A dashed line indicates a vertical section or boundary within the chamber. A component labeled 7 is shown at the bottom of the chamber 6, and a component labeled 8 is shown at the very bottom of the diagram, possibly representing a base or a separate unit connected to the main system.

- ① Recorder ② Indicating thermometer ③ Switch
④ Temperature compensator for reference junction ⑤ Terminal
⑥ Electric furnace for heating ⑦ Sliver rod ⑧ Sample container

- 3) **Insulating tube** That measuring 0.8 mm in inside diameter and 1.2 mm in outside diameter, and of SH of PS2 (round-type one hole) specified in **JIS R 1402** or that equivalent or superior to this.
- 4) **Thermal resistant insulator** That in straight tube shape with the thermal resistant class 1 000 or more specified in **JIS C 4003**.
- 5) **Silver nitrate** That specified in **JIS K 8550** is used.
- 6) **Digital electric resistance measuring instrument** That of 0.1 Ω or more in resolution.
- 7) **Preparation method of silver rod** The preparation method of silver rod is as follows.

- 7.1) Adhere borax at the tip of the preheated alumel wire, and make it a bead by heating. After cooling, remove a borax film on the bead to obtain the bead with metallic lustre. Make the bead diameter 1.2 mm to 1.4 mm. Polish sufficiently the place where the bead and the silver rod are touching to get good contact.
- 7.2) Measure the specific resistance value of alumel wire by the digital electrical resistance measuring instrument.
- 7.3) Insert an insulating tube through the hole opened in the silver rod body; moreover, insert the alumel wire inside of the insulating tube.
- 7.4) Draw the alumel wire, and make the bead prepared according to **6.2.2 b) 7.1)** come in contact with the silver rod body.
- 7.5) Measure the electrical resistance between the end part of alumel wire at the side without the bead and the silicon rod body by the digital electrical resistance measuring instrument, and confirm that it is the same value as the resistance value obtained according to **6.2.2 b) 7.2)**.

NOTE : The value obtained according to **6.2.2 b) 7.5)** indicates the same value obtained according to **6.2.2 b) 7.2)**, because the electrical resistance of silver is small. When the value obtained according to **6.2.2 b) 7.5)** is smaller than the value obtained according to **6.2.2 b) 7.2)**, the silver is touching to the alumel wire at the inside of hole.

- 7.6) Draw the alumel wire, and fasten the screw of silver pipe on the silver rod body while the bead and silver rod body are contacting.
- 7.7) Lightly tap the bead to be buried in the silver rod body, and grind off the extruded bead head by a file.
- 7.8) Attach the silver rod body on a supporting rod.
- 7.9) Heat the silver pipe at 700 °C to 800 °C, and bend the silver pipe.
- 7.10) Raise the temperature of the screw part of silver pipe and silver rod body up to about 800 °C, apply silver nitrate crystals to the circumference of the joint part between silver pipe and silver rod body, and join them.

NOTE : If the sample oil penetrates to the hole inside from the insufficient jointed part, the silver rod becomes liable to be damaged.

- 7.11) Grind the bead of the alumel wire with a file, and heat the portion up to 800 °C. While grinding the bead with a file, apply silver nitrate crystals sufficiently until the existence of bead is no longer recognized, and join them.

NOTE : Owing to this operation, the bead of alumel wire is oxidized.

- 7.12) After cooling, finish its surface smooth and flat with a file.
- 7.13) Wind the silver wire on upper end of the silver pipe, heat the portion up to 700 °C to 800 °C, and join them by applying silver nitrate crystals.
- 7.14) Pass the silver wire and alumel wire through the insulating tube, mix the heat-resistant aluminous cement capable of withstanding at least the test temperature with water, fill the clearance inside the supporting rod with it for fixation, and dry it.