PASCAL®

Fiberglass Reinforced Plastic (FRP) Ground Pipe

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1. Classification and Definition

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  - Epoxy fiberglass ground pipe
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    - Fiberglass reinforced plastic mortar pipe

I. Product Introduction

1. Classification and Definition

Epoxy fiberglass ground pipe

The high-strength fiberglass without twist yarn is used as the reinforcing material, and epoxy resin is used as the matrix material. The composite material pipe is formed by winding.

✓ Production range:

Maximum diameter: DN900

Maximum pressure: 34.5MPa

✓ Classification:

Anhydride epoxy fiberglass pipeline: conventional temperature resistance ≤65.5℃

Amine epoxy fiberglass pipeline: conventional temperature resistance ≤93.3℃

(Note: Separate design is required for other temperature resistance levels)

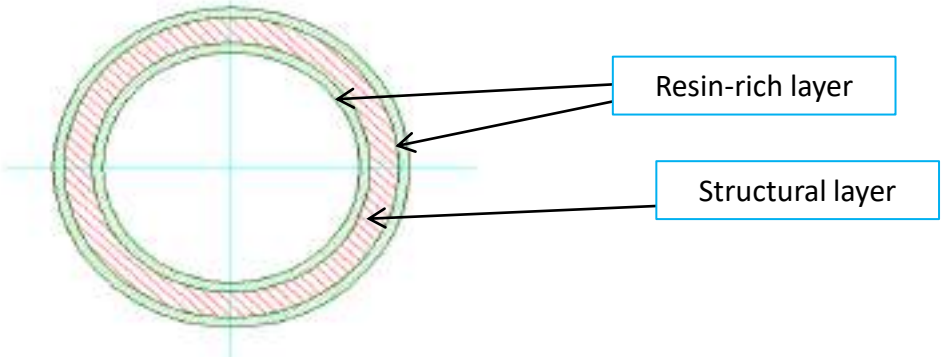
I. Product Introduction

1. Classification and Definition

- The epoxy fiberglass ground pipe is usually composed of a structural layer and a resin-rich layer formed on the inner and outer surfaces of the pipe during solidification, and generally does not require the production of a lining layer.

Resin-rich layer: corrosion resistance, preventing aging of the pipe;

Structural layer: strength layer, bearing the load of the pipe;



I. Product Introduction

1. Classification and Definition

Polyester fiberglass process pipe

The fiberglass and its products are used as reinforcing materials, and unsaturated polyester resin (including ordinary unsaturated polyester resin, bisphenol A unsaturated polyester resin, and vinyl ester resin) is used as the matrix material. The composite material pipe is formed by winding.

✓ Production range:

Maximum diameter: DN4000

Maximum pressure: 2.5MPa

Temperature resistance: conventional temperature resistance level ≤90℃

(Note: Separate design is required for other temperature resistance levels)

I. Product Introduction

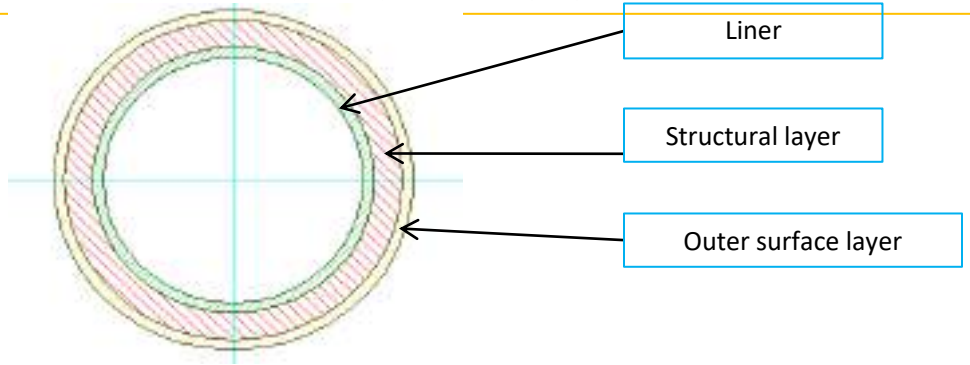
1. Classification and Definition

- The polyester fiberglass process pipe usually consists of a lining layer, a structural layer, and an outer surface layer.

Lining layer: corrosion resistance and leak prevention;

Structural layer: strength layer, bearing the load of the pipe;

Outer surface layer: protective layer, protecting and preventing aging of the pipeline.



I. Product Introduction

1. Classification and Definition

Fiberglass reinforced plastic mortar pipe

The fiberglass reinforced plastic mortar pipe is a type of pipe made using fiberglass and its products as the reinforcing material, unsaturated polyester resin (including ordinary unsaturated polyester resin, bisphenol A unsaturated polyester resin, and vinyl ester resin) as the matrix material, and quartz sand as the filler through the fiber winding process.

✓ Production range:

Maximum range: DN4000

Maximum pressure: 2.5MPa

Stiffness level: 5000-10000N/m^2。 (Higher stiffness levels can be designed)

I. Product Introduction

1. Classification and Definition

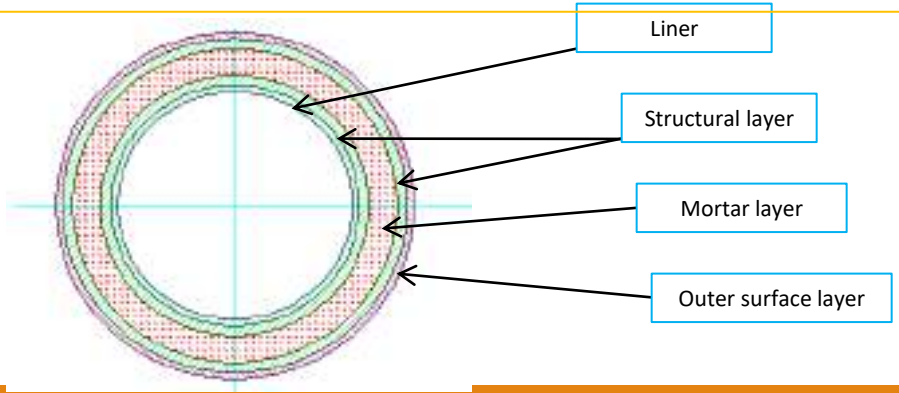
- The fiberglass reinforced plastic mortar pipes usually consist of an inner lining layer, structural layer, mortar layer, and outer surface layer.

Lining layer: corrosion resistance and leak prevention;

Structural layer: strength layer, bearing the load of the pipe;

Mortar layer: for increasing pipe stiffness and reducing cost.

Outer surface layer: protective layer, protecting and preventing aging of the pipeline.



I. Product Introduction

2. Product Standards

- Epoxy fiberglass ground pipe:

  SY/T 6267-2018 High-pressure fiberglass line pipe (equivalent to API 15HR-2016)

  SY/T 6266-2004 Low pressure fiberglass line pipe and fittings (equivalent to API 15LR-2001)

  ISO 14692-2017 Fiberglass reinforced plastic pipe

- Polyester fiberglass process pipe:

  JC/T 552-2011 Filament-wound thermosetting resin pressured pipe

- Fiberglass reinforced plastic mortar pipe:

  GB/T 21238-2016 Fiberglass Reinforced Plastic Mortar Pipes

I. Product Introduction

3. Product Characteristics

➢Corrosion resistance: Corrosion resistance is a prominent advantage of fiberglass reinforced plastic pipes. By selecting suitable materials, it can meet the requirements of different types, concentrations, and temperatures of transportation, with long service life and outstanding comprehensive benefits.

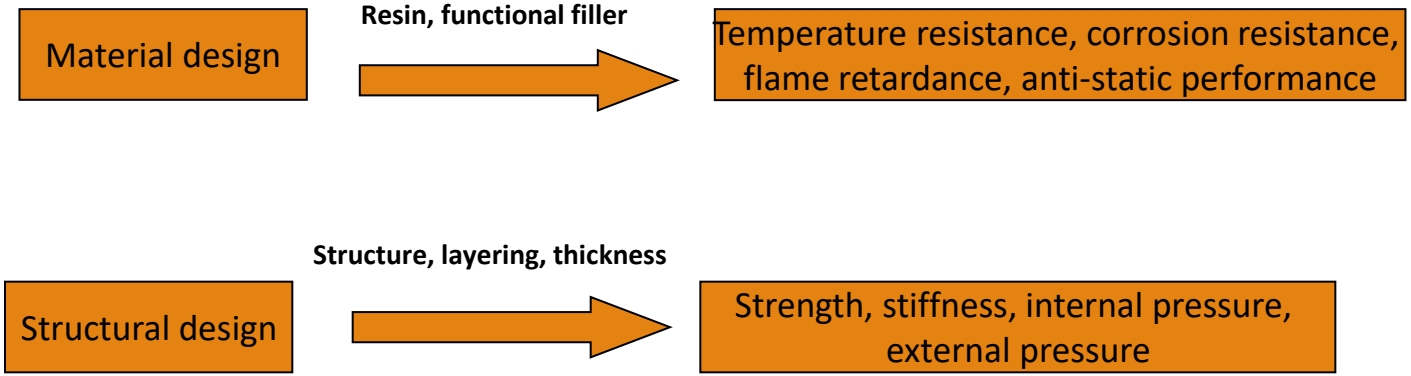
➢Water protection: The product is chemically stable and does not cause secondary pollution to the transport medium.

Xin 38X113 well Comparison between fiberglass reinforced plastic pipes and steel pipes

I. Product Introduction

3. Product Characteristics

➢Designable performance, strong applicability of products: Fiberglass reinforced plastic pipes can meet the needs of different media and operating conditions through reasonable material and structural design.



I. Product Introduction

3. Product Characteristics

➢Good hydraulic performance: The inner wall of the fiberglass reinforced plastic pipe is smooth, not easy to scale or wax, and does not adhere to microorganisms, with low flow resistance. In the case of the same flow rate, the pressure drop is 0.85 times that of a steel pipe. The use of fiberglass pipes can increase flow and reduce energy consumption.

Pipe type	Fiberglass pipe
Roughness/mm	0.01

Smooth inner wall, low flow resistance

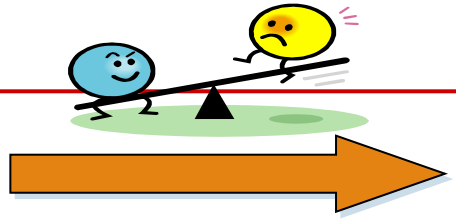
Pipe type	New steel pipe
Roughness/mm	0.1

I. Product Introduction

3. Product Characteristics

➢Lightweight and easy to install: The weight of fiberglass reinforced plastic pipelines of the same specifications is about 40% of that of steel pipes, and the larger the pipe diameter is, the smaller the proportion will be. During installation, small and medium-diameter fiberglass reinforced plastic pipelines generally do not require heavy machinery and can be manually transported and installed easily.

Steel pipe
7.8 g/cm^3



Convenient transportation, easy to install

Fiberglass pipe
1.9 g/cm^3

I. Product Introduction

3. Product Characteristics

➢Low thermal conductivity: The thermal conductivity is only 0.6% of steel pipes, therefore the product has better insulation performance and can reduce heat energy loss during transportation, and reduce insulation costs.

➢Excellent insulation performance: With a volume resistivity of $10^{14}\Omega\bullet cm$, the product is made of electrical insulation materials, suitable for electrical insulation fields.

Pipe type	Fiberglass pipe
Thermal conductivity: W/(m·℃)	0.4

Reducing heat energy loss

Pipe type	New steel pipe
Thermal conductivity: W/(m·℃)	62.8

I. Product Introduction

4. Applicable Operating Conditions

- Epoxy fiberglass ground pipe:

Oil, gas and water mixture transport in petroleum, petrochemical and other areas.

- Polyester fiberglass process pipe:

Used in Oilfields, chemical industry, municipal engineering, water conservancy, etc.

- Fiberglass reinforced plastic mortar pipe:

Oil field, chemical industry, municipal, water conservancy, power station, etc.

Municipal engineering

Chemical industry

Electric power

Water conservancy

Desalination

Nuclear power

I. Product Introduction

4. Applicable Operating Conditions

In addition, fiberglass reinforced plastic pipes can be used for the following parts of LNG receiving stations:

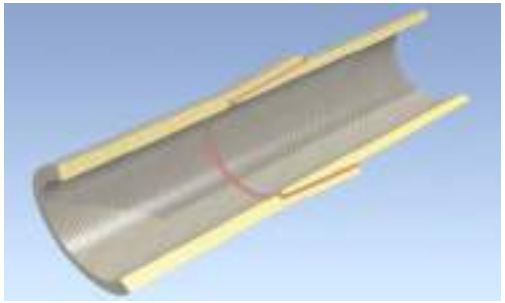
- Sea water heat exchange pipe (tank farm)
- Fire pipe (tank farm to pier)

No.	Pipe type	Pipe material	Common specifications	Pressure rating
1	Fiberglass reinforced plastic heat exchange pipe	Polyester (GRP)	DN100-2200	1.0MPa
2	Fiberglass reinforced plastic fire protection pipe	Epoxy (GRE)	DN25-DN600	2.0MPa

I. Product Introduction

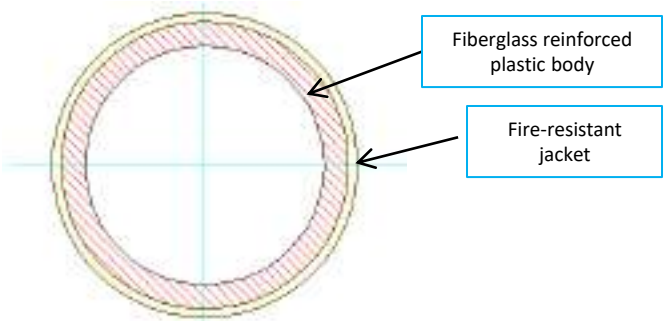
4. Applicable Operating Conditions

Product	Fire rating	Common range	Pressure rating	Applications
GRE ordinary fire protection pipe	L3	DN25-600	2.0MPa	External transmission or buried fire protection pipe
GRE jacket fire pipe	JF/L1	DN25-600	2.0MPa	Station overhead fire pipe
GRP seawater heat exchange pipe	N/A	DN100-2200	1.0MPa	Sea water heat exchange pipe



GRE pipe connection method
(Taper adhesive)

GRP pipe connection method
(Socket connection)



Fire-resistant jacket pipe structure

4. Applicable Operating Conditions

Comparison Table of Fire Test Methods				
Fire rating	**Testing Standard**	**Flame Condition**	**Combustion Environment**	**Medium in the Pipe and Combustion Time**
L3	IMO A.753(18)	1100℃ flame	Open	Residual water, 30 min
JF-20	OTI 95634 Jet Fire	1200℃ spray flame	Open	Let the water flow for 15min after drying the pipe for 5min
JF-30	OTI 95634 Jet Fire	1200℃ spray flame	Open	Let the water flow for 25min after drying the pipe for 5min
L1	IMO A.753(18)	1100℃ furnace fire	Enclosed	Dry nitrogen, 1 hour

L3 fire resistance test

JF fire resistance test

L1 fire resistance test

4. Applicable Operating Conditions

L3 fire test report
Far East Fire Testing Centre in Shanghai

JF-20 fire test report
Southwest Research Institute (USA)

JF-30 fire test report
NBL Laboratory (Norway)

L1 fire test report
Bureau Veritas (French)

5. Comparison with Competitive Products

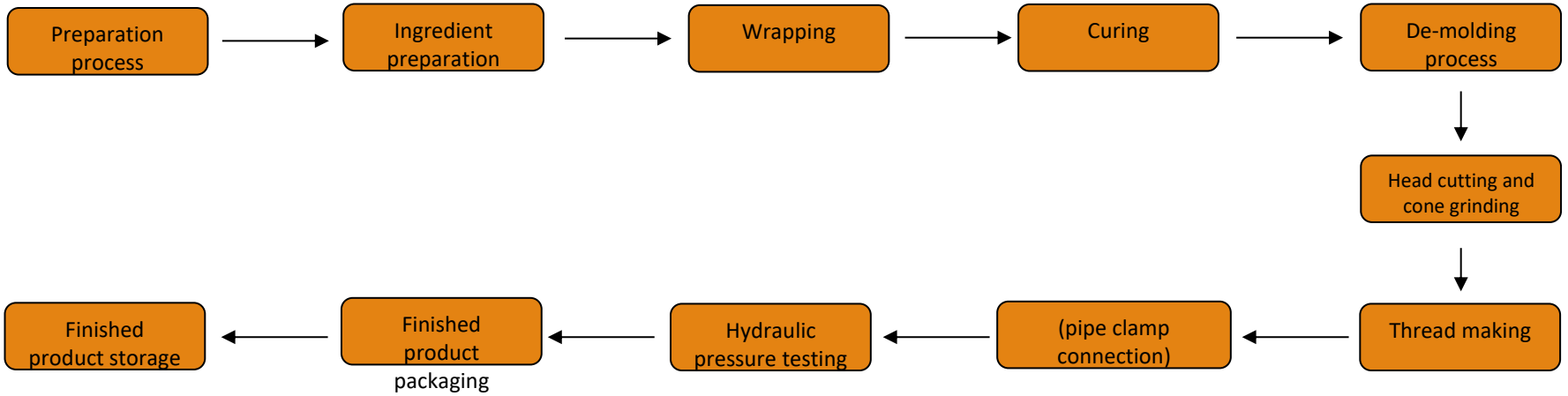
Comparison between Fiberglass Reinforced Plastic Ground Pipes and Ordinary Steel Pipes

Item	Advantages	Disadvantages
Mechanical property	Higher specific strength	Slightly poorer impact resistance
Corrosion resistance	Excellent corrosion resistance	/
Service life	Under the same operating conditions, the service life can reach twice that of steel pipes	/
Maintenance	Maintenance-free	A professional team is required for emergency repairs
Economic efficiency	The comprehensive economic efficiency is better than that of steel pipes	Slightly higher product prices

II. Product Manufacturing

1. Manufacturing Process

- Epoxy fiberglass ground pipe:



Process flow diagram of epoxy fiberglass ground pipe production

II. Product Manufacturing

1. Manufacturing Process

Winding

Solidification

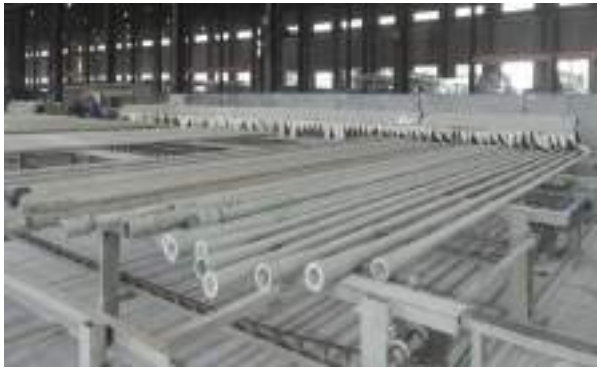
De-molding

II. Product Manufacturing

1. Manufacturing Process

Cutting

Grinding cores



Thread making

II. Product Manufacturing

1. Manufacturing Process

Hydraulic pressure testing

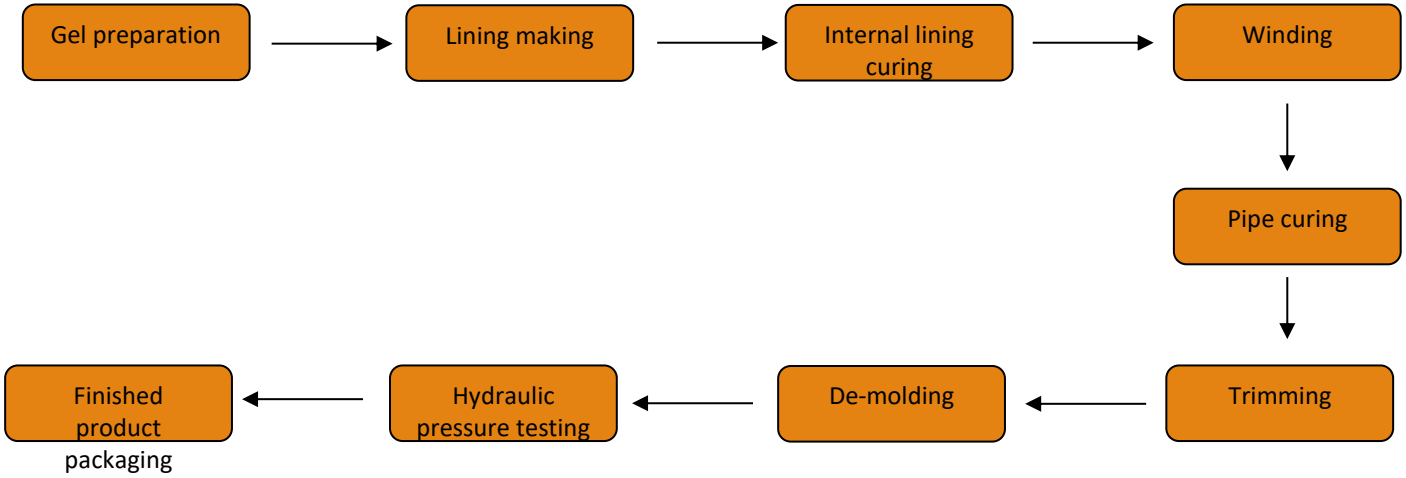
Finished product packaging

Finished product storage

II. Product Manufacturing

1. Manufacturing Process

- Polyester fiberglass ground pipe:



Process Flow Diagram of Polyester Fiberglass Ground Pipe Production

II. Product Manufacturing

1. Manufacturing Process

Lining making

Internal lining curing

Winding

II. Product Manufacturing

1. Manufacturing Process

Pipe curing

Trimming and de-molding

II. Product Manufacturing

2. Product Capacity Information

- High-pressure pipe plant: production of epoxy fiberglass pipelines and fittings;

25 winding lines for pipes and 10 winding lines for fittings, with an annual production capacity of up to 4,000 km.

Product specifications: ≤DN900.

- Low-pressure pipe plant: production of polyester fiberglass pipes and fittings;

8 winding lines for pipes and hand lay-up for fittings, with an annual production capacity of up to 300 km.

Product specifications: ≤DN4000.

II. Product Manufacturing

3. Factory Inspection

- The factory inspection items for epoxy fiberglass ground pipes (based on the SY/T 6267 standard) include:

No.	Inspection item	Indicator
1	1.5 times static water pressure	Maintain 1.5 times the design pressure for 2 minutes without leakage
2	Short-term failure pressure	≥2.5 times pipeline pressure rating
3	Glass transition temperature	Acid anhydride pipe Tg ≥ 115℃ Amine pipe Tg ≥ 140℃
4	Visual inspection	Comply with product inspection specifications
5	Dimensions:	The pipe and thread meet the standard requirements

Note: The above items have covered the inspection requirements of SY/T6266 standard.

Unidirectional thread measuring instrument

Differential scanning calorimeter

Hydrostatic pressure testing machine

II. Product Manufacturing

3. Factory Inspection

- The factory inspection items for polyester fiberglass process pipes (based on JC552) include:

No.	Inspection item	Indicator
1	Static water pressure test	Maintain 1.5 times the design pressure for 2 minutes without leakage
2	Barcol hardness	≥40
3	Visual inspection	Comply with product inspection specifications
4	Dimensions:	Comply with product inspection specifications

Barcol hardness tester

Hydrostatic pressure testing machine

II. Product Manufacturing

3. Factory Inspection

➢ The factory inspection items for fiberglass reinforced plastic mortar pipes (based on GB/T21238) include:

No.	Inspection item	Indicator
1	Visual quality	Comply with product inspection specifications
2	Dimensions:	Comply with product inspection specifications
3	Barcol hardness	≥40
4	Insoluble content in the resin	≥90%
5	Component content of a straight pipe section wall	Deviation: ≤ ± 3%
6	Initial mechanical properties	Comply with product inspection specifications
7	Static water pressure test	Maintain 1.5 times the design pressure for 2 minutes without leakage

Hydrostatic pressure testing machine

Universal testing machine

II. Product Manufacturing

4. Model and Specification

- Epoxy fiberglass ground pipe:

Nominal diameter (mm)	Recommended Connection	Maximum design pressure (MPa)	Mature application pressure (MPa)	Withstand temperature
DN40	API thread	34.5	25	Acid anhydride: conventional temperature resistance ≤ 65.5℃ Amines: conventional temperature resistance ≤ 93.3℃ (Note: other temperature resistance levels need to be evaluated and designed separately)
DN50-DN65		25		
DN80-DN100		25	22	
DN150		16	12	
DN200		14	10	
DN250-DN300	2. Trapezoidal thread	8.6	8.6	
DN400-DN500	Taper bonded	4.0	2.5	
DN600-DN700		3.5	1.6	
DN800-DN900		2.5	1.0	

II. Product Manufacturing

4. Model and Specification

- Polyester fiberglass process pipe:

Nominal diameter (mm)	Recommended Connection	Maximum design pressure (MPa)	Mature application pressure (MPa)	Withstand temperature
DN150-DN350	Flat butt joint	2.5	2.5	Conventional temperature resistance level ≤ 90℃ (Note: other temperature resistance levels need to be evaluated and designed separately)
DN400-DN600	Socket joint (locking) flat butt joint	2.5	2.5	
DN700-DN900		1.6	1.6	
DN1000-DN1600		1.0	1.0	

II. Product Manufacturing

4. Model and Specification

- Fiberglass reinforced plastic mortar pipe:

Nominal diameter (mm)	Recommended Connection	Maximum design pressure (MPa)	Mature application pressure (MPa)	Withstand temperature
DN400-DN1600	Socket joint (locking)	1.0	1.0	Conventional temperature resistance ≤ 50℃ (Note: other temperature resistance levels need to be evaluated and designed separately)
DN1600-DN2200		1.0	0.6	
DN2200-DN4000		1.0	0.4	

III. Handling, Storage and Transportation

1. Packaging

No.	Packaging Requirements for Epoxy fiberglass ground pipes (≤DN200)	Remarks
1	Pipe end protection with threaded caps to prevent damage to the pipe ends and threads;	Other pipelines do not require special packaging.
2	Wooden spacers between each layer of pipes, with the thickened areas of the pipe end staggered;	
3	Packing and fastening with 5 wooden spacers, with a stacking height not exceeding 2m.	
4	Pipe fittings should be packaged with bubble film, at least 2 layers.	

III. Handling, Storage and Transportation

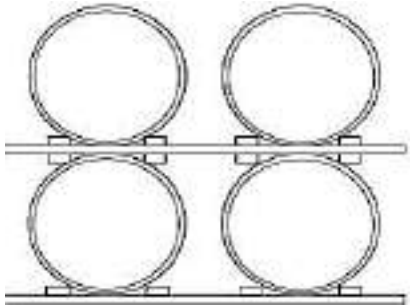
2. Transportation

Item	Basic requirements
Trailer	Flatbed trailer, cargo truck
Tying	Tying with soft ropes or soft straps is advisable; metal ropes such as steel wire or chains are not allowed
Transshipment	At least four supports between each layer of pipes, with a total height not exceeding 2m;
Transporting	Securely fixed to avoid friction and collision that may cause pipe damage.

III. Handling, Storage and Transportation

3. Storage

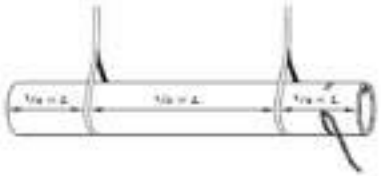
Item	Basic requirements
Stacking height	≤2m
Number of support points	≥4
Support plate width	≥90mm
Distribution of support points	Even
Product protection	Pipe end protection with threaded caps and other protective measures
Installation materials	Rubber gaskets, thread sealing grease, adhesive for sun protection and anti-freezing, away from heat sources.



III. Handling, Storage and Transportation

4. Handling

No.	Basic requirements
1	When using a forklift for handling, the fork should be provided with rubber protection;
2	Recommended lifting method: two-point lifting;
3	Use soft and flexible belts, slings, or ropes for lifting, with a minimum width of 19cm;
4	It is forbidden to use a single rope to pass through both ends or to use hooks of any material to handle the pipe.



Single pipe handling

IV. Construction and Installation

1. Connection Method:

API thread

2. Trapezoidal thread

Socket connection

Socket locking

Taper bonded

Flat butt joint

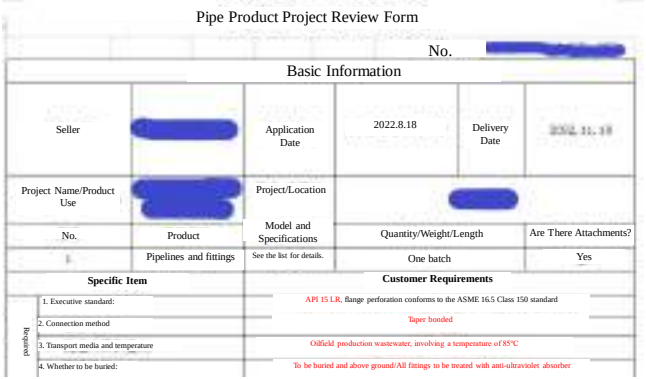
Flange connection

IV. Construction and Installation

1. Connection Method:

Flange connection precautions

Flange connection is mainly used for connecting metal flanges on process equipment, valves, and pipes. Gaskets need to be placed between flanges to achieve sealing through tightening bolts. Flange opening sizes are divided into American standard (ASME B16.5 Class150/300/600) and national standard (0.25MPa/0.6MPa/1.0MPa/1.6MPa/2.5MPa/4.0MPa/6.3MPa/10MPa/16MPa). Be sure to confirm the standard and pressure level corresponding to the opening size.



Pipe Product Project Review Form

No. [redacted]

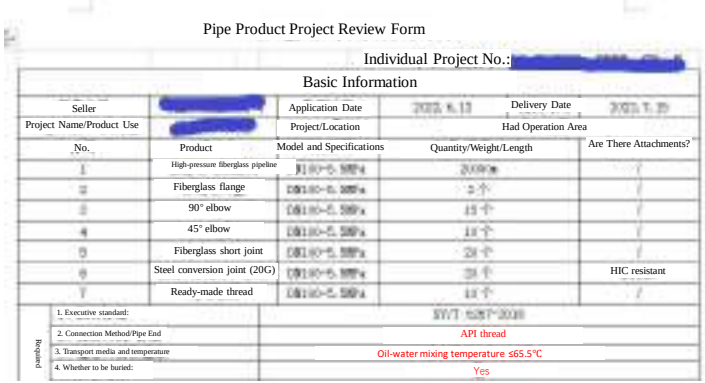
Basic Information

Seller	[redacted]	Application Date	2022.8.18	Delivery Date	[redacted]
Project Name/Product Use	[redacted]	Project/Location	[redacted]		
No.	Product	Model and Specifications	Quantity/Weight/Length		Are There Attachments?
1	Pipelines and fittings	See the list for details.	One batch		Yes

Specific Item	Customer Requirements
1. Executive standard:	API 15 LR, flange perforation conforms to the ASME 16.5 Class 150 standard
2. Connection method	Taper bonded
3. Transport media and temperature	Oilfield production wastewater, involving a temperature of 85℃
4. Whether to be buried:	To be buried and above ground/All fittings to be treated with anti-ultraviolet absorber

Background

✓



Pipe Product Project Review Form

Individual Project No.: [redacted]

Basic Information

Seller	[redacted]	Application Date	[redacted]	Delivery Date	[redacted]
Project Name/Product Use	[redacted]	Project/Location	[redacted]	Had Operation Area	
No.	Product	Model and Specifications	Quantity/Weight/Length		Are There Attachments?
1	High-pressure fiberglass pipeline	[redacted]	[redacted]		/
2	Fiberglass flange	[redacted]	[redacted]		/
3	90° elbow	[redacted]	[redacted]		/
4	45° elbow	[redacted]	[redacted]		/
5	Fiberglass short joint	[redacted]	[redacted]		/
6	Steel conversion joint (20G)	[redacted]	[redacted]		HIC resistant
7	Ready-made thread	[redacted]	[redacted]		/

1. Executive standard:	[redacted]
2. Connection Method/Pipe End	API thread
3. Transport media and temperature	Oil-water mixing temperature ≤65.5℃
4. Whether to be buried:	Yes

Background

✗

IV. Construction and Installation

2. Construction and Installation

➢ Related specifications

- SY/T 6769.1-2010 Specifications for the design, construction and acceptance of non-metallic pipelines—Part 1: High pressure fiberglass reinforced plastic line pipes
- SY/T 6419-2009 (API 15TL4) Care and use of fiberglass tubulars
- Fiberglass Pipe Installation Manual

➢ Precautions

- Pipe trench excavation: reaching the design depth, with a flat trench bottom and free of large rocks;
- Pipeline connection: Pay attention to the direction of the socket pointing to the flow direction of the medium;
- Connection with the steel pipe: the fiberglass male thread is connected with the metal female thread;
- Before the pressure test: Fix the buried piers and stop blocks according to the design and cover the pipe body with sufficient soil to prevent pipeline displacement;
- Pressure test: Exhaust the air, prohibit using gas pressure test, and recommend the test pressure to be 1.25 times the working pressure of the pipeline.

Construction site

On-site pressure test

IV. Construction and Installation

3. Maintenance and Rush Repair

According to statistics, the failure modes of fiberglass pipelines mainly include: pipe body perforation, fracture, joint leakage, and detachment.

Pipe body perforation

Pipe body fracture

Joint leakage

Joint detachment

IV. Construction and Installation

3. Maintenance and Rush Repair

Applicable scope of various emergency repairs

No.	Maintenance method	Applications	Remarks
1	Pressure plugging repair with pressure (plugging tape + plugging rod + hand lay-up)	1. Damage form: pipe body perforation or joint leakage, with the diameter of the leaking part not exceeding 2cm; 2. Operating pressure ≤ 16MPa; 3. Plugging pressure ≤ 0.2MPa; 4. Non-stop production maintenance.	Not applicable to pipe body tearing and joint detachment
2	Epoxy resin hand lay-up repair	1. Damage form: pipe body perforation, fracture, joint leakage, and detachment are all available; 2. Operating pressure ≤ 16MPa; 3. Shutdown maintenance.	The operation is difficult and the pressure is high, which is prone to maintenance failure.
3	Adhesive pipe clamp emergency repair	1. Damage form: pipe body perforation, fracture, joint leakage, and detachment are all available; 2. Operating pressure ≤ 16MPa, pipe diameter: ≤200mm; 3. Shutdown maintenance.	Long excavation distance
4	On-site thread and steel conversion emergency repair	1. Damage form: pipe body perforation, fracture, joint leakage, and detachment are all available; 2. All specifications of high-pressure fiberglass pipelines; 3. Shutdown maintenance.	Metal component repair, involving a low cost

Remarks:

1. For pipe body perforation and joint leakage, pressure plugging repair is preferred;

2. For pipe body tearing and joint detachment that cannot be repaired under pressure, other repair methods should be selected.

V. Application Cases

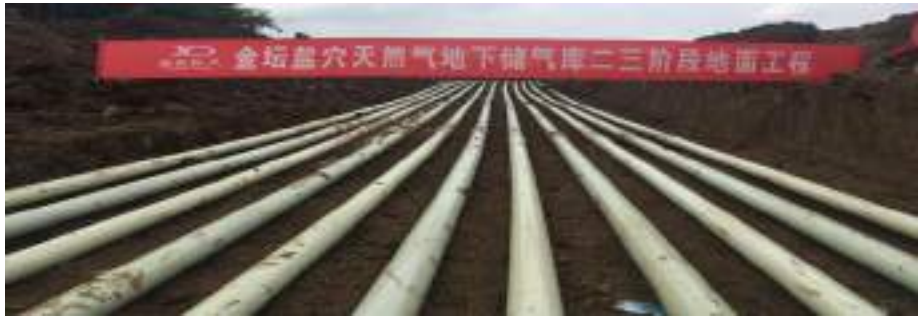
1. Application Cases

- Epoxy fiberglass ground pipe:

In 2015, the Salt Cave Natural Gas Underground Storage Tank Water Injection and Brine Extraction Pipe project in Jintan was implemented.

Specification: DN150-12MPa epoxy fiberglass ground pipe

Transport medium: brine, temperature 60℃



V. Application Cases

1. Application Cases

- Epoxy fiberglass ground pipe:

In 2019, the Shunbei Block of the Tahe Oilfield H_2S-containing oil, gas and water mixed transportation project was implemented.

Pipeline specification: DN200-7MPa

Transport media: oil, gas and water

H_2S content: 1.8%;

Medium temperature: 70℃.

V. Application Cases

1. Application Cases

- Epoxy fiberglass ground pipe:

In 2020, the fire pipeline project of the Jiangsu Rudong LNG receiving station of CNOOC was implemented: fire protection level: L1/L3; transport medium: seawater/clear water; pipeline specification: DN50-DN450, PN1.6MPa.

V. Application Cases

1. Application Cases

- Epoxy fiberglass ground pipe:

In 2021, the fire protection pipeline project of the Jiangsu Binhai LNG receiving station of CNOOC was implemented: fire protection level: L3; transport medium: seawater/clear water; pipeline specification: DN100-DN600, PN2.0MPa.

V. Application Cases

1. Application Cases

- Polyester fiberglass process pipe:

In 2016, the Chunfeng Oil Production Plant Oil-containing Sewage Resource Utilization Treatment Station Project of Sinopec was implemented Polyester fiberglass process pipeline network (underground, ground, overhead, valve group, insulation), with more than a thousand pipe fittings and over 3700 interfaces

Specification: DN50-DN700, PN1.6MPa.

V. Application Cases

1. Application Cases

- Fiberglass reinforced plastic mortar pipe:

FRP Pipeline Project for Seawater Desulfuration in Shandong Rizhao Electric Power Plant
Model and Specification: DN1400, SN10000N/m^2

Circulating Water/Cooling Water Fiberglass Pipe Engineering Project of Shengli Power Plant, China Sinopec
Model and Specification: DN1600, SN10000N/m^2

Thank you!