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中华人民共和国国家标准

National Standard of the People's Republic of China

GB 6479-2000

neq ISO 9329-2: 1997

Supersedes GB 6479-1986

高压化肥设备用无缝钢管

Seamless steel tubes for high-pressure

For chemical fertilizer equipments

Foreword

This Standard is not equivalent to adopt ISO 9329 – 2:1997 *Seamless Steel Tubes for Pressure Vessels ---- Delivery Specifications ---- Part 2: Carbon Steel and Alloy Steel of Specified High Temperature Performance*.

The criteria of allowable deviation for size, degree of bend, press-flat deformation coefficient for steel tubes in this Standard are more strict than international criteria while the criteria of physical performance is equivalent to international ones.

This Standard, compared with original edition, has made revision to following provisions:

1. The criteria of allowable deviation for size are revised. Original Table 1 is deleted. The specification for the size is changed to refer to Table 1 of GB/T 17395 – 1998.
2. The brand number of 12SiMoVNb is added. Phosphorous and sulfur content in different brand numbers of steel is revised.
3. Supplementation is made to the delivery status of steel tubes.
4. The provision of using leaking magnetic testing to replace hydraulic test is added while the provision of using ultrasonic testing to replace hydraulic test is deleted.
5. The stipulations of making press-flat test to steel tubes with OD > 400mm is deleted.
6. The requirements for low-fold inspection for steel tubes rolled of steel ingot is added as well as the requirements for inspection of non-metal inclusion in steel tubes rolled of continuous cast blank and steel ingot.
7. Definite stipulations are made for the class of ultrasonic testing.

From the date of implementation, this Standard shall supercede ***GB 6479 – 1986 Seamless Steel Tubes for Chemical Fertilizer Equipment***.

This Standard is put forth by the State Bureau of Metallurgical Industry.

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

This Standard is prepared by: the Anshan Steel Group Company and the Chengdu Seamless Steel Tube Co. Ltd.

Key persons for preparation of this Standard are Pu Zhiming, Dong Changfu, Wu Keping, Xu Yongmei and Feng Wenhua

This Standard is issued in June 1986 for the first time.

高压化肥设备用无缝钢管

Seamless steel tubes for high-pressure for chemical fertilizer equipments

1. Scope

This Standard specifies size, profile, weight, technical requirements, test method, inspection rules, packing, marks and quality certificate of seamless steel tubes for high-pressure chemical fertilizer equipment.

This Standard applies to seamless steel tubes of best quality carbon steel, low alloy steel and stainless steel for high-pressure chemical fertilizer equipment and piping as well as for other chemical equipment.

2. Cited Standards

Provisions in following standards, referred by this Standard, have constituted provisions of this Standard. At publishing of this Standard, the referred editions are still in force. Any standard may be revised. Any user of this Standard shall study the possibility of using the new edition of following standards.

GB/T222 –1984	Method for Sampling the Test Sample for Chemical Analysis of Steel and Allowable Deviation for Chemical Composition of Final Products
GB/T 223.5–1997	Method for Chemical Analysis of Steel and Alloy Measuring Acid Solvable Silicon Content with Photometry of Reduction Type Silicon Molybdate
GB/T 223.11–1991	Method for Chemical Analysis of Steel and Alloy Measuring Chromium Content with Method of Ammonium Supersulfate Oxidation Capacity
GB/T 223. 14 -1989	Method for Chemical Analysis of Steel and Alloy Measuring Vanadium Content with Photometry of Tantalum Test Agent Extraction
GB/T 223.19 - 1989	Method for Chemical Analysis of Steel and Alloy Measuring Copper Content with Photometry of neocuproine-trichloromethane Extraction
GB/T 223.23 -1994	Method for Chemical Analysis of Steel and Alloy Measuring Nickel Content with Spectrum Photometry of diacetyldioxime
GB/T 223.26-1989	Method for Chemical Analysis of Steel and Alloy Measuring Molybdenum Content with Direct Photometry of thiocyanate

GB/T 223.40- 1985	Method for Chemical Analysis of Steel and Alloy Measuring Niobium Content with Photometry of Ion Exchanging and Separation – chlorosulfophenol S.
GB/T 223.43–1994	Method for Chemical Analysis of Steel and Alloy Measuring Tungsten Content
GB/T 223.58 - 1987	Method for Chemical Analysis of Steel and Alloy Measuring Manganese Content with Method of Titration of sodium arsenite-sodium nitrite
G/TB 223.59-1987	Method for Chemical Analysis of Steel and Alloy Measuring Phosphorous Content with Photometry of antimonophosphoromolybdo-blue
GB/T 223.68 – 1997	Method for Chemical Analysis of Steel and Alloy Measuring Sulfur Content with Method of Titration of potassium iodate after Burnt in Tube Type Furnace
GB/T 223.69 - 1997	Method for Chemical Analysis of Steel and Alloy Measuring Carbon Content with Method of Gas Capacity after Burnt in Tube Type Furnace
GB/T 226 – 1991	Method for Inspection of Low-fold Organization and Acid Soak Defects of Steel
GB/T 228 –1987	Metal Tensile Test Method
GB/T 229 – 94	Metal Charpy notch Impact Test Method
GB/T 241 – 1990	Metal Tube Hydraulic Test Method
GB/T 242 – 1997	Metal Tube Opening Expansion Test Method
GB/T 246 – 1997	Metal Tube Press-flat Test Methods
GB/T 1979 – 1980	Diagram for Class Evaluation of Defects in Low-fold Organization of Structural Steel
GB/T 2101 – 1988	Inspection and Acceptance, Packing, Marks and Quality Certificate of Steel Tubes
GB/T 4336 – 1984	Method of Spectrum Analysis of Photoemission of Carbon Steel and Medium and Low Alloy Steel
GB/T 5777 – 1996	Ultrasonic Testing Method for Seamless Steel Tubes
GB/T 7735 – 1995	Eddy Testing Method for Steel Tubes
GB/T 10561 – 1989	Method for Microscopic Evaluation of Non-metal Inclusion of Steel
GB/T 12606 – 1999	Method for Leaking Magnetic Testing of Steel Tubes
GB/T 17395 – 1998	Size, Profile, Weight and Allowable Deviation of Seamless Steel Tubes

GB/T 17505 – 1998 General Specifications for Delivery of Steel and Steel Products

YB/T 5137-1998 Round Tube Blank for High Pressure Seamless Steel Tubes

3. Size, Profile and Weight

3.1 Outer diameter and wall thickness

3.1.1 For the definite specification for steel tubes with OD of 14 ~ 426mm and wall thickness $\geq 45\text{mm}$, see Table 1 in GB/T 17395 – 1998.

As requested by the demander and agreed by both parties, steel tubes with specifications beyond Table 1 in GB/T 17395 – 1998 may also be produced.

3.1.2 Allowable deviation of OD and wall thickness shall meet what specified in Table 1.

Table 1 Allowable Deviation of OD and Wall thickness

Type of steel	Size of steel tube		Allowable deviation	
			Common class	High class
Hot rolled (Extrude pressed) steel tubes	OD, D	≤159	± 1.0% (Minimum value is ± 0.5mm)	± 0.75% (Minimum value is ± 0.3mm)
		>159	± 1.0%	±0.90%
	Wall thickness, S	≤20	+15% -10%	±10%
		>20	+12.5% -10.0%	±10%
Cold drawn (rolled) steel tubes	OD, D	14~30	±0.20mm	±0.15mm
		>30~50	±0.30mm	±0.25mm
		>50	±0.75%	±0.6%
	Wall thickness	≤3.0	+12.5% -10%	±10%
>3.0		±10%	±7.5%	
Note: Allowable deviation for OD of hot expanded steel tubes is ± 1.0 %, allowable deviation for wall thickness is ± 15% .				

In case the class of allowable deviation for the size of steel tubes is not specified in the contract by the demander, the allowable deviation for the OD and wall thickness of steel tubes shall meet what specified for common class

On the request of the demander, agreed by both parties and specified in the contract, steel tubes with allowable deviation for size beyond what specified in Table 1 may also be produced.

3.2 Length

3.2.1 General length of steel tubes

General length of steel tubes is 4000 ~ 12000mm.

As agreed by both parties, short steel tubes with length not less than 3000mm and with weight not exceeding 5% of total weight may be delivered.

3.2.2 Fixed-rule length and multiple-rule length

The fixed-rule length and the multiple-rule length of steel tubes shall be within the range of usual length. The allowable deviation for total length shall be $^{+20}_0$ mm. For each multiple-rule length, allowance for cutting shall be provided in accordance with following stipulations:

OD $\leq$ 159mm.....5 ~ 10mm;
OD > 159mm.....10 ~ 15mm.

3.3 Degree of bend

The degree of bend of steel tubes shall not exceed what specified below:

Wall thickness $\leq$ 15mm.....1.5mm/m;
Wall thickness > 15 ~ 30mm..... 2.0mm/m;
Wall thickness > 30mm or OD > 351mm..... 3.0mm/m.

3.4 Profile of end

Both ends of steel tubes shall be right angle cut and spur shall be removed.

3.5 Delivery weight

Steel tubes shall be delivered as per actual weight. It may also be delivered as per theoretic weight. The calculation of theoretic weight of steel tubes shall meet what specified in GB/T 17395. The density of steel shall be as 7.85 kg/cm³.

As requested by the demander, agreed by both parted and specified in the contract, the deviation between the actual weight and the theoretic weight of delivered steel tubes shall meet what specified below:

Single steel tube: $\pm 10\%$;

Steel tubes with weight of at least 10t in each batch: $\pm 7.5\%$

3.6 Examples of marks

For steel tubes made of 20# steel, with OD of 89mm and wall thickness of 6.0mm:

- a) Hot rolled (extruded) steel tube at common class precision of OD and wall thickness with length of 4000mm multiple-rule:

20 – 89 x 6 x 4000 multiple– GB 6479 - 2000

- b) Cold drawn (rolled) steel tube at high class precision of OD and common class of wall thickness with length of 4000mm:

Cold tube 20 – 89 Height x 6 x 4000 – GB 6479 - 2000

4. Technical Requirements

4.1 Brand number and chemical composition

4.1.1 The brand number and chemical composition of steel (smelting analysis) shall meet what specified in Table 2. Steel tubes shall be inspected and accepted as per smelting composition.

Table 2 Brand Number and Chemical Composition of Steel

Brand number	Chemical composition, %										
	C	Si	Mn	Cr	Mo	V	W	Nb	Ni	P	S
	Not more than										
10	0.07~ 0.14	0.17~ 0.37	0.35~ 0.65	—	—	—	—	—	—	0.030	0.030
20	0.17~ 0.24	0.17~ 0.37	0.35~ 0.65	—	—	—	—	—	—	0.030	0.030
16Mn	0.12~ 0.20	0.20~ 0.60	1.20~ 1.60							0.030	0.030
15MnV	0.12 ~0.18	0.20~ 0.60	1.20~ 1.60	—	—	0.04~ 0.12	—	—	—	0.030	0.030
10MoWVNb	0.07~ 0.13	0.50~ 0.80	0.50~ 0.80	—	0.60~ 0.90	0.30~ 0.50	0.50~ 0.90	0.06~ 0.12	—	0.030	0.030
12CrMo	0.08~ 0.15	0.17~ 0.37	0.40~ 0.70	0.40~ 0.70	0.40~ 0.55					0.030	0.030
15CrMo	0.12~ 0.18	0.17~ 0.37	0.40~ 0.70	0.80~ 1.10	0.40~ 0.55	—	—	—	—	0.030	0.030
1Cr5Mo	≤0.15	≤0.50	≤0.60	4.00~ 6.00	0.45~ 0.60	—	—	—	≤0.60	0.030	0.030
12Cr2Mo	0.80~ 0.15	≤0.50	0.40~0.70	2.0~ 2.50	0.90~ 1.20					0.030	0.030
12SiMoVNb	0.08~ 0.14	0.50~ 0.80	0.60~ 0.90	—	0.90~ 1.10	0.30~ 0.50	—	0.04~ 0.08	—	0.030	0.030

4.1.2 The content of residual elements in steel shall meet what specified in Table 3.

Table 3 Content of Residual Elements in Different Brands of Steel

Brand number	Residual element, % ≠				
	Ni	Cr	Cu	Mo	V
10	0.25	0.15	0.20	—	—
20	0.25	0.25	0.20	0.15	0.08
Others	0.30	0.30	0.20	—	—

4.1.3 Nitrogen content of steel made in oxygen converter shall not be > 0.008%.

4.1.4 As requested by the demander and specified in the contract, the carbon content of steel20 for low temperature use shall be 0.17 % ~ 0.22 %.

4.1.5 In case a product analysis is requested by the demander, it shall be specified in the contract. The allowable deviation for chemical composition of product steel tubes shall meet what specified in GB/T 222.

4.2 Manufacture method

The manufacture method of steel and tube blank shall meet what specified in YB/T 5137. Steel tubes shall be manufactured by seamless method of hot rolling (extrude pressing, expansion) or cold drawn (rolling). In case the demander assigns one manufacture method, it shall be specified in the contract.

4.3 Delivery status

Steel tubes shall be delivered after heat treatment in the way specified in Table 4. The way of heat treatment shall be noted in the quality certificate.

Table 4 Heat Treatment of Steel Tubes

Sequence No.	Brand Number	Heat treatment process
1	10	Normalization
2	20	Normalization
3	16Mn	Normalization
4	15MnV	Normalization
5	12CrMo	Normalization at 900℃~930℃, tempering at 670℃~720℃, holding time: over 2 hours for cycle furnace and over 1 hour for continuous furnace
6	15CrMo	Normalization at 930℃~960℃, tempering at 680℃~720℃, holding time: over 2 hours for cycle furnace and over 1 hour for continuous furnace
7	12Cr2Mo	Normalization at 900℃~960℃, tempering at 700℃~750℃. It may also be done in the way to heat up to 900℃~960℃ and cool the furnace to 700℃ and hold over 1 hour, air cooling.
8	10MoWVNb	Normalization at 970℃~990℃, tempering at 730℃~750℃, or annealing at high temperature of 800℃~820℃
9	1Cr5Mo	Annealing
10	12SiMoVNb	Normalization at 980℃~1020℃, tempering at 710℃~750℃
Note: In case the final rolling temperature of hot rolled tubes is in conformity with tempering temperature, it may substitute tempering.		

4.4 Physical performance

4.4.1 The longitudinal physical performance of steel tubes at delivery status at room temperature shall meet what specified in Table 5.

U notch impact test shall be made to the standard test sample for steel tubes with OD ≤ 57 mm and wall thickness ≤ 14 mm.

The assessment of the impact test result shall be done in accordance with what specified in GB/T 17505.

Table 5 Physical Performance of Steel Tubes

Sequence No.	Brand No.	Physical performance				
		Tensile strength σ_b , MPa	Yield point, σ_s , MPa	Elongation after breaking, δ , %	Contraction rate, ψ , %	Impact power A _{ku2} , J
		Not less than				
1	10	335~490	205	24	—	—
2	20	410~550	245	24	—	39
3	16Mn	490~670	320	21	—	47
4	15MnV	510~690	350	19		47
5	12CrMo	410~560	205	21	—	55
6	15CrMo	440~640	235	21	—	47
7	12Cr2Mo	450~600	280	20	—	38
8	10MoWVNb	470~670	295	19	—	62
9	1Cr5Mo	390~590	195	22		94
10	12SiMoVNb	≥ 470	315	19	50	47
Note: In case 12Cr2Mo is used to produce steel tubes, if OD is ≥ 30 mm and wall thickness is ≥ 3 mm, the yield point is allowable to be reduced by 10 Mpa. For other brand numbers of steel, if the wall thickness is $> 16 \sim 40$ mm, the yield point is allowable to be reduced by 10 Mpa.						

4.4.2 Test results of Charpy (V- notch) impact test at low temperature shall be furnished to steel tubes of 10, 20 and 16Mn by manufacturer. The test temperature shall be in accordance with Table 6 and the impact power shall not be taken as the basis for delivery.

As requested by the demander, agreed by both parties and specified in the contract, the test temperature and impact power for Charpy (V- notch) impact test to steel tubes of 10, 20 and 16Mn shall meet what specified in Table 6. Charpy (V- notch) impact test at -30°C may also be done to steel tubes of steel 10 and the value shall be agreed by both parties.

The assessment of test results of impact tests shall be done in accordance with what specified in GB/T 17505.

Table 6 Impact Performance at Low Temperature

Brand No	Test temperature, °C	Direction of test sample	Impact power A _{k v} , J	
			Size of test sample, mm	
			10 × 10 × 55	5 × 10 × 55
10	-20	Longitudinal	≥18	≥12
20				
16Mn	-40		≥21	≥14
Note: In the case OD is ≤57mm, wall thickness is ≤14mm, impact test shall be made to the test sample of standard size while OD is ≤49mm and wall thickness is ≤8mm, impact test shall be made to small size test sample of 5mm wide				

4.5 Process performance

4.5.1 Hydraulic test

Hydraulic test shall be made to steel tubes piece by piece. The test pressure shall be calculated according to formula (1). Max. test pressure shall be 20 Mpa and holding time not less than 10 seconds. Under test pressure, steel tubes shall not have any leakage or penetration.

$$P = \frac{2SR}{D} \dots\dots\dots (1)$$

In which:

P ----- Test pressure, Mpa;

S ----- Nominal wall thickness of steel tubes, mm

D ----- Nominal OD of steel tubes, mm;

R ----- Allowable stress, Mpa. It shall be 80% of yield point specified in Table 4.

Eddy testing or leaking magnetic testing may be used to replace hydraulic test up to manufacturer's option.

In case an eddy testing is made, the reference test tube shall be Class A for inspection and acceptance in GB/T 7735. In case leaking magnetic testing is made, the longitudinal notch channel in outer surface of reference tube shall meet what specified in L₄ of GB/T 12606. The minimum value of the depth of cut channel shall be 0.5mm.

4.5.2 Press-flat test

A press-flat test shall be done to all steel tubes with OD > 22 ~ 400mm, except 1Cr5Mo steel tubes. After steel tubes are pressed to be flat, the space between two flat plates, H, shall be calculated in accordance with formula (2):

$$H = \frac{(1+\alpha)S}{\alpha + S/D} \dots\dots\dots (2)$$

In which,

S ----- Nominal wall thickness of steel tubes, mm;

D ----- Nominal OD of steel tubes, mm;

a ----- Unit length deformation coefficient.

In case S/D is > 0.15 , a “C” shape press-flat test may be done to steel tubes. When pressing, the position of “C” shape test sample between two flat plates is shown in Figure 1.

No cracks or cracking opening shall exist in test sample after test.

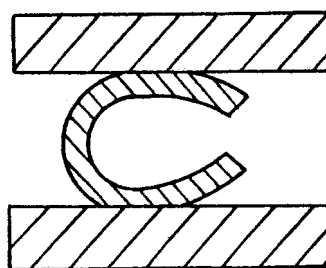


Figure 1 Position of “C” Shape of Test Sample between Two Flat Plates

4.5.3 Opening expansion test

As requested by the demander and specified in the contract, opening expansion test may be done to steel tubes with wall thickness $\geq 8\text{mm}$.

The opening expansion test shall be made at room temperature. The taper of the tip shall be either 30° , or 45° or 60° . After the opening is expanded, the test sample shall not have any crack or cracking opening. The expansion rate of the OD of the test sample shall meet what specified in Table 7.

Table 7 Opening Expansion Rate of OD of Steel Tubes

Type of steel	Opening expansion rate of OD of steel tubes, %		
	ID/OD		
	≤ 0.6	$>0.6\sim 0.8$	>0.8
Best quality carbon steel	10	12	17
Low alloy steel			
Alloy steel	8	10	16

4.6 Low-fold inspection

Low-fold inspection shall be made to steel tubes which were directly rolled of steel ingot. No

visual white point, impurity inclusion, peripheric blister, skin turning up or de-lamination shall exist in the acid soak test piece of steel tube sections.

4.7 Inspection of non-metal inclusion

Inspection of non-metal inclusion shall be made to steel tubes directly rolled of continuous blanks or steel ingots. Class assessment shall be made in accordance with Method A and JK series assessment diagrams in GB/T 10561 to non-metal inclusion in steel tubes.

For impurity inclusion of different categories of A, B, C and D, the most series shall apply. The class shall not be more than Class 2.5 respectively.

4.8 Surface quality

No defect of crack, folding, cutting, scar, de-lamination shall exist to inside or outside surface of steel tubes. Any of these defects shall be removed. The depth for defect removal shall not exceed minus deviation of nominal wall thickness. The actual wall thickness at the place of defect removal shall not be < allowable minimum value of the wall thickness.

The allowable depth of the straight line in inside or outside surface of steel tubes is as follows:

For cold drawn (rolled) tubes: $\nless 4\%$ of wall thickness, maximum depth $\nless 0.3\text{mm}$.

For hot rolled (extrude pressed, expanded) tubes: $\nless 5\%$ of wall thickness, maximum depth $\nless 0.5\text{ mm}$.

Other defects which do not exceed minus deviation of wall thickness are allowable.

4.9 Non-destructive inspection

Ultrasonic testing shall be made to steel tubes piece by piece in accordance with GB/ 5777. For class of longitudinal cut channel in outer surface of reference sample tubes, for cold drawn (rolled) tubes, C5 shall apply while for hot rolled (extrude pressed, expanded) steel tubes, C8 shall apply.

As agreed by both parties, other non-destructive inspections may also be done additionally.

5. Test Method

5.1 Size and profile of steel tubes shall be measured with measuring tools of which the precision meets requirement.

5.2 Visual inspection shall be made to inside and outside surfaces of steel tubes under sufficient illumination.

5.3 Other inspection of steel tubes shall meet what specified in Table 8.

Table 8 Test Items, Test Method and Quantity of Sampling for Steel Tubes

Sequence No.	Items to test	Test method	Quantity for sampling
1	Chemical composition	GB/T 222 GB/T 223 GB/ 4336	One sample for each furnace
2	Tensile test	GB/T 228	One sample respectively taken from two tubes of each batch
3	Impact test	GB/T 229	Three samples respectively taken from two tubes of each batch
4	Hydraulic test	GB/T 241	Piece by piece
5	Press-flat test	GB/T 246	One sample respectively taken from two tubes of each batch
6	Opening expansion test	GB/T 242	
7	Low-fold test	GB/T 226 GB/T 1979	
8	Non-metal inclusion	GB/T 10561	
9	Ultrasonic testing	GB/T 5777	Piece by piece
10	Eddy testing	GB/T 7735	
11	Leaking magnetic testing	GB/T 12606	

6. Rules for Inspection

6.1 Inspection and acceptance

The inspection and acceptance of steel tubes shall be done by the technical supervision department of the supplier.

6.2 Rules for batching

Steel tubes shall be inspected and accepted in batches. Steel tubes of same brand number, same furnace number, same specification and same heat treatment way shall make up one batch. Quantity of steel tubes in one batch shall not exceed what specified below:

OD $\geq$ 70mm, and wall thickness $\geq$ 3mm -----400 pieces

OD > 351mm, -----50 pieces

Other sizes -----200 pieces

6.3 Quantity for sampling

The quantity for sampling for different performance test of steel tubes shall meet what specified in Table 8.

6.4 Re-test and rules for judgement

The re-test and the rules for judgement of the re-test of steel tubes shall met what specified in GB/T 2102 and GB/T 17505

7. Packing, Marks and Quality Certificate

The packing, marks and quality certificate for steel tubes shall meet what specified in GB/T 2102.