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ICS 77.140.75

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NATIONAL STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 3091-2008
Replacing GB/T 3091-2001

Welded Steel Pipes
for Low Pressure Liquid Delivery

(ISO 559:1991, NEQ)

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Issued on: May 13, 2008

Implemented on: November 01, 2008

Issued by: General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China;
Standardization Administration of China.

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Foreword

This standard is not equivalent to ISO 559:1991 “Steel Tubes for Water and Sewage” (English edition).

This standard will replace GB/T 3091-2001 “Welded Steel Pipe for Low Pressure Liquid Delivery”. There have been some significant changes in this standard over GB/T 3091-2001 in the following technical aspects:

- Add spiral seam submerged arc welding steel tube and relevant contents;
- Adjust external diameter and wall thickness series;
- It is stricter to the permissible variation of external diameter of steel tube whose external diameter is larger than 508mm;
- It is stricter to the permissible variation of steel tube's wall thickness;
- Add permissible variation of weight;
- Add Q195 steel grade;
- It is stricter to the tensile test;
- It is stricter to the flattening test requirement;
- Add requirement of face guided bend test for submerged arc welding steel tube;
- Adjust hydraulic test value of steel tube;
- Clearly define the provisions about galvanizing coat.

Appendix A of this standard is informative; appendix B and appendix C are normative.

This standard was proposed by China Iron & Steel Association.

This standard is under the jurisdiction of National Technical Committee of Standardization for Steel.

This standard was drafted by: Jinxi Steel Pipe Co., Ltd., Panyu Chu Kong Steel Pipe Co., Ltd., Jinghua Innovation Group Co., Ltd., and Zhejiang Kingland Pipeline Co., Ltd.

Chief drafting staffs of this standard: Qi Huijuan, Zhu Xingwei, Zhao Fuliang, Wang Lishu, Shen Ganrong, Huang Kejian, and Yang Weifang.

The previous editions of the standard replaced by this standard are:

- GB/T 3091-1982, GB/T 3091-1993, GB/T 3091-2001.

Welded Steel Pipes for Low Pressure Liquid Delivery

1 Scope

This standard specifies the dimension, appearance, weight, technical requirements, test method, test rules, packing, marking, and quality certificate of welded steel pipes for low pressure liquid delivery.

This standard is applicable to welded steel pipes for delivering low pressure liquid such as water, air, heating steam, and gasses.

This standard comprises longitudinal-seam high-frequency electrical resistance welded (ERW) steel pipes, longitudinal-seam submerged arc welded (SAWL) steel pipe, and spiral-seam submerged arc welded (SAWH) steel pipe. And it denotes the different requirements to each of them respectively. Those without marks are simultaneously applicable to longitudinal-seam high-frequency electrical resistance welded steel pipe, longitudinal-seam submerged arc welded steel pipe, and spiral seam submerged arc welded steel pipe.

2 Normative references

The following documents contain provisions which, through reference in this standard, constitute provisions of this standard. For dated reference, subsequent amendments to (excluding corrigenda contents), or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents. For undated references, the latest edition of the normative document referred to applies.

GB/T 222 Permissible Tolerances for Chemical Composition of Steel Products

GB/T 223.3 Methods for Chemical Analysis of Iron, Steel and Alloy; The Diantipyrylmethane Phosphomolybdate Gravimetric Method for the Determination of Phosphorus Content.

GB/T 223.5 Methods for Chemical Analysis of Iron, Steel and Alloy; The reduced molybdosilicate spectrophotometric method for the determination of acid-soluble silicon content

GB/T 223.10 Methods for Chemical Analysis of Iron, Steel and Alloy; The Cupferron Separation-chrome Azurol S Photometric Method for the Determination of Aluminium Content

GB/T 223.11 Methods for Chemical Analysis of Iron, Steel and Alloy; he Ammonium Persulfate Oxidation Volumetric Method for the Determination of Chromium Content

GB/T 223.12 Methods for Chemical Analysis of Iron, Steel and All The Sodium Carbonate Separation-diphenyl Carbazide Photometric Method for the Determination of Chromium Contentoy;

GB/T 223.14 Methods for Chemical Analysis of Iron, Steel and Alloy; The N-benzoyl-N-phenylhydroxylamine Extraction Photometric Method for the Determination of Vanadium Content

GB/T 223.16 Methods for Chemical Analysis of Iron, Steel and Alloy; The Chromotropic Acid Photometric Method for the Determination of Titanium Content

GB/T 223.18 Methods for Chemical Analysis of Iron, Steel and Alloy; The Sodium Thiosulfate Separation Iodimetric Method for the Determination of Copper Content

GB/T 223.19 Methods for Chemical Analysis of Iron, Steel and Alloy; The Neocuproine-chloroform Extraction Photometric Method for the Determination of Copper Content

GB/T 223.23 Methods for Chemical Analysis of Iron, Steel and Alloy; The Dimethylglyoxime Spectrophotometric Method for the Determination of Nickel Content

GB/T 223.24 Methods for Chemical Analysis of Iron, Steel and Alloy; The Extraction Seperation-The Dimethylglyoxine Spectrophotometric Method for the Determination of Nickel Content

GB/T 223.32 Methods for Chemical Analysis of Iron, Steel and Alloy; The Hypophosphite Reduction-iodimetric Method for the Determination of Arsenic Content

GB/T 223.36 Methods for Chemical Analysis of Iron, Steel and Alloy; The Neutral Titration Method for the Determination of Nitrogen Content after Distillation Separation

GB/T 223.37 Methods for Chemical Analysis of Iron, Steel and Alloy; The Indophenal Blue Photometric Methods for the Determination of Nitrogen Content after Distillation Separation

GB/T223.40 Iron Steel and Alloy-Determination of Niobium Content by the Sulphochlorophenol S Spectrophotometri Method

GB/T223.53 Methods for Chemical Analysis of Iron, Steel and Alloy; The Flame Atomic Absorption Spectrophotometric Method for the Determination of Nitrogen Content

GB/T 223.54 Methods for Chemical Analysis of Iron, Steel and Alloy; The Flame Atomic Absorption Spectrophotometric Method for the Determination of Nickel Content

GB/T 223.58 Methods for Chemical Analysis of Iron, Steel and Alloy; The Sodium Arsenite-Sodium Nitrite Titrimetric Method for the Determination of Manganese Content

GB/T 223.59 Methods for Chemical Analysis of Iron, Steel and Alloy; The Reduced Molybdoantimonyl Phosphoric Acid Phosphoric Method for the Determination of Phosphorus Content

GB/T 223.60 Methods for Chemical Analysis of Iron, Steel and Alloy; The Perchloric Acid Dehydration Gravimetric Method for the Determination of Silicon Content

GB/T 223.61 Methods for Chemical Analysis of Iron, Steel and Alloy; The Ammonium Phosphomolybdate Volumetric Method for the Determination of Phosphorus Content

GB/T 223.62 Methods for Chemical Analysis of Iron, Steel and Alloy; The Butyl Acetate Extraction Photometric Method for the Determination of Phosphorus Content

GB/T 223.63 Methods for Chemical Analysis of Iron, Steel and Alloy; The Sodium (potassium) Periodate Photometric Method for the Determination of Manganese Content

GB/T 223.64 Methods for Chemical Analysis of Iron, Steel and Alloy; The Flame Atomic Absorption Spectrometric Method for the Determination of Manganese Content

GB/T 223.67 Methods for Chemical Analysis of Iron, Steel and Alloy; The Reducing Distillation-methylene Blue Photometric Method for the Determination of Sulfur Content

GB/T 223.68 Methods for Chemical Analysis of Iron, Steel and Alloy; The Potassium Iodate Titration Method after Combustion in the Pipe Furnace for the Determination of Sulfur Content

GB/T 223.69 Methods for Chemical Analysis of Iron, Steel and Alloy; The Gas-volumetric Method after Combustion in the Pipe Furnace for the Determination of Carbon Content

GB/T 223.71 Methods for Chemical Analysis of Iron, Steel and Alloy; The Gravimetric Method after Combustion in the Pipe Furnace for the Determination of Carbon Content

GB/T 223.72 Methods for Chemical Analysis of Iron, Steel and Alloy; The Alumina Chromatographic Separation-Barium Sulfate Gravimetric Method for the Determination of Sulphur Content

GB/T 228 Metallic Materials--Tensile Testing at Ambient Temperature (GB/T 228-2002, ISO 6892: 1998, EQV)

GB/T 232 Metallic Materials--Bend Test (GB/T 232-1999, neq ISO 7438: 1985)

GB/T 241 Metallic Materials-Tube - Hydrostatic Pressure Test

GB/T 244 Metallic Materials-Tube - Bend test (GB/T 244-2008, ISO 8491: 1998, IDT)

GB/T 246 Metallic Materials-Tube-Flattening Test (GB/T 246-2007, ISO 8492: 1998, IDT)

GB/T 700 Carbon Structural Steels (GB/T 700-2006, ISO 630: 1995, NEQ)

GB/F 1591 Low-alloy High-strength Structural Steels (GB/T 1591-1994, neq ISO 4950-1: 1981, ISO 4950-2: 1981, ISO 4951: 1981)

GB/T 2102 Acceptance, Packing, Marking and Quality Certification of Steel Pipe

GB/T 2975 Steel and Steel Products-Location and Preparation of Test Pieces for Mechanical Testing (GB/T 2975-1998, eqv ISO 377: 1997)

GB/T 4336 Standard Test Method for Spark Discharge Atomic Emission Spectrometric Analysis of Carbon and Low-alloy Steel (Routine Method)

GB/T 7735 Steel Tubes-The Inspection Method on Eddy Current Test (GB/T 7735-2004, ISO 9304: 1989, MOD)

GB/T 20066 Steel and Iron; Sampling and Preparation of Samples for the Determination of Chemical Composition (GB/T 20066-2006, ISO 14284: 1996, IDT)

GB/T 20123 Steel and Iron-Determination of Total Carbon and Sulfur Content Infrared Absorption Method after Combustion in an Induction Furnace (Routine Method) (GB/T 20123 -2006, ISO 15350: 2000, IDT)

GB/T 21835 Dimensions and Masses Per Unit Length of Welded Steel Pipes(GB/T21835-2008, ISO 4200: 1991, ISO 1127: 1992, NEQ)

SY/T 6423.1 Petroleum and Natural Gas Industries; Non-destructive Testing (NDT) Methods of Steel Tubes for Pressure Purposes-radiographic Testing of the Weld Seam of Submerged Arc welded Steel Tubes for the Detection of Imperfections (SY/T 6423.1 - 1999, eqv ISO 12096: 1996)

SY/T 6423.2 Non-destructive Testing (NDT) Methods of Steel Tubes for Pressure Purposes-Ultrasonic Testing of the Weld Seam of Electric Resistance and Induction Welded Steel Tubes for the Detection of Longitudinal Imperfections(SY/T 6423.2- 1989, eqv ISO 9764: 1989)

SY/T 6423.3 Petroleum and Natural Gas Industries; Non-destructive Testing (NDT) Methods of Steel Tubes for Pressure Purposes-ultrasonic Testing of the Weld Seam of Submerged Arc welded Steel Tubes for the Detection of Longitudinal and/or Transverse Imperfections(SY/T 6423.3-1999, eqv ISO 9765: 1990)

5.5.3 Guided bend test

Front-face guided bend test shall be carried out for submerged arc welded steel pipe. Guided bend sample shall be intercepted from steel pipe's vertical weld (including welded seam of longitudinal-seam steel pipe, spiral welded seam of spiral seam steel pipe, and steel strip butt weld). Welded seam shall locate in the middle of sample. Sample shall not have repair welding seam, and weld reinforcement of welded seam shall be removed. Sample shall be bent for 180° in bending die. Diameter of bending core shall be eight times of steel pipe's wall thickness. It shall comply with the following provisions, after the test:

- a) The sample must not be completely broken;
- b) Crack or rupture exceeds 3.2mm in length must not appear on weld metal of sample, not considering the depth;
- c) Crack exceeds 3.2mm in length, or crack or rupture exceeds 10% of wall thickness in depth must not appear on base material, heat affected area or weld line.

During the test, cracks which are less than 6.4mm in length and appear at sample edge shall not be treated as reason of rejection.

5.6 Hydraulic pressure test

Hydraulic pressure test shall be carried out for every steel pipe. Test pressure shall be calculated according to formula (3) and correct to proximal 0.1Mpa. But the maximum test pressure shall be 5.0MPa. Holding time of test pressure shall not be less than 5 s. Leakage shall not occur to steel pipe during the test.

$$P = \frac{2St}{D} \quad (3)$$

Where: P — Minimum test pressure of steel pipe, unit is MPa (MPa);

S — 60% of steel pipe's lower yield strength, unit is newton per square millimeter (N/mm²);

D — External diameter of steel pipe, its unit is millimeter (mm);

t — Wall thickness of steel pipe, its unit is millimeter (mm).

Note: 1 N/mm²=1 MPa.

Electric-resistance-welded steel pipe may replace hydraulic pressure test with ultrasonic flaw detection or eddy current test. Submerged arc welded steel pipe may replace hydraulic pressure test with ultrasonic flaw detection or radiographic flaw detection. Ultrasonic flaw detection of electric-resistance-welded steel pipe shall comply with provisions on acceptance level L3 (C10) of SY/T 6423.2. Eddy current test shall comply with provisions on acceptance level A of GB/T 7735. Ultrasonic flaw detection of

Interior and exterior surfaces of steel pipe shall be smooth without fold crack, stratification, lap welding, interruption arc, burnout or other defects exceeding wall thickness' lower deviation in depth. Other partial defects that do not exceed wall thickness' lower deviation in depth may exist.

5.7.3 Defect repair

Repair welding must not be conducted for steel pipe whose external diameter is less than 114.3mm.

Repair for defect of base material and welded seam may be carried out for steel pipe whose external diameter is no less than 114.3mm. The section requires repair welding shall be treated before operation, so as to make it meet welding requirements. The shortest length of repair welded seam shall not be less than 50mm. For electric-resistance-welded steel pipe, maximum length of repair welded seam shall be no larger than 150mm. And repair for each steel pipe shall not exceed three sections. Repair welding must not be carried out within range of 200mm away from pipe end. Welding-pass of repair welding shall regrind. The regrind welding-pass shall smoothly connect with original outline. And it shall carry out hydraulic pressure test according to 5.6.

5.8 Butt joint of steel pipe

According to the requirements of purchaser, and through negotiation between both supplier and purchaser, steel pipe may also be delivered in butt joint. And that shall be indicated in contract. Length of nozzle stub for butt joint shall not be less than 1.5m and only allowed to joint two nozzle stubs. The pipe end shall be treated before butt joint, so as to make it meet welding requirements. During butt jointing, steel pipe's welded seams (including welded seam of longitudinal-seam pipe, spiral welded seam of spiral pipe and butt weld of steel strip) shall be away from each other with circumferential interval of 50mm-200mm. After butt jointing, butt weld shall be even and tidy along circumferential direction. And it complies with those specified in 5.7.1. Flexibility ratio of steel pipe after butt jointing shall comply with those specified in 4.3. Hydraulic pressure test shall be carried out according to requirements of 5.6.

5.9 Galvanizing coat

5.9.1 Galvanizing method

Galvanizing for steel pipe shall adopt hot-dip process.

5.9.2 Gravimetry of galvanizing coat

According to the requirements of purchaser, through negotiation between both supplier and purchaser and indicated in contract, gravimetry may be carried out for galvanizing coat. Total weight of galvanizing coat on interior and exterior surfaces shall not be less than 500g/m². The measurement shall be carried out according to Appendix B. During the test, it is allowed that total weight of one sample galvanizing coat is less than 500g/m², but it shall not be less than 480g/m².

7 Test rules

7.1 Inspection and acceptance

Inspection and acceptance of steel pipe shall be carried out by technical supervision department of supplier.

7.2 Batch-group rules

Steel pipe shall be checked and accepted in batch. Each batch shall be composed by steel pipes of same furnace number, same grade, same specification, same welding technology, same heat treatment (if suitable) and same galvanizing coat (if suitable). The quantity of each batch of steel pipe shall not exceed the following provisions:

- a) $D < 33.7\text{mm}$: 1000 pipes;
- b) $D > 33.7\text{mm} - 60.3\text{mm}$: 750 pipes;
- c) $D > 60.3\text{mm} \sim 168.3\text{mm}$: 500 pipes;
- d) $D > 168.3\text{mm} \sim 323.9\text{mm}$: 200 pipes;
- e) $D > 323.9\text{mm}$: 100 pipes.

7.3 Sampling quantity

Sampling quantity for test shall comply with those specified in Table 4.

7.4 Reinspection and determination rules

Reinspection and determination rules for steel pipe shall comply with those specified in GB/T 2102.

8 Packing, marking and quality certificate

Packing, marking and quality certificate for steel pipe shall comply with those specified in GB/T 2102.

Appendix B

(Normative)

Gravimetry for galvanizing coat with antimony chloride method

B.1 Preparation of samples

Gravimetry for galvanizing coat shall be carried out after galvanizing steel pipe. Randomly take two steel pipes from each batch. Intercept pipeline section of 30 mm-60mm (depends on specification) at one end of each steel pipe as sample. Rough surface and zinc tumor shall not exist on sample surface. Sample surface shall be cleaned with pure solvent such as benzene, petroleum benzene, trichloroethylene or carbon tetrachloride. And then rinse with ethanol and clear water. Then paint varnish (oxybenzene) on end face of sample's two ends, and intensively dry.

B.2 Preparation of test solution

Dissolve 32g of antimony chloride (SbCl_3) or 20g of antimony oxide (Sb_2O_3) in 1000mL of hydrochloric acid whose density is 1.18 kg/dm^3 to make raw liquor. Before the test, it is required to add 5mL of raw liquor to 100mL of hydrochloric acid whose density is 1.18 kg/dm^3 as the test solution.

B.3 Test operation method

B.3.1 Weigh sample with scale and correct to proximal 0.01g.

B.3.2 Sample shall be dipped into test solution. Once sample is immersed, liquid level shall be higher than sample. Solution temperature must not be larger than 38°C during measuring process.

B.3.3 Samples shall be taken out when generation of hydrogen becomes less in solution and galvanizing coat has disappeared. Wash samples in clear water and dry them with cotton or clean cloth. Weigh them with scale after fully dried. And correct to proximal 0.01g.

B.3.4 After desquamation of galvanizing coat, it is required to respectively measure external diameter and internal diameter at ends of sample along two orthogonal direction. Respectively take the mean value as actual external diameter and internal diameter. And correct to most proximal 0.01mm.

B.3.5 Test solution may be reused if it can easily remove galvanizing coat.

B.4 Calculation for test result

Sample surface shall be calculated according to Formula (B.1):

Appendix C

(Normative)

Uniformity test for galvanizing coat with bluestone immersion method

C.1 Preparation of sample

Uniformity test for galvanizing coat shall be carried out after galvanizing steel pipe. Take two steel pipes from each batch. And intercept pipeline section of no less than 150mm from one end of each steel pipe as sample. Oily soil on sample surface shall be removed then wiped up with clean soft cloth.

C.2 Preparation of test solution

Dissolve 33g of cupric sulfate crystals ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) or about 36g of industrial bluestone to 100mL of distilled water. Then add excessive powdered cupric hydroxide [$\text{Cu}(\text{OH})_2$] or verdigris (chemically pure) [$\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$], so as to neutralise free acid. If cupric hydroxide is added, it shall be 10g for every 10L of solution. If verdigris is added, it shall be 12g for every 10L of solution. Determine whether it is over dosage according to deposit at container bottom. Sufficiently mix at the same time, standing for 24h and then filter and defecate. If use powdered cupric oxide (CuO) to replace cupric hydroxide, then 8g of cupric oxide powder is required for every 10L of solution. but it shall be filtered after standing for 48h.

Density of made-up test solution shall be 1.170 kg/dm^3 at 15°C .

C.3 Test container

C.3.1 Material that is inert to bluestone shall be selected as the test container.

C.3.2 Internal dimension of container must make sample at least 25mm away from any wall of container after dipping sample into solution.

C.4 Test operation method

C.4.1 Sample shall be laid with its cutting end downward. Its length immersing in solution shall not be less than 100mm. Continuously immerse in copper sulphate solution for five times. During test, sample and solution temperature shall be kept at 15°C - 21°C and must not be stirred. Samples require 1 min impregnation every time, they shall be immediately washed with flowing clear water after taking out from solution and clean black sediment with soft brush, then mop up with soft cloth.

C.4.2 Except last immersion, samples shall be immediately immersed in solution.

C.4.3 Test solution shall be discarded after 20 times immersion.

C.5 Determination of test result

Samples shall not present in red (color of copper-plating), after five times of continuous immersion and final cleaning and drying - except that red metallic copper deposits within 25mm from sample end and 10mm away from liquid level of solution.

If red metallic copper deposits still present on sample after aforesaid test, the adhesive attraction of sample may be determined with following methods: Swab the sample forcibly in flowing clear water after immersing for 15s in 1:10 hydrochloric solution. If galvanizing coat recurs at its bottom surface, sample is determined as qualified.

If there is doubt about whether galvanizing coat exists on bottom surface under red metallic copper deposits, red metallic copper deposits may be removed. And then drip one or more drops of dilute hydrochloric acid at such section. Active hydrogen gas will be generated if galvanizing coat exists. Furthermore, it can also be determined with zinc qualitative test, Namely, collect dripping acid liquor with small filter paper or pipette; then neutralise with ammonium hydroxide and make it present with sub-acidity. Let hydrogen sulfide in solution to view whether white zinc sulfide deposits are generated so as to make determination.

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