Foreword

The standard has revised GB/T 3077-1988 ”The Technical Conditions of Alloy Structure Steel”.

There have been some changes in this national’s standard over its previous edition in the following technical aspects:

- Change the name of the standard to “Alloy Structure Steel”;
- After consultation between the two sides of supply and demand, the bar stock of which the diameter is more than 250mm can also be provided;
- Add a chapter of “Order Content”;
- Add the unified digital code for steel grades;
- Cancel steel grades 30Mn2MoW, 20Mn2B, 20SiMnVB, 20Cr3MoWVA, 20CrV and add steel grade 18CrMnNiMoA which was developed by China;
- Add the maximum content limit for Mo;
- Delete the clauses 3.1.1.3, 3.1.1.5, 3.5.2.1 and 3.5.2.2 of GB/T 3077-1988;
- Adjust appropriately the heat treatment process of Table 3 and the heat treatment parameters of individual steel grades.

The standard will replace GB/T 3077-1988 from the date of the implementation of this standard.

The standard was proposed by the State Bureau of Metallurgical Industry.

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

The standard was mainly drafted by the following organizations: Daye Special Steel Co., Ltd., the Standards Research Institute of Ministry of Metallurgical, and Baoshan Iron & Steel Co., Ltd. Special Steel Branch.

The standard was mainly drafted by: Mr. Fang Jun, Mr. Liu Wende, Ms. Luan Yan, Mr. Han Guoliang and Mr. Chen Changxi.

The standards was first released in May 1982 release and first emended in February 1988.

# National Standard of PRC

# Alloy Structure Steels

# GB/T 3077-1999

# Replace GB/T 3077-1988

## 1. Scope

The standard covers the following issues of hot rolled and forging alloy steel: the dimension, shape, weight, tolerance, engineering specification, test method, inspection rules, packaging, marking, and quality certificates.

The standard applies to alloy structural steel bar 250mm maximum diameter or thickness. After consultation between the two sides of supply and demand, bar stock of diameter greater than 250 mm can also be provided

The chemical compositions of steel grades specified in the standard also apply to steel ingot, billet and its productions.

## 2. Normative reference

The following standards contain provisions, which through reference in this text constitute provisions of this standard. At time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

| | |
|---|---|
| GB/T 222-1984 | Method of sampling steel for determination of chemical composition and permissible variations for product analysis |
| GB/T 224-1984 | Determination of depth of decarburization of steel |
| GB/T 225-1988 | Methods of Harden ability Test for Steel End Quench Method |
| GB/T 226-1991 | Etch test for macrostructure and defect of steels |
| GB/T 228-1987 | Methods of tensile tests for metal |
| GB/T 229-1994 | Metallic materials—Charpy notch impact test |
| GB/T231-1984 | Metallic materials—Brinell Hardness test |
| GB/T233-1982 | Metallic materials—Forging test |
| GB/T702-1986 | Hot-rolled round and square steel bars—Dimension, shape, weight and tolerance |
| GB/T 908-1987 | Forged round and square steels dimension, shape, weight and tolerance |
| GB/T1979-1980 | Diagram of a low magnification texture blemish grading of structural steel |
| GB/T2101-1989 | General requirements of acceptance, packaging, marking, and certification for section steel |
| GB/T2975-1998 | Steel and steel products--Location and preparation of test pieces for mechanical testing |
| GB/T4336-1984 | Method for photoelectric emission spectroscopic analysis of carbon steel, medium and low alloy steel |
| GB/T6397-1986 | Test pieces for tensile test for metallic materials |

| | |
|---|---|
| GB/T7736-1987 | Ultrasonic inspecting method for macro-structure and imperfection of steel |
| GB/T10561-1989 | Microscopic valuation method for the non-metallic inclusions in steel |
| GB/T13299-1991 | Steel－Determination of microstructure |
| GB/T15711-1995 | Steel products--Method for etch test of tower sample |
| GB/T17505-1998 | Steel and steel products General technical delivery requirements |
| GB/T17616-1998 | Unified numbering system for designations of iron, steel and alloy |
| YB/T5148-1993 | Metal-methods for estimating the average grain size |

Normative reference of chemolysis methods of iron and steel please see Annex A. (Normative Annex)

## 3. Order Content

Order or contract according to this standard should including following content:

a) Standard Number;

b) Product Name;

c) Steel grade or unified digital code;

d) Control of residual elements (For requirements, refer 6.1.1.2);

e) The weight or quantity of delivery;

f) Size and Shape;

g) Processing methods;

h) Delivery condition;

i) Delivery with heat treatment condition (For requirements, refer 6.4);

j) Hot heading (For requirements, refer 6.7);

k) Decarburization (For requirements, refer 6.8);

l) Non-metallic impurities (For requirements, refer 6.9);

m) Special requirements (For requirements, refer 6.10).

## 4. Classification and code

4.1 By different metallurgical quality, steel divided into the following three categories:

a) Fine steel;

b) High-grade fine steel (code “A” added following steel grade);

c) Extra fine steel (code “E” added following steel grade).

4.2 By different using and processing purpose, steel divided into the following two categories. The

applied processing method should be specified in the contract. If it is not specified, cutting used steel is default.

a) Pressure process used steel (code: UP)
    1) Hot pressure process used steel (code: UHP)
    2) Upset forging steel (code: UF)
    3) Cold drawn steel (code: UCD)
b) Cutting used steel (code: UC)

## 5. Size, Shape, Weight and Tolerance

5.1 The size, shape weight and tolerance of hot-rolled bar and square steel should be consistent with the relevant regulation of GB/T 702, and the particular requirements should be specified in the contract.

5.2 The size, shape weight and tolerance of forged bar and square steel should be consistent with the relevant regulation of GB/T 908, and the particular requirements should be specified in the contract.

5.3 The size, shape weight and tolerance of profiled bar should be comply with the appropriate standards or terms of the agreement reached between supplier and buyer, and the particular requirements should be specified in the contract.

6. Technical specification

6.1 Steel grade and chemical composition

6.1.1 Steel grade, unified digital code and chemical composition (melting analysis) should be consistent with the specification of Table 1.

6.1.1.1 The sulfur, phosphorus and residual content of copper, chromium, nickel, molybdenum of steel should be consistent with the specification of Table 2.

6.1.1.2 The residual content of tungsten, vanadium, and titanium content should be analyzed, and the results should be recorded in the quality certificate. According to the buyer’s request, the restrictions of residual tungsten, vanadium, titanium content can be set up.

6.1.1.3 The maximum copper content of hot pressure process used steel is 0.2%.

6.1.2 The permissible deviation of chemical composition of steels (or billets) should comply with GB/T 222.

# Table 1

| Steel Group | Item | Unified digital code | Steel grade | Chemical Composition % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Si | Mn | Cr | Mo | Ni | W | B | Al | Ti | V |
| Mn | 1 | A00202 | 20Mn2 | 0.17~0.24 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| | 2 | A00302 | 30Mn2 | 0.27~0.34 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| | 3 | A00352 | 35Mn2 | 0.32~0.39 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| | 4 | A00402 | 40Mn2 | 0.37~0.44 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| | 5 | A00452 | 45Mn2 | 0.42~0.49 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| | 6 | A00502 | 50Mn2 | 0.47~0.55 | 0.17~0.37 | 1.40~1.80 | | | | | | | | |
| MnV | 7 | A01202 | 20MnV | 0.17~0.24 | 0.17~0.37 | 1.30~1.60 | | | | | | | | 0.07~0.12 |
| SiMn | 8 | A10272 | 27SiMn | 0.24~0.32 | 1.10~1.40 | 1.10~1.40 | | | | | | | | |
| | 9 | A10352 | 35SiMn | 0.32~0.40 | 1.10~1.40 | 1.10~1.40 | | | | | | | | |
| | 10 | A10422 | 42SiMn | 0.39~0.45 | 1.10~1.40 | 1.10~1.40 | | | | | | | | |
| SiMnMoV | 11 | A14202 | 20SiMn2MoV | 0.17~0.23 | 0.90~1.20 | 2.20~2.60 | | 0.30~0.40 | | | | | | 0.05~0.12 |
| | 12 | A14262 | 25SiMn2MoV | 0.22~0.28 | 0.90~1.20 | 2.20~2.60 | | 0.30~0.40 | | | | | | 0.05~0.12 |
| | 13 | A14372 | 37SiMn2MoV | 0.33~0.39 | 0.60~0.90 | 1.60~1.90 | | 0.40~0.50 | | | | | | 0.05~0.12 |
| B | 14 | A70402 | 40B | 0.37~0.44 | 0.17~0.37 | 0.60~0.90 | | | | | 0.0005~0.0035 | | | |
| | 15 | A70452 | 45B | 0.42~0.49 | 0.17~0.37 | 0.60~0.90 | | | | | 0.0005~0.0035 | | | |
| | 16 | A70502 | 50B | 0.47~0.55 | 0.17~0.37 | 0.60~0.90 | | | | | 0.0005~0.0035 | | | |
| MnB | 17 | A71402 | 40MnB | 0.37~0.44 | 0.17~0.37 | 1.10~1.40 | | | | | 0.0005~0.0035 | | | |
| | 18 | A71452 | 45MnB | 0.42~0.49 | 0.17~0.37 | 1.10~1.40 | | | | | 0.0005~0.0035 | | | |
| MnMoB | 19 | A72202 | 20MnMoB | 0.16~0.22 | 0.17~0.37 | 0.90~1.20 | | 0.20~0.30 | | | 0.0005~0.0035 | | | |
| MnVB | 20 | A73152 | 15MnVB | 0.12~0.18 | 0.17~0.37 | 1.20~1.60 | | | | | 0.0005~0.0035 | | | 0.07~0.12 |
| | 21 | A73202 | 20MnVB | 0.17~0.23 | 0.17~0.37 | 1.20~1.60 | | | | | 0.0005~0.0035 | | | 0.07~0.12 |
| | 22 | A73402 | 40MnVB | 0.37~0.44 | 0.17~0.37 | 1.10~1.40 | | | | | 0.0005~0.0035 | | | 0.05~0.10 |
| MnTiB | 23 | A74202 | 20MnTiB | 0.17~0.24 | 0.17~0.37 | 1.30~1.60 | | | | | 0.0005~0.0035 | | 0.04~0.10 | |
| | 24 | A74252 | 25MnTiBRE | 0.22~0.28 | 0.20~0.45 | 1.30~1.60 | | | | | 0.0005~0.0035 | | 0.04~0.10 | |

# Table 1(continued)

| Steel Group | Item | Unified digital code | Steel grade | Chemical Composition % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Si | Mn | Cr | Mo | Ni | W | B | Al | Ti | V |
| Cr | 25 | A20152 | 15Cr | 0.12~0.18 | 0.17~0.37 | 0.40~0.70 | 0.70~1.00 | | | | | | | |
| | 26 | A20153 | 15CrA | 0.12~0.17 | 0.17~0.37 | 0.40~0.70 | 0.70~1.00 | | | | | | | |
| | 27 | A20202 | 20Cr | 0.18~0.24 | 0.17~0.37 | 0.50~0.80 | 0.70~1.00 | | | | | | | |
| | 28 | A20302 | 30Cr | 0.27~0.34 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | |
| | 29 | A20352 | 35Cr | 0.32~0.39 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | |
| | 30 | A20402 | 40Cr | 0.37~0.44 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | |
| | 31 | A20452 | 45Cr | 0.42~0.49 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | |
| | 32 | A20502 | 50Cr | 0.47~0.54 | 1.10~1.40 | 0.50~0.80 | 0.80~1.10 | | | | | | | |
| CrSi | 33 | A21382 | 38CrSi | 0.35~0.43 | 1.00~1.30 | 0.30~0.60 | 1.30~1.60 | | | | | | | |
| CrMo | 34 | A30122 | 12CrMo | 0.08~0.15 | 0.17~0.37 | 0.40~0.70 | 0.40~0.70 | 0.40~0.55 | | | | | | |
| | 35 | A30152 | 15CrMo | 0.12~0.18 | 0.17~0.37 | 0.40~0.70 | 0.80~1.10 | 0.40~0.55 | | | | | | |
| | 36 | A30202 | 20CrMo | 0.17~0.24 | 0.17~0.37 | 0.40~0.70 | 0.80~1.10 | 0.15~0.25 | | | | | | |
| | 37 | A30302 | 30CrMo | 0.26~0.34 | 0.17~0.37 | 0.40~0.70 | 0.80~1.10 | 0.15~0.25 | | | | | | |
| | 38 | A30303 | 30CrMoA | 0.26~0.33 | 0.17~0.37 | 0.40~0.70 | 0.80~1.10 | 0.15~0.25 | | | | | | |
| | 39 | A30352 | 35CrMo | 0.32~0.40 | 0.17~0.37 | 0.40~0.70 | 0.80~1.10 | 0.15~0.25 | | | | | | |
| | 40 | A30422 | 42CrMo | 0.38~0.45 | 0.17~0.37 | 0.50~0.80 | 0.90~1.20 | 0.15~0.25 | | | | | | |
| CrMoV | 41 | A31122 | 12CrMoV | 0.08~0.15 | 0.17~0.37 | 0.40~0.70 | 0.30~0.60 | 0.25~0.35 | | | | | | 0.15~0.30 |
| | 42 | A31352 | 35CrMoV | 0.30~0.38 | 0.17~0.37 | 0.40~0.70 | 1.00~1.30 | 0.20~0.30 | | | | | | 0.10`0.20 |
| | 43 | A31132 | 12Cr1MoV | 0.08~0.15 | 0.17~0.37 | 0.40~0.70 | 0.90~1.20 | 0.25~0.35 | | | | | | 0.15~0.30 |
| | 44 | A31253 | 25Cr2MoVA | 0.22~0.28 | 0.17~0.37 | 0.40~0.70 | 1.50~1.80 | 0.25~0.35 | | | | | | 0.15~0.30 |
| | 45 | A31263 | 25Cr2Mo1VA | 0.22~0.29 | 0.17~0.37 | 0.50~0.80 | 2.10~2.50 | 0.90~1.10 | | | | | | 0.30~0.50 |
| CrMoAl | 46 | A33382 | 38CrMoAl | 0.35~0.42 | 0.20~0.45 | 0.30~0.60 | 1.35~1.65 | 0.15~0.25 | | | | 0.70~1.10 | | |
| CrV | 47 | A23402 | 40CrV | 0.37~0.44 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | 0.10~0.20 |
| | 48 | A23503 | 50CrVA | 0.47~0.54 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | | | | | | | 0.10~0.20 |

# Table 1(continued)

| Steel Group | Item | Unified digital code | Steel grade | Chemical Composition % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Si | Mn | Cr | Mo | Ni | W | B | Al | Ti | V |
| CrMn | 49 | A22152 | 15CrMn | 0.12~0.18 | 0.17~0.37 | 1.10~1.40 | 0.40~0.70 | | | | | | | |
| | 50 | A22202 | 20CrMn | 0.17~0.23 | 0.17~0.37 | 0.90~1.20 | 0.90~1.20 | | | | | | | |
| | 51 | A22402 | 40CrMn | 0.37~0.45 | 0.17~0.37 | 0.90~1.20 | 0.90~1.20 | | | | | | | |
| CrMnSi | 52 | A24202 | 20CrMnSi | 0.17~0.23 | 0.90~1.20 | 0.80~1.10 | 0.80~1.10 | | | | | | | |
| | 53 | A24252 | 25CrMnSi | 0.22~0.28 | 0.90~1.20 | 0.80~1.10 | 0.80~1.10 | | | | | | | |
| | 54 | A24302 | 30CrMnSi | 0.27~0.34 | 0.90~1.20 | 0.80~1.10 | 0.80~1.10 | | | | | | | |
| | 55 | A24303 | 30CrMnSiA | 0.28~0.34 | 0.90~1.20 | 0.80~1.10 | 0.80~1.10 | | | | | | | |
| | 56 | A24353 | 35CrMnSiA | 0.32~0.39 | 1.10~1.40 | 0.80~1.10 | 1.10~1.40 | | | | | | | |
| CrMnMo | 57 | A34202 | 20CrMnMo | 0.17~0.23 | 0.17~0.37 | 0.90~1.20 | 1.10~1.40 | 0.20~0.30 | | | | | | |
| | 58 | A34402 | 40CrMnMo | 0.37~0.45 | 0.17~0.37 | 0.90~1.20 | 0.90~1.20 | 0.20~0.30 | | | | | | |
| CrMnTi | 59 | A26202 | 20CrMnTi | 0.17~0.23 | 0.17~0.37 | 0.80~1.10 | 1.00~1.30 | | | | | | 0.04~0.10 | |
| | 60 | A26302 | 30CrMnTi | 0.24~0.32 | 0.17~0.37 | 0.80~1.10 | 1.00~1.30 | | | | | | 0.04~0.10 | |
| CrNi | 61 | A40202 | 20CrNi | 0.17~0.23 | 0.17~0.37 | 0.40~0.70 | 0.45~0.75 | | 1.00~1.40 | | | | | |
| | 62 | A40402 | 40CrNi | 0.37~0.44 | 0.17~0.37 | 0.50~0.80 | 0.45~0.75 | | 1.00~1.40 | | | | | |
| | 63 | A40452 | 45CrNi | 0.42~0.49 | 0.17~0.37 | 0.50~0.80 | 0.45~0.75 | | 1.00~1.40 | | | | | |
| | 64 | A40502 | 50CrNi | 0.47~0.54 | 0.17~0.37 | 0.50~0.80 | 0.45~0.75 | | 1.00~1.40 | | | | | |
| | 65 | A41122 | 12CrNi2 | 0.10~0.17 | 0.17~0.37 | 0.30~0.60 | 0.60~0.90 | | 1.50~1.90 | | | | | |
| | 66 | A42122 | 12CrNi3 | 0.10~0.17 | 0.17~0.37 | 0.30~0.60 | 0.60~0.90 | | 2.75~3.15 | | | | | |
| | 67 | A42202 | 20CrNi3 | 0.17~0.24 | 0.17~0.37 | 0.30~0.60 | 0.60~0.90 | | 2.75~3.15 | | | | | |
| | 68 | A42302 | 30CrNi3 | 0.27~0.33 | 0.17~0.37 | 0.30~0.60 | 0.60~0.90 | | 2.75~3.15 | | | | | |
| | 69 | A42372 | 37CrNi3 | 0.34~0.41 | 0.17~0.37 | 0.30~0.60 | 1.20~1.60 | | 3.00~3.50 | | | | | |
| | 70 | A43122 | 12Cr2Ni4 | 0.10~0.16 | 0.17~0.37 | 0.30~0.60 | 1.25~1.65 | | 3.25~3.65 | | | | | |
| | 71 | A43202 | 20Cr2Ni4 | 0.17~0.23 | 0.17~0.37 | 0.30~0.60 | 1.25~1.65 | | 3.25~3.65 | | | | | |
| CrNiMo | 72 | A50202 | 20CrNiMo | 0.17~0.23 | 0.17~0.37 | 0.60~0.95 | 0.40~0.70 | 0.20~0.30 | 0.35~0.75 | | | | | |
| | 73 | A50403 | 40CrNiMoA | 0.37~0.44 | 0.17~0.37 | 0.50~0.80 | 0.60~0.90 | 0.15~0.25 | 1.25~1.65 | | | | | |

## Table 1(finished)

| Steel Group | Item | Unified digital code | Steel grade | Chemical Composition % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | Si | Mn | Cr | Mo | Ni | W | B | Al | Ti | V |
| CrMnNiMo | 74 | A50183 | 18CrNiMnMoA | 0.15~0.21 | 0.17~0.37 | 1.10~1.40 | 1.00~1.30 | 0.20~0.30 | 1.00~1.30 | | | | | |
| CrNiMoV | 75 | A51453 | 45CrNiMoVA | 0.42~0.49 | 0.17~0.37 | 0.50~0.80 | 0.80~1.10 | 0.20~0.30 | 1.30~1.80 | | | | | 0.10~0.20 |
| CrNiW | 76 | A52183 | 18Cr2Ni4WA | 0.13~0.19 | 0.17~0.37 | 0.30~0.60 | 1.35~1.65 | | 4.00~4.50 | 0.80~1.20 | | | | |
| | 77 | A52253 | 25Cr2Ni4WA | 0.21~0.28 | 0.17~0.37 | 0.30~0.60 | 1.35~1.65 | | 4.00~4.50 | 0.80~1.20 | | | | |

Notes:

1. The steel grades with code “A” in the standard can only be ordered as high-grade fine steel and other as fine steel.
2. According to their requirement, the buyer can order, by adding code “A” or “E” following the steel grades (remove code “A” first for the steel grades with it), the steel grades in Table 1 as high-grade fine steel (for the steel grades without code “A”) or extra fine steel (for all steel grades). The buyer can place a special order if they have more requirements against chemical compositions of steel grades in table.
3. The unified digital codes are added according to the regulation of GB/T 17616. The trailing number of fine steel is “2”, high-grade fine steel (with code “A”) is “3”, and extra fine steel (with code “E”) is “6”.
4. Rare earth element can be added as 0.05% calculated volume, and the analysis results of finished products for reference.

## Table 2

| Steel Categories | P | S | Cu | Cr | Ni | Mo |
|---|---|---|---|---|---|---|
| | Maximum % | | | | | |
| Fine Steel | 0.035 | 0.035 | 0.30 | 0.30 | 0.30 | 0.15 |
| High-grade Fine Steel | 0.025 | 0.025 | 0.25 | 0.30 | 0.30 | 0.10 |
| Extra Fine Steel | 0.025 | 0.015 | 0.25 | 0.30 | 0.30 | 0.10 |

6.2 Smelting method

The smelting method is optional for metallurgical refinery unless it has been specified in the contract.

6.3 Delivery condition

The delivery condition of steels is usually hot-rolled or hot heading. According to buyer’s requirements (written in the contract), steels can also be delivered as heat treatment condition (anneal, normalizing, or high tempering).

Pressure process used bar steel, according to the agreement reached between supplier and buyer, can be delivered as turning, peeling or other finishing condition.

6.4 Mechanical properties

6.4.1 Determine the longitudinal mechanical properties and hardness of anneal or high tempering of steel, by the test specimen with heat treatment, and the determination results should be accordance with Table 3.

6.4.2 The mechanical properties specified in Table 3 apply to steels of 80mm maximum section size. For steels from 80 to 100mm in size, the elongation, reduction of area and impact absorbing energy are permissible to reduce 1% (absolute value), 5% (absolute value), and 5% (absolute value) respectively; for size from 100 to 150mm, the elongation, reduction of area and impact absorbing energy are permissible to reduce 2% (absolute value), 10% (absolute value) and 10% (absolute value) respectively; for size from 150 to 250mm, the elongation, reduction of area and impact absorbing energy are permissible to reduce 3% (absolute value), 15 (absolute value) and 15% (absolute value) respectively.

6.4.3 It is permissible to forge (or roll) the steels test specimen, of which the size more than 80mm, to make its section size as 70~80mm. The determination result should comply with Table 3.

6.4.4 If the steels are deliver as quenching or tempering condition by the buyer request; the test specimen for mechanical properties should be free of heat treatment. The mechanical properties should be specified on the agreement reached between supplier and buyer.

6.5 Macrostructure

6.5.1 The acid etch macroscopic cross-section of steel specimens should be free of visible cavity, air bubble, crackle, inclusion, skull patch, shatter crack, and intergranular crack.

6.5.2 The acid etch macrostructure grade should be comply with the Table 4.

6.5.2.1 The surface spot segregation and edge spot segregation of 38CrMoAl or 38CrMoAlA should not be more than grade 2.5 and 1.5 respectively.

6.5.2.2 The cutting used steel is allowed to have subsurface inclusion, subsurface bubble etc. defects which not more than the depth of surface defects permissible.

6.5.2.3 If the supplier can guarantee the macrostructure test of steels is qualified, ultrasonic or other nondestructive inspection method can be used to replace acid etch.

# Table 3

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | Minimum | | | | | |
| | | | | First Quenching | Second Quenching | | | | | | | | | |
| Mn | 1 | 20Mn2 | 15 | 850 | - | Water, Oil | 200 | Water, Air | 785 | 590 | 10 | 40 | 47 | 187 |
| | | | | 880 | - | Water, Oil | 440 | Water, Air | | | | | | |
| | 2 | 30Mn2 | 25 | 840 | - | Water | 500 | Water | 785 | 635 | 12 | 45 | 63 | 207 |
| | 3 | 35Mn2 | 25 | 840 | - | Water | 500 | Water | 835 | 685 | 12 | 45 | 55 | 207 |
| | 4 | 40Mn2 | 25 | 840 | - | Water, Oil | 540 | Water | 885 | 735 | 12 | 45 | 55 | 217 |
| | 5 | 45Mn2 | 25 | 840 | - | Oil | 550 | Water, Oil | 885 | 735 | 10 | 45 | 47 | 217 |
| | 6 | 50Mn2 | 25 | 820 | - | Oil | 550 | Water, Oil | 930 | 785 | 9 | 40 | 39 | 229 |
| MnV | 7 | 20MnV | 15 | 880 | - | Water, Oil | 200 | Water, Air | 785 | 590 | 10 | 40 | 55 | 187 |
| SiMn | 8 | 27SiMn | 25 | 920 | - | Water | 450 | Water, Oil | 980 | 835 | 12 | 40 | 39 | 217 |
| | 9 | 35SiMn | 25 | 900 | - | Water | 570 | Water, Oil | 885 | 735 | 15 | 45 | 47 | 229 |
| | 10 | 42SiMn | 25 | 880 | - | Water | 590 | Water | 885 | 735 | 15 | 40 | 47 | 229 |
| SiMnMoV | 11 | 20SiMn2MoV | Sample | 900 | - | Oil | 200 | Water, Air | 1380 | - | 10 | 45 | 55 | 269 |
| | 12 | 25SiMn2MoV | Sample | 900 | - | Oil | 200 | Water, Air | 1470 | - | 10 | 40 | 47 | 269 |
| | 13 | 37SiMn2MoV | 25 | 870 | - | Water, Oil | 650 | Water, Air | 980 | 835 | 12 | 50 | 63 | 269 |
| B | 14 | 40B | 25 | 840 | - | Water | 550 | Water | 785 | 635 | 12 | 45 | 55 | 207 |
| | 15 | 45B | 25 | 840 | - | Water | 550 | Water | 835 | 685 | 12 | 45 | 47 | 217 |
| | 16 | 50B | 20 | 840 | - | Oil | 600 | Air | 785 | 540 | 10 | 45 | 39 | 207 |

# Table 3 (Continued)

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | Minimum | | | | | |
| | | | | First Quenching | Second Quenching | | | | | | | | | |
| MnB | 17 | 40MnB | 25 | 850 | - | Oil | 500 | Water, Oil | 980 | 785 | 10 | 45 | 47 | 207 |
| | 18 | 45MnB | 25 | 840 | - | Oil | 500 | Water, Oil | 1030 | 835 | 9 | 40 | 39 | 217 |
| MnMoB | 19 | 20MnMoB | 15 | 880 | - | Oil | 200 | Oil, Air | 1080 | 885 | 10 | 50 | 55 | 207 |
| MnVB | 20 | 15MnVB | 15 | 860 | - | Oil | 200 | Water, Air | 885 | 635 | 10 | 45 | 55 | 207 |
| | 21 | 20MnVB | 15 | 860 | - | Oil | 200 | Water, Air | 1080 | 885 | 10 | 45 | 55 | 207 |
| | 22 | 40MnVB | 25 | 850 | - | Oil | 520 | Water, Oil | 980 | 785 | 10 | 45 | 47 | 207 |
| MnTiB | 23 | 20MnTiB | 15 | 860 | - | Oil | 200 | Water, Air | 1130 | 930 | 10 | 45 | 55 | 187 |
| | 24 | 25MnTiBRE | Sample | 860 | - | Oil | 200 | Water, Air | 1380 | - | 10 | 40 | 47 | 229 |
| Cr | 25 | 15Cr | 15 | 880 | 780~820 | Water, Oil | 200 | Water, Air | 735 | 490 | 11 | 45 | 55 | 179 |
| | 26 | 15CrA | 15 | 880 | 770~820 | Water, Oil | 180 | Oil, Air | 685 | 490 | 12 | 45 | 55 | 179 |
| | 27 | 20Cr | 15 | 880 | 780~820 | Water, Oil | 200 | Water, Air | 835 | 540 | 10 | 40 | 47 | 179 |
| | 28 | 30Cr | 25 | 860 | - | Oil | 500 | Water, Oil | 885 | 685 | 11 | 45 | 47 | 187 |
| | 29 | 35Cr | 25 | 860 | - | Oil | 500 | Water, Oil | 930 | 735 | 11 | 45 | 47 | 207 |
| | 30 | 40Cr | 25 | 850 | - | Oil | 520 | Water, Oil | 980 | 785 | 9 | 45 | 47 | 207 |

# Table 3 (Continued)

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | Minimum | | | | | |
| | | | | First Quenching | Second Quenching | | | | | | | | | |
| Cr | 31 | 45Cr | 25 | 840 | - | Oil | 520 | Water, Oil | 1030 | 835 | 9 | 40 | 39 | 217 |
| | 32 | 50Cr | 25 | 830 | - | Oil | 520 | Water, Oil | 1080 | 930 | 9 | 40 | 39 | 229 |
| CrSi | 33 | 38CrSi | 25 | 900 | - | Oil | 600 | Water, Oil | 980 | 835 | 12 | 50 | 55 | 255 |
| CrMo | 34 | 12CrMo | 30 | 900 | - | Air | 650 | Air | 410 | 265 | 24 | 60 | 110 | 179 |
| | 35 | 15CrMo | 30 | 900 | - | Air | 650 | Air | 440 | 295 | 22 | 60 | 94 | 179 |
| | 36 | 20CrMo | 15 | 880 | - | Water, Oil | 500 | Water, Oil | 885 | 685 | 12 | 50 | 78 | 197 |
| | 37 | 30CrMo | 25 | 880 | - | Water, Oil | 540 | Water, Oil | 930 | 785 | 12 | 50 | 63 | 229 |
| | 38 | 30CrMoA | 15 | 880 | - | Oil | 540 | Water, Oil | 930 | 735 | 12 | 50 | 71 | 229 |
| | 39 | 35CrMo | 25 | 850 | - | Oil | 550 | Water, Oil | 980 | 835 | 12 | 45 | 63 | 229 |
| | 40 | 42CrMo | 25 | 850 | - | Oil | 560 | Water, Oil | 1080 | 930 | 12 | 45 | 63 | 217 |
| CrMoV | 41 | 12CrMoV | 30 | 970 | - | Air | 750 | Air | 440 | 225 | 22 | 50 | 78 | 241 |
| | 42 | 35CrMoV | 25 | 900 | - | Oil | 630 | Water, Oil | 1080 | 930 | 10 | 50 | 71 | 241 |
| | 43 | 12Cr1MoV | 30 | 970 | - | Air | 750 | Air | 490 | 245 | 22 | 50 | 71 | 179 |
| | 44 | 25Cr2MoVA | 25 | 900 | - | Oil | 640 | Air | 930 | 785 | 14 | 55 | 63 | 241 |
| | 45 | 25Cr2Mo1VA | 25 | 1040 | - | Air | 700 | Air | 735 | 590 | 16 | 50 | 47 | 241 |
| CrMoAl | 46 | 38CrMoAl | 30 | 940 | - | Water, Oil | 640 | Water, Oil | 980 | 835 | 14 | 50 | 71 | 229 |
| CrV | 47 | 40CrV | 25 | 880 | - | Oil | 650 | Water, Oil | 885 | 735 | 10 | 50 | 71 | 241 |

# Table 3 (Continued)

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | Minimum | | | | | |
| | | | | First Quenching | Second Quenching | | | | | | | | | |
| CrV | 48 | 50CrVA | 25 | 860 | - | Oil | 500 | Water, Oil | 1280 | 1130 | 10 | 40 | - | 255 |
| CrMn | 49 | 15CrMn | 15 | 880 | - | Oil | 200 | Water, Air | 785 | 590 | 12 | 50 | 47 | 179 |
| | 50 | 20CrMn | 15 | 850 | - | Oil | 200 | Water, Air | 930 | 735 | 10 | 45 | 47 | 187 |
| | 51 | 40CrMn | 25 | 840 | - | Oil | 550 | Water, Oil | 980 | 835 | 9 | 45 | 47 | 229 |
| CrMnSi | 52 | 20CrMnSi | 25 | 880 | - | Oil | 480 | Water, Oil | 785 | 635 | 12 | 45 | 55 | 207 |
| CrMnSi | 53 | 25CrMnSi | 25 | 880 | - | Oil | 480 | Water, Oil | 1080 | 885 | 10 | 40 | 39 | 217 |
| | 54 | 30CrMnSi | 25 | 880 | - | Oil | 520 | Water, Oil | 1080 | 885 | 10 | 45 | 39 | 229 |
| | 55 | 30CrMnSiA | 25 | 880 | - | Oil | 540 | Water, Oil | 1080 | 835 | 10 | 45 | 39 | 229 |
| | 56 | 35CrMnSiA | Sample | Heating up to 880℃, isothermal quench at 280~310℃ | | | | | | | | | | |
| | | | Sample | 950 | 890 | Oil | 230 | Air, Oil | | | | | | |
| CrMnMo | 57 | 20CrMnMo | 15 | 850 | - | Oil | 200 | Water, Air | 1180 | 885 | 10 | 45 | 55 | 217 |
| | 58 | 40CrMnMo | 25 | 850 | - | Oil | 600 | Water, Oil | 980 | 785 | 10 | 45 | 63 | 217 |
| CrMnTi | 59 | 20CrMnTi | 15 | 880 | 870 | Oil | 200 | Water, Air | 1080 | 850 | 10 | 45 | 55 | 217 |
| | 60 | 30CrMnTi | Sample | 880 | 850 | Oil | 200 | Water, Air | 1470 | - | 9 | 40 | 47 | 229 |
| CrNi | 61 | 20CrNi | 25 | 850 | - | Water, Oil | 460 | Water, Oil | 785 | 590 | 10 | 50 | 63 | 197 |
| | 62 | 40CrNi | 25 | 820 | - | Oil | 500 | Water, Oil | 980 | 785 | 10 | 45 | 55 | 241 |

# Table 3 (Continued)

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | Minimum | | | | | |
| | | | | First Quenching | Second Quenching | | | | | | | | | |
| CrNi | 63 | 45CrNi | 25 | 820 | - | Oil | 530 | Water, Oil | 980 | 785 | 10 | 45 | 55 | 255 |
| | 64 | 50CrNi | 25 | 820 | - | Oil | 500 | Water, Oil | 1080 | 835 | 8 | 40 | 39 | 255 |
| | 65 | 12CrNi2 | 15 | 860 | 780 | Water, Oil | 200 | Water, Air | 785 | 590 | 12 | 50 | 63 | 207 |
| | 66 | 12CrNi3 | 15 | 860 | 780 | Oil | 200 | Water, Air | 930 | 685 | 11 | 50 | 71 | 217 |
| | 67 | 20CrNi3 | 25 | 830 | - | Water, Oil | 480 | Water, Oil | 930 | 735 | 11 | 55 | 78 | 241 |
| | 68 | 30CrNi3 | 25 | 820 | - | Oil | 500 | Water, Oil | 980 | 785 | 9 | 45 | 63 | 241 |
| | 69 | 37CrNi3 | 25 | 820 | - | Oil | 500 | Water, Oil | 1130 | 980 | 10 | 50 | 47 | 269 |
| | 70 | 12Cr2Ni4 | 15 | 860 | 780 | Oil | 200 | Water, Air | 1080 | 835 | 10 | 50 | 71 | 269 |
| | 71 | 20Cr2Ni4 | 15 | 880 | 780 | Oil | 200 | Water, Air | 1180 | 1080 | 10 | 45 | 63 | 269 |
| CrNi Mo | 72 | 20CrNiMo | 15 | 850 | - | Oil | 200 | Air | 980 | 785 | 9 | 40 | 47 | 197 |
| | 73 | 40CrNiMoA | 25 | 850 | - | Oil | 600 | Water, Oil | 980 | 835 | 12 | 55 | 78 | 269 |
| CrMn NiMo | 74 | 18CrMnNi MoA | 15 | 830 | - | Oil | 200 | Air | 1180 | 885 | 10 | 45 | 71 | 269 |
| CrNi MoV | 75 | 45CrNiMoVA | Sample | 860 | - | Oil | 460 | Oil | 1470 | 1330 | 7 | 35 | 31 | 269 |
| Cr2Ni 4W | 76 | 18Cr2Ni4WA | 15 | 950 | 850 | Air | 200 | Water, Air | 1180 | 835 | 10 | 45 | 78 | 269 |
| | 77 | 25Cr2Ni4WA | 25 | 850 | - | Oil | 550 | Water, Oil | 1080 | 930 | 11 | 45 | 71 | 269 |

## Table 3 (Finished)

| Steel Group | Item | Steel Grade | Test Specimen Size (mm) | Heat Treatment | | | | | Mechanical Properties | | | | | Max. Brinell Hardness on anneal or high tempering condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quenching | | | Temper | | Tensile Strength (MPa) | Yield Strength (MPa) | Elong. (%) | Red. of area (%) | Impact absorbing Energy (J) | |
| | | | | Heating-up Temperature (℃) | | Quenching compound | Heating-up Temperature (℃) | Coolant | | | | | | |
| | | | | First Quenching | Second Quenching | | | | Minimum | | | | | |

Notes:

1. The allowable adjusting range of heat treatment temperature specified in table: quenching ±15℃, low tempering ±20℃, and high tempering ±50℃.
2. Boron Steel can be normalizing before quenching, and the normalizing temperature should be lower than quenching. For Chromium-manganese-titanium steel, normalizing can be used to replace first quenching.
3. In tensile test, if unable to determine the yield strength, the alternative is to determine residual tensile stress $\delta_{r0.2}$.

## Table 4

| Steel Categories | Pattern Segregation | Center Porosity | Surface Porosity | Surface spot segregation | Edge spot segregation |
|---|---|---|---|---|---|
| | Maximum grade permissible | | | | |
| Fine Steel | 3 | 3 | 3 | 1 | 1 |
| High-grade Fine Steel | 2 | 2 | 2 | Impermissible | |
| Extra Fine Steel | 1 | 1 | 1 | | |

6.6 Surface Texture

6.6.1 The surfaces of pressure process used steel should be free of crackle, spilly place, folding and inclusion. These defects must be cleaned away if they exist, and the remove depth, calculated by the actual size of steels, should be complying with Table 5. The minimum width of removed material should be five times of depth, and the maximum depth removed on a same section should not be more than one. Calculated by the actual size, the maximum individual fine nick, impression and pitting should be half the tolerance of basic size, and the maximum depth of small crackle permissible is 0.2.

## Table 5

mm

| Steel Size<br>Diameter or Thickness | Remove Depth permissible | |
|---|---|---|
| | Fine Steel &<br>High-grade Fine Steel | Extra Fine Steel |
| <80 | Half tolerance of steel size | |
| >=80~140 | Tolerance of steel size | Half tolerance of steel size |
| >=140~200 | 5% of steel size | 3% of steel size |
| >200 | 6% of steel size | |

6.6.2 Calculated by normal size, the surface local defects of cutting used steels, which not more than specifications of Table 6 are permissible.

## Table 6

mm

| Steel Size<br>Diameter or Thickness | Remove Depth permissible | |
|---|---|---|
| | Fine Steel &<br>High-grade Fine Steel | Extra Fine Steel |
| <100 | The negative deviation of steel size | |
| >=100 | Tolerance of steel size | The negative deviation of steel size |

6.7 Hot heading

According to buyer’s requirements (written in the contract), the hot heading used steel should be applied forging test. The height of specimen after test should be one-third of original. The specimen after test should be free of breach and slit. For the steel is larger than 80mm in size, the forging test can be ruled out if the supplier can guarantee it’s qualified.

6.8 Decarburization

According to buyer’s requirements (written in the contract), the determination of decarburization should be applied to steels of which the carbon content is more than 0.3%. The maximum total depth of decarburization (the ferrite banding added transition layer) of each edge, inspecting by microstructure method, should be 1.5% of the diameter or thickness of steels.

6.9 Non-metallic impurities

The non-metallic impurities can be inspected according to buyer’s requirements, and the qualified-level

should be specified in the agreement reached by the supplier and buyer.

6.10 Special requirements

As the buyer required and the supplier agreed, written in the contract, the steels with following special requirements can be provided:

a) The chemical composition range of steel grade specified in Table 1 can be narrow or broaden;
b) The sulfur content should be controlled between 0.015%~0.040%;
c) Hardenability requirement can be set up; Jominy hardenability should be tested per GB/T 225; according to agreement, the hardenability can be forecasted by computer and the detail method used to replace Jominy end quench test should be bargained between supplier and buyer;
d) The grain refining steel of which grain size is not small than 5 grade can be offered;
e) Tower sample test can be required;
f) Microstructure test can be required;
g) V-notch Charpy impact test can be required;
h) Others.

7. Test method

Test method for each batch of steel per Table 7.

Table 7

| Item | Inspection Item | Sampling quantity | Sampling position | Determination method |
|---|---|---|---|---|
| 1 | Chemical composition | 1 | GB/T 222 | GB/T 223, GB/T 4336 |
| 2 | Tensile test | 2 | Different bar steel, GB/T 2975 | GB/T 228, GB/T 6397 |
| 3 | Impact test | 2 | Different Bar Steel | GB/T229 |
| 4 | Hardness | 3 | Different Bar Steel | GB/T 231 |
| 5 | Macrostructure | 2 | Different Steel Billet or bar steel | GB/T 226, GB/T 1979 |
| 6 | Hot upsetting forging | 2 | Different Bar Steel | GB/T 233 |
| 7 | Decarburization | 3 | Different Bar Steel | GB/T 2249 (Metallographical method) |
| 8 | Non-metallic impurities | 2 | Different Bar Steel | GB/T 10561 |
| 9 | End quench hardenability | 1 | Any one | GB/T 225 |
| 10 | Grain size | 1 | Any one | YB/T 5148 |
| 11 | Microstructure | 2 | Different bar steel | GB/T 13299 |
| 12 | Tower sample test | 2 | Different bar steel | GB/T 15711 |
| 13 | Ultrasonic inspection | Each one | A whole bar steel | GB/T 7736 |
| 14 | Surface | Each one | A whole bar steel | Vision |
| 15 | Size | Each one | A whole bar steel | Calipers, micrometer |

8. Inspection regulation

8.1 Inspection and acceptance

8.1.1 The quality and technical supervision department of supplier is responsible for the delivery inspection and acceptance of steels.

8.1.2 The supplier must guarantee the delivery steels are complying with the specification of this standard or contract. If it's necessary, the buyer has the right to inspect any item specified in the standard or contract and decide to accept or not.

8.2 Batch up rules

Steels should be inspected and accepted by batch. Batch steel should have the same grade, same furnace number, same processing method, same size, same delivery condition and same heat. The steel smelted by electroslag remelting process, with the condition that the process is stable and each requirement of this standard can be met, can be batched up and deliver by mother consumable electrode furnace number.

8.3 Sampling quantity and position

The sampling quantity and position of each batch should comply with Table 7. The sampling quantity of slag steel: 2 pieces for macrostructure, 3 pieces for hardness, each one for size and surface, 1 piece for the other items. When the slag steel is batched up by mother furnace number, the sampling quantity comply with Table 7 and 1 piece of each electroslag furnace number for item chemical composition.

8.4 Reinspection and determination rules

8.4.1 The reinspection and determination of steel comply with GB/T 17505.

8.4.2 For determination of item mechanical properties, macrostructure and non-metallic impurities of steels or billet with the same furnace number, as long as the supplier can guarantee the products are qualified, the billet is allowable to replace steels and the small size to replace large one.

9. Packaging, marking and quality certification

The packaging, marking and quality certification of steels should comply with GB/T 2101.

Annex A

(Normative Annex)

Normative reference for chemolysis method

| | | |
|---|---|---|
| GB/T 223.3-1988 | Methods for chemical analysis of iron, steel and alloy | The diantipyrylmethane phosphomolybdate gravimetric method for the determination of phosphorus content |
| GB/T 223.4-1988 | | The volumetric method for determination of manganese content by ammonium nitrate oxidation |
| GB/T 223.5-1997 | | The reduced molybdosilicate spectrophotometric method for the determination of acid-soluble silicon content |
| GB/T 223.8-1991 | | The sodium fluoride separation-EDTA titration method for the determination of aluminum content |
| GB/T 223.9-1989 | | The chrome azurol S photometric method for the determination of aluminum content |
| GB/T 223.11-1991 | | The ammonium persulfate oxidation volumetric method for the determination of chromium content |
| GB/T 223.12-1991 | | The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content |
| GB/T 223.13-1989 | | The ammonium ferrous sulfate titration method for the determination of vanadium content |
| GB/T 223.14-1989 | | The N-benzoy-N-phenylhydroxylamine extraction photometric method for the determination of vanadium content |
| GB/T 223.16-1991 | | The chromotropic acid photometric method for the determination of titanium content |
| GB/T 223.17-1989 | | The diantipyrylmethane photometric method for the determination of titanium content |
| GB/T 223.18-1994 | | The sodium thiosulfate separation iodimetric method for the determination of copper content |
| GB/T 223.19-1989 | | The neocuproine-chloroform extraction photome method for the determination of copper content |
| GB/T 223.23-1994 | | The dimethylglyoxime spectrophotometric method for the determination of nickel content |
| GB/T 223.24-1994 | | The extraction separation -The dimethylglyoxime spectrophotometric method for the determination of nickel content |
| GB/T 223.25-1994 | | The dimethylglyoxime gravimetric method for the determination of nickel content |
| GB/T 223.26-1989 | | The thiocyanate direct photometric method for the determination of molybdenum. |
| GB/T 223.43-1994 | | The flame atomic absorption spectrophotometric method for the determination of nickel content |
| GB/T 223.49-1994 | | Extraction separation-chlorophosphonazo mA spectrophotometric method for the determination of the total rare earth content |
| GB/T 223.54-1987 | | The flame atomic absorption spectrophotometric method for the determination of nickel content |
| GB/T 223.58-1987 | | The sodium arsenite-sodium nitrite titrimetric method for the determination of manganese content |
| GB/T 223.59-1987 | | The reduced molybdoantimonyl phosphoric acid photometric method for the determination of phosphorus content |
| GB/T 223.60-1997 | | The perchloric acid dehydration gravimetric method for the determination of silicon content |

| | | |
|---|---|---|
| GB/T 223.61-1988 | Methods for chemical analysis of iron, steel and alloy | The ammonium phosphomolybdate volumetric method for the determination of phosphorus content |
| GB/T 223.62-1988 | | The butyl acetate extraction photometric method for the determination of phosphorus content |
| GB/T 223.63-1988 | | The sodium (potassium) periodate photometric method for the determination of manganese content |
| GB/T 223.64-1988 | | The flame atomic absorption spectrometric method for the determination of manganese content |
| GB/T 223.66-1989 | | The thiocyanate-chlorpromazine hydrochloride-chloroform extraction photometric method for the determination of tungsten content |
| GB/T 223.67-1989 | | The reducing distillation-methylene blue photometric method for the determination of sulfur content |
| GB/T 223.68-1997 | | The potassium iodate titration method after combustion in the pipe furnace for the determination of sulfur content |
| GB/T 223.69-1997 | | The gas- volumetric method after combustion in the pipe furnace for the determination of carbon content |
| GB/T 223.71-1997 | | The gravimetric method after combustion in the pipe furnace for the determination of carbon content |
| GB/T 223.72-1991 | | The alumina chromatographic separation-barium sulfate gravimetric method for the determination of sulphur content |
| GB/T 223.75-1991 | | The methanol distillation-curcumin photometric method for the determination of boron content |
| GB/T 223.76-1991 | | The flame atomic absorption spectrometric method for the determination of vanadium content |