

PE Gas Pipeline System

I. Scope of Application

Buried polyethylene (PE) pipelines and steel-mesh skeleton PE composite pipelines for gas are suitable for buried urban gas pipeline systems with an operating temperature of **-20°C to 40°C** and a maximum allowable operating pressure not exceeding **0.7MPa**. Suitable types of gas for transportation include:

1. Natural gas; such as pure natural gas, associated petroleum gas, mine gas, etc.;
2. Liquefied petroleum gas (LPG);
3. Artificial coal gas; such as: coke oven gas, water gas, oil gas, blast furnace gas, etc.;
4. Biogas.

II. Pipeline Connection

2.1 Main connection methods for pipelines:

1. Hot-melt butt fusion;
2. Electrofusion connection;
3. Steel-plastic transition joint connection or flange connection, etc.

Note: PE gas pipes and fittings with a diameter $\geq 90\text{mm}$ can be connected by hot-melt butt fusion or electrofusion; PE gas pipes and fittings with a diameter $< 90\text{mm}$ should preferably use electrofusion connection; connection with pipes and pipeline accessories of other materials such as metal must adopt steel-plastic transition joint connection or flange connection.

2.2 Hot-melt butt fusion:

2.2.1 Operating Steps:

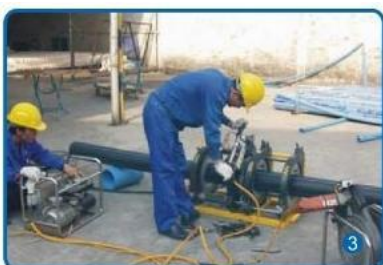
When using this method, a hot-melt butt welding machine is used. The main steps are as follows:



1. Debug the butt welding machine and related tools to ensure normal operation.



2. Place the pipes to be connected on the welding machine clamp and clamp them tight. Clean the connecting ends of the pipes and use a planing tool to mill the connecting faces. Align the two connecting parts so that the misalignment is no more than 10% of the pipe wall thickness



3. After the heating plate temperature reaches the set required temperature, place the heating plate in for heating.



4. After heating is completed, remove the heating plate, quickly start the hydraulic pump pressure to join the heated surfaces of the two pipes, and increase the pressure to the fusion pressure for pressure-holding cooling.



5. After cooling for the specified time, open the clamps and remove the pipe from the rack, observe the curled bead to determine the connection quality, and the connection is complete.

- [Note: Please refer to original document for operational photos.]

2.2.2 Methods for inspecting hot-melt butt fusion quality:

1. The determination of hot-melt butt fusion quality relies mainly on non-destructive visual inspection of the welding bead. This usually includes a visual check of the bead geometry and cutting off the bead, bending it backwards to confirm whether there is incomplete fusion.
2. The application of ultrasonic testing and X-ray testing abroad.
3. Destructive testing. Cut the interface separately for tensile tests, bending tests, tensile creep tests, etc.

2.2.3 Precautions for hot-melt butt fusion:

1. Must comply with the operating procedures and precautions of the butt fusion machine;
2. Operators must wear gloves, work clothes, and take self-protection measures to avoid electric shock or burns;

3. The heating plate surface and the connecting end faces of the fittings must be kept clean;
4. The butt fusion pressure must be adjusted to the actual required value on site;
5. Open flames must not be used to heat PE pipes;
6. During welding, the interface must be protected from contact with sand, soil, and rain.

2.3 Electrofusion connection:

2.3.1 Operating Steps:

Electrofusion connection uses an electrofusion welding machine. Its characteristics are convenient and rapid connection with minimal interference from external factors. It is more economical in small-diameter pipelines, difficult construction, and maintenance scenarios. The main steps are:



1. Clean the dirt on the pipe and connecting surface, and mark the insertion depth.



2. Scrape off the oxidized skin on the surface of the pipe connecting end (generally within a range of about half the length of the sleeve).



3. Take the electrofusion fitting out of the intact packaging bag, sleeve it onto the pipe connecting end up to the limit block, keep the electrode joints facing upwards, fix the pipe on the rack, and align the fitting to ensure it is on the same axis.



4. Set the electrofusion machine connection parameters according to the identification instructions on the fitting. Plug in the electrode plug, power on, fuse for the specified time, and observe the changes in the indicator pin in the fitting signal



5. After cooling for the specified time, the electrode plug can be disconnected for the next connection.

- [Note: Please refer to original document for operational photos.]

2.3.2 Methods for inspecting electrofusion connection quality:

1. The determination of electrofusion connection quality relies mainly on non-destructive visual inspection of the electrofusion interface. This usually includes checking for scraping marks, exudation of melt and heating wires, changes in the signal eye indicator pin, and checking fitting alignment lines.
2. Destructive testing. Cut out the interface separately for peel tests, tensile tests, impact tests, and hydraulic tests, etc.

2.3.3 Precautions for electrofusion connection:

1. The voltage and heating time selected during energized heating for connection should comply with the regulations of the electrofusion machine manufacturer;
2. The interface and fittings must be clean during installation and fusion, and must not come into contact with rain or accumulated water in the trench;
3. During the cooling period of the electrofusion connection, the connection must not be moved, nor should any external force be applied to the fittings;
4. The plastic packaging bag of the electrofusion fitting must only be removed immediately before welding.
5. When performing connection operations in cold weather (below -5°C) and windy environments, protective measures should be taken or construction process parameters adjusted.

2.4 Transition connection:

The interface between the PE gas pipe and metal pipes and pipeline accessories (such as gas valves, gas meters, etc.) must be connected using transition fittings such as steel-plastic transition joints or flanges.

- [Note: Please refer to original document for Flange Transition Connection Diagram.]

2.4.1 Steel-plastic transition joint connection:

The connection between the PE pipe end of the steel-plastic transition joint and the PE pipeline shall comply with the corresponding electrofusion connection or hot-melt butt fusion operating procedures.

The connection between the steel pipe end of the steel-plastic transition joint and the metal pipeline shall comply with the corresponding steel pipe welding, flange connection, or mechanical connection regulations.

All steel-plastic transition joints should be installed according to the manufacturer's guidelines and should have anti-corrosion protection.

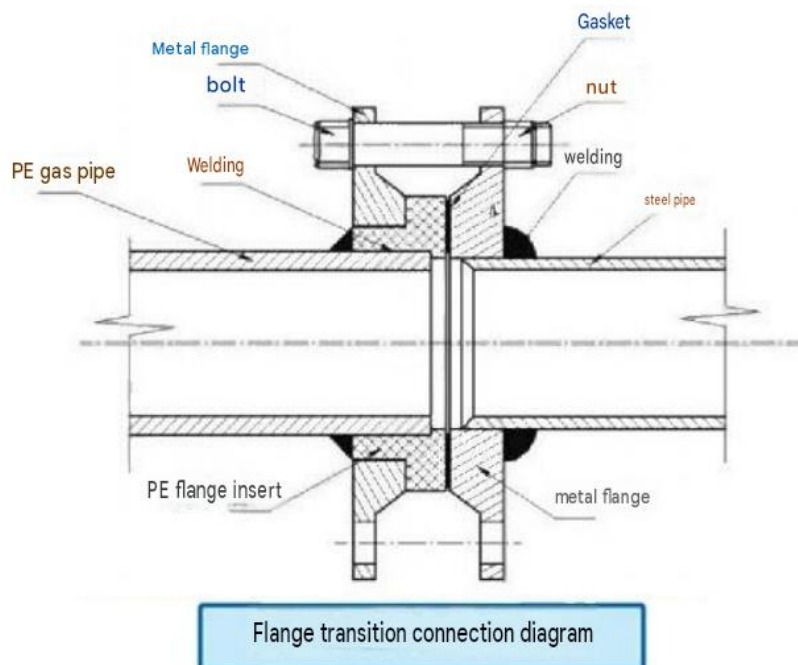
When welding the steel pipe end of the steel-plastic transition joint with a steel pipe, cooling measures should be taken.

2.4.2 Flange connection:

The flange interface should use suitable physical joints or gaskets.

All metal flanges should have anti-corrosion protection.

The sealing surface of the PE flange should be protected before installation to avoid damage.



III. Pipeline Design

3.1 General Regulations

3.1.1 The pressure design of gas pipelines is divided into 7 levels:

Name	Level	Pressure (MPa)
High-pressure gas pipeline	A	$2.5 < p \leq 4.0$
	B	$1.6 < p \leq 2.5$
Sub-high pressure gas pipeline	A	$0.8 < p \leq 1.6$
	B	$0.4 < p \leq 0.8$
Medium-pressure gas pipeline	A	$0.2 < p \leq 0.4$
	B	$0.01 \leq p \leq 0.20$
Low-pressure gas pipeline		$p < 0.01$

3.1.2 Polyethylene gas pipelines are divided into SDR11 and SDR17 series, suitable for medium and low-pressure gas pipeline systems. The SDR11 series is suitable for transporting artificial

coal gas, natural gas, and liquefied petroleum gas (gaseous); the SDR17 series is suitable for transporting natural gas. The quality of the transported gas must comply with current national standards.

3.1.3 The maximum allowable operating pressure for transporting different types of gas should comply with the following table:

Maximum Allowable Operating Pressure of PE Pipelines (MPa)

Urban Gas Type	PE80 SDR11	PE80 SDR17	PE100 SDR11	PE100 SDR17
Natural Gas	0.50	0.30	0.70	0.40
Others	Refer to CJJ63-2008			

Maximum Allowable Operating Pressure of Steel-Mesh Skeleton PE Composite Pipelines (MPa)

Urban Gas Type	Max Allowable Operating Pressure DN≤200mm	Max Allowable Operating Pressure DN>200mm
Natural Gas	0.7	0.5
Others	Refer to CJJ63-2008	

Note: SDR is the Standard Dimension Ratio, i.e., the ratio of nominal outside diameter to wall thickness.

3.1.4 When PE gas pipelines transport gas composed of other components, it must be fully demonstrated. After safety performance is guaranteed, the allowable operating pressure can be determined by referencing similar gas types above. When transporting artificial coal gas containing no condensate, the operating pressure is appropriately increased but should not exceed 0.2MPa; when transporting gaseous LPG containing no condensate, the operating pressure can be appropriately increased, but should not exceed 0.3MPa.

3.1.5 When the operating temperature of PE pipelines and steel-mesh skeleton PE composite pipelines is above 20°C, the maximum allowable operating pressure shall be reduced according to the reduction coefficient for the operating pressure. The pressure reduction coefficient shall comply with the regulations in Table 3.1.5:

Table 3.1.5 Pressure Reduction Coefficient Based on Operating Temperature

Operating Temp (t)	-20°C < t ≤ 20°C	20°C < t ≤ 30°C	30°C < t ≤ 40°C
Pressure Reduction Coefficient	1.00	0.90	0.76

Note: The operating temperature in the table refers to the highest monthly average temperature of the pipeline operating environment.

3.2 Pipeline Calculation

3.2.1 The determination of the calculated flow rate of PE gas pipelines shall comply with the provisions of Articles 6.2.1 and 6.2.2 of the current national standard "Code for Design of City Gas Engineering" (GB50028-2006).

3.2.2 The calculation of frictional resistance loss per unit length of low and medium-pressure PE gas pipelines shall comply with Articles 6.2.5 and 6.2.6 of (GB50028-2006). The frictional resistance coefficient should be determined by the following formulas:

1. Laminar flow state: $Re \leq 2100$

$$\lambda = 64/Re$$

$$Re = \frac{\rho \cdot v \cdot d}{\mu}$$

2. Critical state: $2100 < Re \leq 3500$

$$\lambda = 0.03 + \frac{Re - 2100}{65Re - 10^3}$$

3. Flow state: $Re > 3500$

$$\lambda = 0.11 \left(\frac{6}{Re} \right)^{1/4}$$

Where: λ - the frictional resistance coefficient of the polyethylene gas pipeline

d - Inner diameter of polyethylene gas pipeline (mm);

The equivalent absolute roughness (mm) of the inner surface of a k-polyeth

Re - Reynolds number;

Calculated flow velocity (m/s) for V-polyethylene gas pipelines;

The kinematic viscosity (m^2/s) of the gas at μ -0°C and 10

3.2.3 The allowable pressure drop for medium-pressure pipelines can be determined by the difference between the inlet pressure of that level pipeline and the minimum allowable inlet pressure of the secondary network pressure regulator. The flow velocity should not exceed 5m/s.

3.2.4 The local resistance loss of PE gas pipelines and the allowable pipeline resistance loss from the low-pressure pipeline from the pressure regulating station to the farthest gas appliance shall comply with Articles 6.2.7 and 6.2.8 of (GB50028-2006).

3.3 Pipeline Layout

3.3.1 The layout and construction of buried PE gas pipelines shall comply with the relevant provisions of the industry standard "Technical Specification for Polyethylene Gas Pipeline Engineering" (CJJ63-2008).

3.3.2 PE gas pipelines must not cross under buildings and large structures; must not cross under sites where flammable, explosive materials and corrosive liquids are piled; and must not be laid in the same trench as other pipelines or cables.

3.3.3 The horizontal clearance between PE gas pipelines and heating pipes should not be less than the provisions in the table below. The horizontal clearance with foundations of other buildings, structures, or adjacent pipelines should comply with (GB50028-2006).

Horizontal Clearance Between PE Gas Pipelines and Heating Pipes

Heating Pipe Type	Clearance (m)	Notes
$t < 150^\circ\text{C}$ Direct buried heating pipe - Heating pipe - Return water pipe	3.0 2.0	Gas pipe burial depth < 2m
$t < 150^\circ\text{C}$ Hot water heating trench Steam heating trench	1.5	
$t < 280^\circ\text{C}$ Steam heating trench	3.0	PE pipe operating pressure $\leq 0.1\text{MPa}$, burial depth < 2m

3.3.4 The vertical clearance between PE gas pipelines and various underground pipelines or facilities should not be less than the provisions in the table below.

Vertical Clearance Between PE Gas Pipelines and Underground Facilities

Name	Clearance (m): PE pipe above facility	Clearance (m): PE pipe below facility
Water supply pipe	0.15	0.15
Gas pipe	0.15	0.15
Drainage pipe	0.15	0.20 (with casing)
Cable (Direct buried)	0.50	0.50
Cable (In conduit)	0.20	0.20
Heating Pipeline ($t < 150^{\circ}\text{C}$ Direct buried)	0.50 (with casing)	1.30 (with casing)
Heating Pipeline ($t < 150^{\circ}\text{C}$ Hot water/steam trench)	0.20 (with casing) or 0.40	0.30 (with casing)
Heating Pipeline ($t < 280^{\circ}\text{C}$ Steam trench)	1.00 (with casing, can be reduced with cooling)	Not allowed
Railway rail bottom		1.20 (with casing)

3.3.5 The minimum soil cover thickness on top of the buried PE gas pipeline should comply with the following:

1. Not less than 0.8m when buried under carriageways;
2. Not less than 0.6m when buried under non-carriageways;
3. Not less than 0.8m when buried under paddy fields.

3.3.6 The foundation for PE gas pipelines should preferably be undisturbed soil without sharp hard rocks and salts. If present, fine sand or soil should be laid. For sections that may cause uneven pipeline settlement, the foundation should be treated.

3.3.7 When transporting gas containing condensate, PE gas pipelines should be buried below the soil freezing line and equipped with a condensate trap. The slope towards the trap should not be less than 0.003.

3.3.8 Sectional valves should be installed on medium-pressure PE gas trunk lines, with blowdown pipes on both sides of the valve. Valves should be installed at the starting point of medium-pressure branches. Low-pressure pipelines may not require valves. Valves should preferably be in valve wells.

3.3.9 PE gas pipelines should not be directly introduced into buildings or regulator boxes attached to walls. When done, the portion crossing the foundation/wall and above ground must be protected by rigid casing.

3.3.10 PE gas pipelines should not directly cross river bottoms. With casing or protection, crossing should comply with (GB50028-2006).

3.3.11 Buried PE gas pipelines are strictly prohibited from being used for exposed installation above ground indoors. They are only for buried use.

IV. Transportation and Storage of Pipes and Fittings

4.1 When moving pipes and fittings, non-metallic ropes must be used for hoisting. Handle with care, do not drop or subject to severe impact, and avoid contact with sharp objects.

4.2 Pipes and fittings should be stored in well-ventilated warehouses or simple sheds, protected from exposure to sun and rain; temporary storage should be covered; do not come into contact with oils, acids, alkalis, salts, and other chemicals. Stacking height should not exceed 1.5m.

4.3 Pipes of different diameters and wall thicknesses should be stacked separately. If restricted, larger diameter and thicker wall pipes should be placed at the bottom and marked.