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HG/T 3690-2012
In lieu of HG/T 3690-2001

Steel Mesh Reinforced Polyethylene (PE) Pipes for Industry

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Contents

Foreword 2

1 Scope 3

2 Normative References 3

3 Terms and Definitions 3

4 Raw Materials 6

5 Basic Performance 6

6 Requirements 10

7 Test Procedures 12

8 Inspection Regulations 13

9 Marking, Packing, Transportation and Storage 14

Foreword

This standard is prepared in accordance with GB/T 1.1-2009.

This standard is in lieu of *Steel Mesh Reinforced Polyethylene (PE) Pipes for Industry* (HG/T 3690-2001) and has the following technical changes:

- The pipe specification of DN600 is added along with its corresponding parameters (refer to Table 5.1);
- The nominal pressure product series are enriched, and the "common pipe series" and "thin walled pipe series" are replaced by the series divided as per pressure level (refer to Table 5.1);
- The structure of the table of specifications and dimensions are adjusted and determined per the product specifications and nominal pressure levels (refer to Table 5.1);
- The classification of "common pipes" and "thin walled pipes" with flange connection is replaced by that of "flange joint type" and "flange fitting type" (refer to Table 5.3).

This standard is proposed by China Petroleum and Chemical Industry Federation.

This standard is under centralized management of Technical Committee on Non-metal Chemical Equipment of Standardization Administration of the People's Republic of China (SAC/TC162).

This standard is prepared by China Chemical Standardization Institute, Huachuang Tianyuan Industrial Development Co., Ltd., and Harbin Starway Machinery Manufacturing Co., Ltd.

This standard is mainly drafted by Li Peng, Liu Jishui, Liu Huafeng, Niu Mingchang, Mei Jian, Wang Xiaobing, and Zhou Wei.

This standard is initially published in January, 2002, and this is the first revision.

Steel Mesh Reinforced Polyethylene (PE) Pipes for Industry

1 Scope

This standard specifies the raw materials, basic performance, requirements, test procedures, inspection regulations, marking, packing, transportation and storage for steel mesh reinforced polyethylene (PE) pipes for industry (hereinafter referred to as "pipes" or "pipe").

This standard applies to pipes that are continuously extruded and molded with polyethylene as the base and steel mesh as reinforcement, and can be used in petroleum, chemical, pharmacy, metallurgical, mining, ship building, municipal construction and food industries, etc. The operating temperature of the media conveyed by the pipes is from 0℃ to 70℃.

2 Normative References

The following documents are essential for the application of this document. For the references with specified dates, only the editions of the specified dates are applicable to this document; for the references without specified dates, the latest editions (including all the amendments) are applicable to this document.

GB/T 1033.1-2008 *Plastics—Methods for Determining the Density of Non-cellular Plastics—Part 1: Immersion Method, Liquid Pycnometer Method and Titration Method*

GB/T 2828.1-2003 *Sampling Procedures for Inspection by Attributes—Part1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-lot Inspection*

GB/T 2918-1998 *Plastics—Standard Atmospheres for Conditioning and Testing*

GB/T 3681-2000 *Plastics—Test Method of Exposure to Weathering*

GB/T 6111-2003 *Thermoplastics Pipes for the Conveyance of Fluids—Resistance to Internal Pressure—Test Method*

GB/T 6283-2008 *Chemical Products—Determination of Water—Karlf Ischer Method (General Method)*

GB/T 6671-2001 *Thermoplastics Pipes—Determination of Longitudinal Reversion*

GB/T 8806-2008 *Plastics Piping Systems - Plastics Components - Determination of Dimensions*

GB/T 13021-1991 *Determination for the Carbon Black Content of Polyethylene Pipes and Fittings by Calcination and Pyrolysis*

GB 15558.1-2003 *Buried Polyethylene (PE) Piping Systems for the Supply of Gaseous Fuels—Part 1: Pipes*

GB/T 17391-1998 *Test method for Thermal Stability of Polyethylene Pipes and Fittings*

HG-T 3691-2012 *Fittings of Steel Mesh Reinforced Polyethylene (PE) Pipes for Industry*

QB/T 2803-2006 *Determination of Deflection for Rigid Plastic Pipes*

YB/T 5294-2009 *Low Carbon Steel Wire for General Uses*

3 Terms and Definitions

For purposes of this standard, the following terms and definitions apply:

Nominal pressure

PN

The maximum allowable operating pressure of the pipe at 20℃ for the conveyance of water, in MPa

4 Raw Materials

4.1 Polyethylene

4.1.1 Special Polyethylene Material

Polyethylene for molded pipes must be premixed special material for pipes, the basic performance of which shall meet the regulations in Table 1.

Table 1: Basic Performance of Special Polyethylene Material

Item	Performance requirement
Density/ (kg/m^3)	≥9
Moisture content/ (mg/kg)	<300
Volatile content/ (mg/kg)	<350
Carbon black content/ %	2~5
Thermal stability (200℃)/ min	>20
ESCR (environmental stress crack resistance) (100℃, 100%, F_0)/ h	≥1 000
Resistance to gas composition (80℃, 2 MPa)/ h	≥300
LTHS (Long term hydrostatic strength) (20℃, 50 years, 95%)/ MPa	≥8.0
Note: the carbon black content is only applicable to black pipes, and the resistance to gas composition is only applicable to fuel gas pipes.	

4.1.2 Recyclable Polyethylene Material

The clean excess material generated during production of pipes according to this standard and the scraps of commissioning and cutting processes can be recycled into fresh materials as per a proportion of not more than 5% after being crushed and re-prilled to produce pipes meeting the requirements of this standard.

4.2 Steel Wire Selection

4.2.1 Low carbon steel wire for general uses is generally used as the steel wire of the steel mesh, which is delivered in the state of SZ galvanized/copper plated steel wire. Subject to the requirement, low carbon alloy steel or structural steel wire with better performance can also be used.

4.2.2 Specifications, Dimensional Deviations and Performance

4.2.2.1 The tensile strength of the latitude steel wire is not less than 400MPa.

4.2.2.2 The steel wire below Φ3.0 (including Φ3.0) must not have any bending with a radius of less than 30mm; the steel wire above Φ3.0 must not have any bending with a radius of less than 60mm. Other dimensions and performance shall be in accordance with YB/T 5294-2009.

4.2.3 Surface Coating

The galvanized or copper coating on the surface of the steel wire shall be uniform without peeling or skip of plating. The coating surface shall be smooth without dirt like oil stain and dust accumulation.

4.2.4 Grid of Steel Wire

Refer to Table 2 for the grid density and the diameter of the steel wire. The manufacturer can make design adjustments according to the process requirements, but the burst strength of the pipe after adjustments shall not be lower than the regulations in Table 8.

Table 2: Pipe Grid Density and Steel Wire Diameter Unit: mm

Nominal inner diameter *DN*	Grid density ≤	Steel wire diameter d ≥	
		Longitudinal wire	Transverse wire
50	9×9	2.0	2.5
65	9×9	2.0	2.5
80	9×9	2.0	2.5
100	9×9	2.0	2.5
125	9×9	2.0	2.5
150	9×9	2.0	2.5
200	9×9	2.0	2.5
250	9×9	2.0	2.5
300	9×9	2.5	3.0
350	12×12	3.0	3.5
400	12×12		3.5
450	12×12		
500	12×12	3.0	3.5
600	12×12	3.5	3.5

5 Basic Performances

5.1 Nominal Pressure, Nominal Inner Diameter and Wall Thickness Dimensions

The nominal pressure of the pipe is classified into five series: *PN*1.0, *PN*1.6, *PN*2.0, *PN*2.5 and *PN*4.0. The nominal inner diameter, dimension deviation of wall thickness of the pipe and the distance from the steel wire to the inner and outer walls shall be in accordance with Table 3.

Table 3: Pipe Specifications and Dimensions

Nominal inner diameter *DN* /mm	Allowable relative deviation /%	Nominal pressure *PN*/MPa					Distance from steel wire to inner and outer walls /mm
		1.0	1.6	2.0	2.5	4.0	
		Pipe body wall thickness[a] and limit deviation/mm					
50	±1	——	——	——	$9.0_0^{+1.4}$	$10.\ _0$	⩾2.0
65		——	——	——	$9.0_0^{+1.4}$	$10.6_0^{1.6}$	
80		——	——	——	$9.0_0^{+1.4}$	$11.7_0^{1.8}$	
100		——	$9.0_0^{+1.4}$	$9.0_0^{+1.4}$	$11.7_0^{1.8}$	$12.2_0^{1.8}$	
125		——	$10.0_0^{+1.5}$	$10.0_0^{+1.5}$	$11.8_0^{1.8}$	$12.3_0^{1.8}$	
150		——	$12.0_0^{+1.8}$	$12.0_0^{+1.8}$	$12.5_0^{+1.9}$	$\ _0^{2.6}$	
200	±0.8	——	$12.0_0^{+1.8}$	$12.5_0^{+1.9}$	$\ ^{1.9}$	——	⩾3.0
250		$12.0_0^{+1.8}$	$12.5_0^{+1.9}$	$13.0_0^{+2.}$	13.0_0	——	
300		$12.5_0^{+1.9}$	$12.5_0^{+1.9}$	$14.\ _0^{2.2}$	——	——	
350	±0.5	$15.0_0^{+2.4}$	$15.0_0^{+2.4}$	$\ _0^{+2.6}$	——	——	⩾3.0
400		$15.0_0^{+2.4}$	$15.0_0^{+2.4}$	$1\ .6$	——	——	
450		$15.5_0^{+2.6}$	$16.0_0^{+2.6}$	16.5_0	——	——	
500		$15.5_0^{+2.6}$	$1\ .6$	$16.5_0^{+2.6}$	——	——	
600		$19.0_0^{+3.0}$	20.0_0	——	——	——	

[a] The pipe body refers to the pa[illegible] the pipe b[illegible] all the internal [illegible]e. The dimensions of the pipe end of socket or flange joint [illegible]uctures shall be dete[illegible]d upon the re[illegible]irement of connection, but its wall thickness shall not be les[illegible]n 95% of that of the body.

5.2 Temperature Co[illegible]ect[illegible] Nominal Pressure

5.2.1 Temperatu[illegible] Correctio[illegible]fficient

The nom[illegible]inal p[illegible]essure shall b[illegible]rected for the pipe conveying media above 20℃. The correction method is [illegible] multiple the nominal pre[illegible] values specified in Table 3 by the corresponding temperature correc[illegible]ion [illegible]cient specified in Table 4.

Table 4: Tem[illegible]ure Correction Coeffici[illegible]t for Nominal Pressure

Tempera[illegible] t/℃	0<t⩽20	20<t⩽30	30<t⩽40	40<t⩽50	50<t⩽60	60<t⩽70
[illegible]ominal p[illegible]essure correc[illegible] coefficient	1.00	0.95	0.90	0.86	0.81	0.76

5.2.2 Nom[illegible] Pressure Correction Method for the Conveyance of Special Media

5.2.2.1 In cas[illegible]edia conveyed by the pipe have chemical actions to the polyethylene material, such as corrosion and [illegible]xidization, refer to the chemical corrosive properties of the media and determine the reduction coefficient accordingly.

5.2.2.2 The conveyance of special hazardous media must be in accordance with relevant laws and regulations.

5.3 Pipe Connection Method

5.3.1 There are two connection methods for the pipe, i.e. flange connection and electro fusion connection, corresponding to different pipe end structures.

Pipe outer diameter

5.3.2 Flange Connection

5.3.2.1 There are two types of flange connection: one is to prefabricate flange joint at the pipe end, and the other is to use special flange fitting.

5.3.2.2 The structure of the prefabricated flange joint at the pipe end is as shown in Figure 1. Refer to Table 5 for the specifications and dimensions.

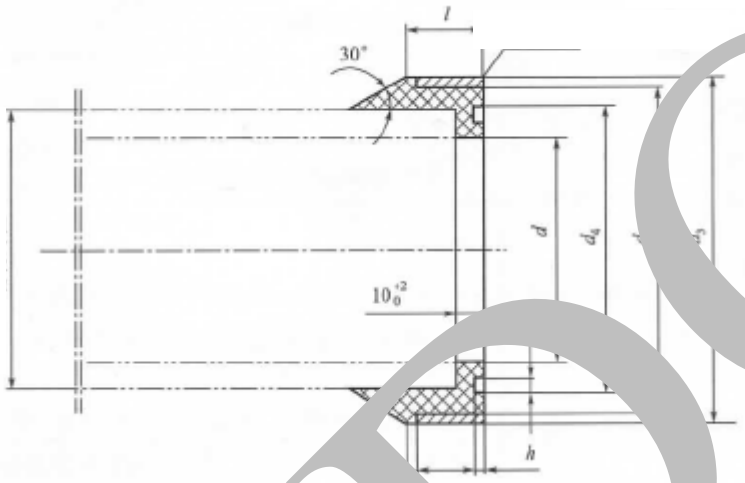

Figure 1: Structural Schematic [illegible]refabricated Flange [illegible]int

Table 5: Specifications and Dimensions [illegible] Prefabricated [illegible]e Joint at Pipe [illegible]nd

Unit: mm

Nominal inner diameter *DN*	d	d_1	d_3	d_4	l	h	b	O ring (inner diameter× sectional diameter)
50	50	[illegible]	97	79	35	4.15±[illegible]	7.10±0.15	69×5.30
65	65	10[illegible]	[illegible]3	90	35	4.15±0.1[illegible]	7.10±0.15	80×5.30
80	80	122	[illegible]	105	35	4.15±0.[illegible]0	7.10±0.15	95×5.30
100	100	146	152	[illegible]	35	4.15±0.10	7.10±0.15	115×5.30
[illegible]	125	173	179	[illegible]	[illegible]5	[illegible].15±0.10	7.10±0.15	145×5.30
150	150	199	205	175	[illegible]	4.15±0.10	7.10±0.15	165×5.30
200	[illegible]0	250	256	227	35	4.15±0.10	7.10±0.15	218×5.30
250	[illegible]	305	311	285	41	5.45±0.10	9.45±0.20	272×7.00
300	300	[illegible]5	361	335	41	5.45±0.10	9.45±0.20	325×7.00
35[illegible]	350	4[illegible]	422	385	50	5.45±0.10	9.45±0.20	375×7.00
[illegible]	400	4[illegible]4	472	435	55	5.45±0.10	9.45±0.20	425×7.00
4[illegible]	450	520	528	485	60	5.45±0.10	9.45±0.20	475×7.00
500	[illegible]00	572	580	540	65	5.45±0.10	9.45±0.20	530×7.00
600	600	670	678	640	95	5.45±0.10	9.45±0.20	630×7.00

5.3.2.3 Select to use or not to use the reinforcement hoop in the design based on the temperature and pressure of the conveyed media.

5.3.2.4 If other sealing components are used, select the suitable processing type of the sealing surface according to relevant standards.

5.3.2.5 If a special flange fitting is used for connection, the flange fitting shall be in conformity with HG/T

3691-2012. The pipe end shall be in conformity with the requirements for electro fusion connection.

5.3.3 Electro Fusion **Connection**

5.3.3.1 There are two types of pipe end structures for electro fusion connection according to the insertion methods, i.e. plain end and coned end structures.

5.3.3.2 The plain end structure is as shown in Figure 2. Refer to Table 6 for the specifications and dimensions.

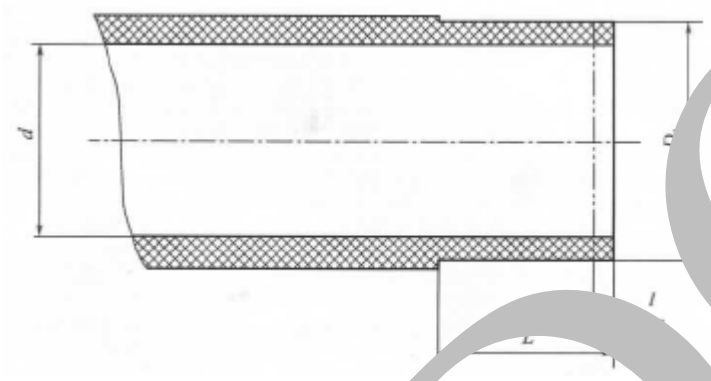

Figure 2: Plain End Structure

Table 6: Specifications and Dimensions of Plain End for Electro Fusion Connection

Unit: mm

Nominal inner diameter	d	Outer diameter of electro fusion area D_1 (possible for secondary processing)	Length of electro fusion area L	Sealing thickness
50		71.00±0.20	75±5	6~10
65		86.00±0.20	75±5	
80		103.00±0.25	85±5	
100		125.00±0.25	90±5	
125		140.00±0.30	100±5	
150		173.10±0.35	110±5	
200		224.40±0.45	115±5	
250		273.80±0.40	130±5	
300		324.00±0.50	150±5	
600		641.50±0.50	255±5	10~15

5.3.3.3 The coned end structure is as shown in Figure 3. Refer to Table 7 for the specifications and dimensions.

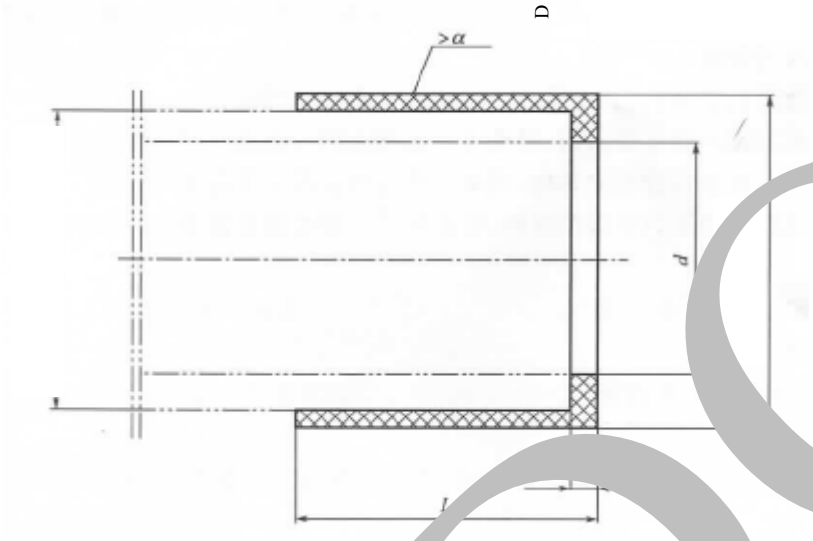

Figure 3: Coned End Structure

Table 7: Specifications and Dimensions of Coned Pipe End for Electrofusion Connection

Unit: mm

Nominal inner diameter *DN*	d	Outer diameter of coned (small end) D	Length of coned end L	α
50	50	[illegible]	100	30’
65	[illegible]	$80^{-}_{-1.}$	100	30’
80	[illegible]	$104^{-0.3}_{-1.3}$	100	30’
100	100	$125^{-0.3}_{-1.3}$	100	30’
125	125	$152^{-0.3}_{-1.3}$	100	30’
150	150	182±0.5	110	30’
[illegible]	200	23[illegible]±0.5	120	30’
250	250	284±0.5	130	30’
300	300	334±0.5	150	30’
350	350	390±0.5	160	1°
400	[illegible]	440±0.5	170	1°
[illegible]50	4[illegible]	492±0.5	180	1°
[illegible]00	5[illegible]0	542±0.5	190	1°

5.4 Pipe Len[illegible]

The standa[illegible] length of the pipe includes 6m, 8m, 10m and 12m with an allowable deviation of $_{0}^{+20}$mm. The length can also be determined by the Supplier and the Client through discussion.

6 Requirements

6.1 Color

The color of the pipe is usually black, but it can also be determined by the Supplier and the Client through discussion based on the uses of the pipe.

6.2 Appearance

6.2.1 The inner surface of the pipe shall be smooth without obvious scratches or decomposition decoloration lines. The outer surface of the pipe is allowed to be threaded in natural contraction state. Partial slight roughness due to natural contraction is allowable; however, obvious scratches, air bubbles, impurities and uneven color, etc. are not allowed. The two ends of the pipe shall be cut smooth and vertical to the axis of the pipe.

6.2.2 The surface of the molded section of the flange joint for flange connection or of the [illegible]oned or plain pipe end for electro fusion connection shall be smooth without defects like pits, scratches and burr.

6.3 Specifications, Dimensions and Dimensional Deviations

6.3.1 The specifications and dimensional tolerances of pipes of different nominal pressure values shall be in accordance with Table 3.

6.3.2 The structure, specifications and dimensions of the prefabricated flange joint shall be in accordance with Figure 1 and Table 5.

6.3.3 The structure, specifications and dimensions of the plain pipe end for electro fusion connection shall be in accordance with Figure 2 and Table 6.

6.3.4 The structure, specifications and dimensions of the [illegible]oned pipe end for [illegible] fusion connection shall be in accordance with Figure 3 and Table 7.

6.4 Roundness

The roundness deviation of the pipe shall not exceed [illegible]DN.

6.5 Physical and Mechanical Performance

The physical and mechanical performance of the pipe shall be in accordance with Table 8.

Table 8: Physical and Mechanical Performance

Sn.	Item		Performance requirement	Test method
1	Crack stability under pressure		Without cracks	Refer to 7.12.1
2	Longitudinal dimension shrinkage (1h at 110℃)		≤0.4%	Refer to 7.12.2
3	Short-term hydrostatic strength test	Temperature: 20℃; test duration: 1h; pressure: 1.5 times of the nominal pressure	Without cracking or leakage	Refer to 7.12.3
		Temperature: 70℃; test duration: [illegible]; pressure: 1.5×0.76 times of nominal pressure	Without cracking or leakage	Refer to 7.12.3
4	[illegible] strength	Temperature: 20℃; pressure rise till the pipe bursts within 60s-70s	The burst pressure is not lower than 3 times of the nominal pressure	Refer to 7.12.3
5	Weathering test (after the pipe receives accumulative aging energy of not less than 3.5GJ/m^2)		The pipe still meets the performance requirements specified in Item 3 in the Table and maintains good welding performance	Refer to 7.12.4

6.6 Bending Degree

The bending degree of the pipe shall be in accordance with Table 9.

Table 9: Bending Degree

Nominal inner diameter *DN*/mm	50	65	80	100	125	150	200	250	300	350	400	450	500	600
Bending degree /%	≤2.00		≤1.20			≤1.00		≤0.80		≤0.60				
Note: the bending degree refers to that in the same direction. S shaped bending is not allowed.														

6.7 Special Industries

The application of the pipe to special industries e.g. food and pharmacy industries shall be in accordance with relevant national laws and regulations.

7 Test Procedures

7.1 Standard Atmospheres for Conditioning and Testing

The standard atmospheres for conditioning and testing shall be in accordance with GB/T 2918-1998. The temperature is (23±2)℃, and the conditioning duration is not less than 24h.

7.2 Appearance Inspection

The appearance can be visually inspected, and the inner wall can be observed against light using a light source.

7.3 Determination of Geometric Dimensions

7.3.1 Pipe Length

Measure the length of the pipe using the general measuring tool with a precision within 1mm.

7.3.2 Inner and Outer Diameters

Measure the inner and outer diameters of the pipe in accordance with GB/T 8806-2008.

7.3.3 Wall Thickness

Measure the wall thickness in accordance with GB/T 8806-2008.

7.3.4 Other Dimensions

Measure the other dimensions using the measuring tool with a precision within 0.02mm.

7.4 Determination of Roundness

Measure the maximum and minimum inner diameters on the same section using the measuring tool with a precision within 1mm. The difference between the two diameters is the roundness deviation of the p

7.5 Determination of Bending Degree

The bending degree shall be in accordance with QB/T 2803-2006.

7.6 Determination of Density

The density shall be in accordance with GB/T 1033.1-2008.

7.7 Determination of Moisture Content

Determine the moisture content in accordance with GB/T 6283-2008. The samples are not subject to conditioning.

7.8 Determination of Volatile Content

Determine the volatile content in accordance with Annex C in GB 15558.1-2003.

7.9 Determination of Carbon Black Content

Determine the carbon black content in accordance with GB/T 13021-1991.

7.10 Thermal Stability Test

Determine the thermal stability in accordance with GB/T 17391-1998.

7.11 Determination of Resistance to Gas Composition

Determine the resistance to gas composition in accordance with Annex D in GB 15558.1-2003.

7.12 Determination of Physical and Mechanical Performance

7.12.1 Test of Crack Stability under Pressure

Take a pipe sample with a length of 100±10mm for test. Place the sample between the pressing plates of the hydraulic machine, slowly press it down to 50% of the diameter of the pipe in 10-15s, and maintain the pressure for 10 minutes. It is considered qualified if there is no crack on the pipe.

7.12.2 Determination of Longitudinal Reversion

Determine the longitudinal reversion in accordance with GB/T 6671-2001

7.12.3 Short-term Hydrostatic Strength Test and Burst Strength Test

Conduct short-term hydrostatic strength test and burst strength test in accordance with GB/T 6111-2003. The test temperature, duration and pressure shall be in accordance with Table 8. Refer to Figure 4 for the tooling arrangement.

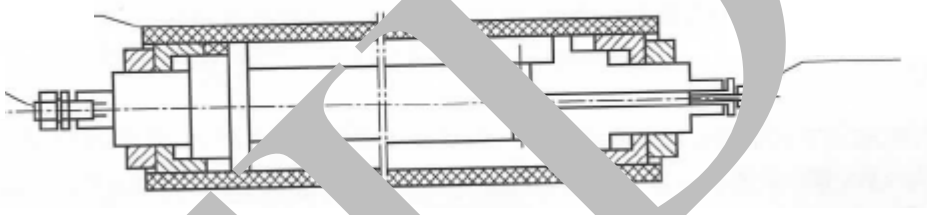

Figure 4: Hydrostatic Strength Test Method

7.12.4 Weathering Test

Conduct weathering test in accordance with GB/T 3[illegible]2000.

8 Inspection Regulations

8.1 General

The products can be delivered only after passing inspection by the quality inspection department of the manufacturer and shall be provided with a Quality Certificate.

8.2 Types of Inspection

There are delivery inspection and type inspection.

8.3 Delivery Inspection

8.3.1 Items of Delivery Inspection

The items of delivery inspection include what is specified in Articles 6.1, 6.2, 6.3, 6.4, 6.6 and longitudinal reversion and short-term hydrostatic strength test at 20℃ specified in Article 6.5.

8.3.2 Batching Sampling

The pipes with the same specifications produced with the same raw materials, formula and process are considered as the same batch. Each batch has a quantity of not more than 200t, and if it does not reach 200t within the production period of 30d, the yield within these 30d is taken as one batch. Conduct sampling in accordance with GB/T 2828.1-2003. The normal inspection primary sampling scheme is employed with the general inspection level IL=I and acceptance quality limit AQL=6.5. Refer to Table 10 for the sampling scheme.

Table 10: Sampling Scheme

Unit: piece

Range of batch *N*	Sample size *n*	Acceptance number A_e	Rejection number R_e
≤150	8	1	2
151~280	13	2	3
281~500	20	3	4
501~1200	32	5	6
1201~3200	50	7	8
3201~10000	80	10	11

8.3.3 Determination Criteria

Take sufficient samples randomly from the qualified products of sampling inspection by attributes, and conduct short-term hydrostatic strength test and longitudinal reversion tests specified in Article 6.5. If disqualified products are found, take samples again of twice the number and conduct the tests again. If there are still disqualified ones, the batch is determined as disqualified.

8.4 Type Inspection

8.4.1 Items of Type Inspection

The items of type inspection include all the items specified in this standard.

8.4.2 Preconditions for Type Inspection

Type inspection shall be conducted in case of any one of the following:

a) Major changes in raw materials and process, which may affect the performance of the products;

b) At least once in a year during normal production;

c) Resumption of production after more than six months' suspension;

d) Big differences between the results of delivery inspection and those of type inspection;

e) Request for type inspection by the national quality supervision authorities.

8.4.3 Sampling and Determination

Determine the items in Articles 6.2, 6.3, 6.4 and 6.5 in accordance with Table 10. If one item in Article 6.5 fails to reach the requirement, take samples randomly of twice the number to test again. If there is still any disqualified item, the batch is determined as disqualified.

9 Marking, Packing, Transportation and Storage

9.1 Marking

The pipes shall be marked with the following information upon delivery:

a) Nominal inside diameter and length;

b) Nominal pressure;

Connection method (F: flange connection; D: electro fusion connection);

Name of manufacturer or trademark;

e) Number of this standard;

f) Date of production or batch number.

9.2 Packing

Suitable protection measures shall be taken for the pipe end faces of the prefabricated flange joints to prevent damage to the sealing surfaces.

9.3 Transportation

During transportation, the pipes shall not be subject to severe impact, scratched by sharp objects or thrown.

9.4 Storage

The pipes shall be stored at places with a temperature of generally not more than 40℃ and away from heat sources. The pipes shall not be exposed to sunshine for long. The storage yards shall be clean and leveled. In case of outdoor stacking, covering shall be provided. The stacking height is preferred to be not more than 1.5m.

HG/T 3690-2012

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of the People's Republic of China

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