

±3 °C.

The serial number of welding joint shall be displayed before and during welding. The control system may be internally installed with standards of welding process parameters in accordance with TSG D2002-2006 or other standards assessed by welding process. Welding parameters executive standard shall be displayed on the screen before welding starts. During welding process, the screen directly displays the corresponding display value and preset value of each parameter in each stage. The welding parameters shall include flanging pressure, endothermic pressure and cooling pressure, flanging time (or flanging displacement), endothermic time, changeover time, pressurization time and cooling time at least.

The parameters shall be locked automatically and the welding process shall be performed correctly and automatically from flanging phase to cooling phase.

Once the monitoring welding process begins, data shall not be inputted or modified.

5.7.9 Monitoring and alarm

When welding parameters are out of specified range or abnormal during the whole welding process, the control system may interrupt and record these informations in the welding process at the specified time, then display the fault type, and give the audible and/or visual alarm signal. The welding machine shall have the alarm functions at least listed in Table 5.

Table 5 — Automatic monitoring and alarm

Serial numbers	Stage belonged	Monitoring and alarm content	Requirements
1	General requirements	Date monitoring of annual inspection	It alarms when the date of annual inspection is surpassed.
2		Ambient temperature monitoring	When the ambient temperature is exceeding working temperature of the welding machine (-5 °C to 45 °C), the welding machine shall alarm and interrupt the operation.
3		misalignment input parameters	When the external parameters format of the parameters reading device is wrong, the fault shall be detectable and alarm, such as the common misalignment of barcodes.
4	Planing	Insufficient length of pipe segment	The length of pipe segment is insufficient.
5	Heating plate	Too high or too low temperature	The temperature is too high or too low.
6	Preheating phase	Too high or too low pressure	The pressure is too high or too low.
7	Endothermic phase	Too high or too low pressure	The pressure is too high or too low.

8		Too long or too short. endothemic time	The endothermic time is too long or too short.
9	Shift phase	Too much changeover time	The changeover time is too much.
10	Fusing or cooling phase	The Too high or too low fusing pressure	The fusing pressure is too high or too low.
11		The Too long or too short fusing time	The fusing time is too long or too short.
12	Storage capacity	Limits of storage capacity	The storage capacity has 200 welding parameters at least. It shall alarm when the storage capacity reaches the maximum capacity, and the earliest information will be deleted when information in the storage overflow.
13	Fusing process	Clamp removed, and the alarm discharged	If the clamp released or pressure relief in advance at each phase, it shall be alarmed and recorded.

5.7.10 Data record

The recorded information of welded junction shall include at least five aspects, including welding management information, welding equipment information, pipe fittings information, welding parameters information and welding result information, etc. Each aspect shall include the following contents at least.

- a) Welding management information shall include welding date and time, project number, welded junction number, serial number of welded junction, and welder code;
- b) Welding equipment information shall include equipment number and model number, total area of hydraulic cylinder piston, and procedure version number;
- c) Pipe fittings information includes raw material grade, nominal outside diameter, nominal wall thickness or SDR value of pipe fittings type;
- d) Welding parameters information shall include welding process parameters executive standard (or preset value of each parameter), temperature of heating plate, drag pressure, specified welding pressure, flanging pressure, flanging displacement or flanging time, endothermic pressure, endothermic time, changeover time, pressurization time, cooling pressure, cooling time and ambient temperature;
- e) Welding result information shall include completion or failure and the fault information of the fusing process.

5.7.11 Mechanical properties of electrical components

5.7.11.1 Impact performance

Electrical components and base framework (if any) of fully automatic control system shall be able to work normally after that is subjected to an impact test with a peak

acceleration of 50 g.

5.7.11.2 Vibration performance

Electrical components and base framework (if any) of fully automatic control system shall be able to work normally after vibration test with the vibration level of 2.186 RMS (average acceleration).

5.8 Power requirements

The butt fusion welding machine shall work normally within the range of $\pm 15\%$ of input rated voltage and $\pm 2\%$ of input rated frequency.

6 Test method

6.1 Test temperature and state adjusting

Unless otherwise specified, the prototype shall be adjusted at least for 24 h at the temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, and tested at this temperature.

6.2 Appearance inspection

The appearance shall be inspected by visual inspection.

6.3 Safety requirements inspection

6.3.1 Electrical control part's enclosure protection grade of butt fusion machine shall be tested as specified in GB 4208.

6.3.2 The input cable connector shall be tested as specified in GB /T 11918.1

6.3.3 The clamps shall be closed with a certain gap.

6.3.4 The digital temperature detector is used to inspect.

6.3.5 Check whether there are clear warning signs such as "high temperature" or "HOT", and other safety signs shall be inspected comply with the requirements of GB 2894.

6.4 Base framework inspection

6.4.1 Clamp inspection

Check the clamp by visual inspection and record the results.

6.4.2 Conversion time inspection

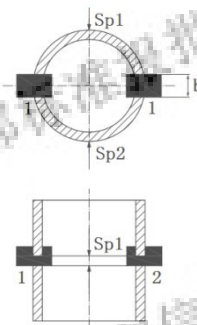
Operate the welding machine according to the manufacturer's instructions, and use the dynamic recording measuring instrument to measure the changeover time with the accuracy not less than 0.1 s. After the milling is completed, the distance between the melting end face of pipe and plate from the end face of the fixture should be 30 mm. Measure three times and take the maximum value as the final result value of

the changeover time.

6.4.3 Rigidity inspection of a guiding element under pressure

The guide element rigid measurement under the pressure namely measures the guide rod and clamping device gap, clamp the pipe with the maximum diameter and wall thickness g within the scope of welding machine on the base framework, and carefully align and milling the pipe to the end of the two pipe without gaps. Open welding machine, place clamp block at 90° relative to the guide bar between the pipe ends, and butt the pipe ends under the connection force of 0.15 N/mm^2 , measure and record the S_{p1} and S_{p2} at both locations (see Figure 3) gap, calculate the difference, and take absolute value. The external dimensions of the clamp block are shown in Figure 4.

The wedge gauge shall be preferred to measure the gap, see Figure 3.



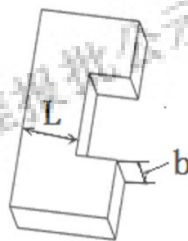
Description:

1, 2 Gauge block;

S_{p1} Measuring point 1;

S_{p2} Measuring point 2.

Figure 3 — Detection of guide rod and clamping device under pressure
— diagram of gap measurement



Description:

$$b = \frac{(d_n - e)\pi}{100}$$

Where:

b is the width of the clamp in millimeters (mm);

d_n is the nominal outer diameter of the pipe, in millimeters (mm);

e is The wall thickness of the pipe, in millimeters (mm).

The width b of the clamp is a minimum of 10 mm, and deviation of the recommended clamp L is $\pm 0.025 \text{ mm}$.

Figure 4 — Gauge block diagram

6.4.4 Rigidity test of a guiding element under bending

Rigidity test of a guiding element under bending is clamp calibration test, which is tested by the following steps:

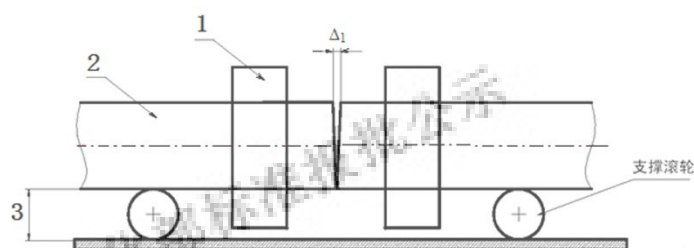
a) Use two rigid metal cylinders to measure the coaxiality of pipe clamp. The nominal outer diameter of the metal cylinder shall be the same as the nominal outer diameter of the welded pipe of butt fusion welding machine, and its out-of-roundness shall be less than 0.1 % dn . The end face of the cylinder shall be flat and perpendicular to the axis. The cylindrical cylinder shall be clamped in the typical pipe welding position in the clamp to measure the amount of misalignment of the two contact surfaces due to the axial deviation ;

b) Measurement steps and result calculation:

—Support may be used to measure the coaxiality and stability of pipe fixture arrangement of butt fusion welding machine. The distance from the lowest point of the maximum nominal diameter pipe on the clamp to the ground shall not be less than 200 mm (see Figure 5);

—Clamp two 6 m-long pipes within the largest nominal diameter range into the clamp (take PE 100, SDR 17.6 or SDR 17 series). The length of the pipe fusion end extension clamp should be 30 mm. Planer cut the end faces of the two pipes, close the end faces of the pipes, and measure the gap Δ_1 between the two contact faces;

—During measurement test, the pipe is extended vertically at 1 m and 4 m from the butt fusion welding machine; when the pipe (or clamp) is at different positions, the different coaxiality caused by the clamp and the different distance between the end faces caused by the bending are measured (see Figure 5);

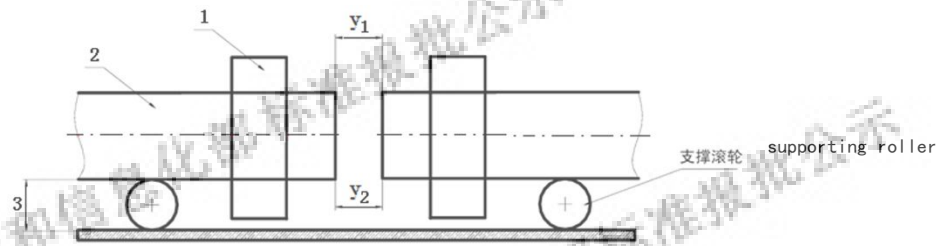


a) — Initial adjustment, the gap Δ_1 between contact faces of the pipe after planer cut

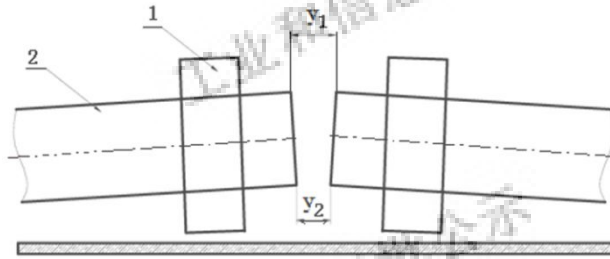
Description:

- 1 Clamp;
- 2 Pipe;
- 3 At least 200 mm to the lowest point;
- y_1 High measurement position gap;
- y_2 Low measurement position gap.

Figure 5 — Rigidity test under bending --gap measurement schematic diagram



b) — With supporting roller and separate clamps



c) — Support roller removed

Figure 5 (continue)

—In the case of support, close the end faces of two pipes, measure the gap Δ_1 ; separate the end faces of the pipe, and measure the distances y_1 and y_2 between the highest point and the lowest point of the end faces of two sections being clamped;

—Remove the support, repeat the test above, measure y_1 and y_2 .

—Calculate the axial deviation value data:

$$\text{Support roller present, } \delta_1 = |y_1 - y_2| - \Delta_1;$$

$$\text{Support roller removed, } \delta_2 = |y_1 - y_2| - \Delta_1 - \delta_1.$$

6.4.5 Pipe rerounding function inspection

Pipe rerounding function test (see Figure 6):

a) Cut two sections of SDR11 series pipe with maximum outside diameter for test. The length of each section shall be at least twice the outer diameter of the pipe, and use vise or press machine to press down at least 20 % of the nominal outer diameter of two sections of pipe radially. If the sample is too long to be flattened the whole section of the pipe, clamp the pipe out of the clamp or press plate for a length not greater than 25 mm (measured from the end) and keep it for 15 min. Clamp the pipe at the connection position of the butt fusion welding machine. The large diameter end of the pipe is perpendicular to the axis of the clamping jaw and/or the clamping direction. Install and tighten clamp according to equipment manufacturer's instructions to maintain pipe in typical connection position;

- b) The maximum and minimum outer diameters of the pipes may be measured at the intermediate position of clamp face and the end-face of the pipes by using a vernier caliper or other suitable tool;
- c) The difference between the maximum and the minimum outer diameter is unroundness.

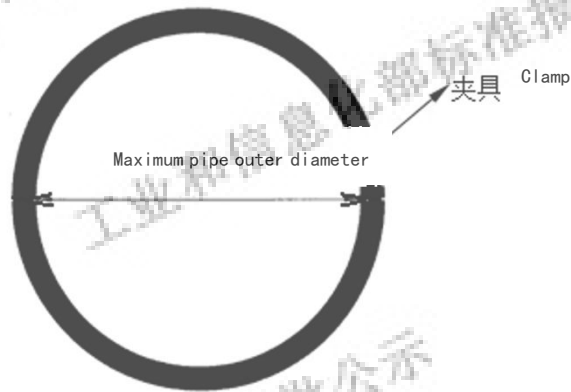


Figure 6 — location clamp

6.5 Milling cutter inspection

6.5.1 Visual inspect by operating welding machine for pipe planing, and observe if the planing tool is double-sided surface planer. The cut material shall be separated from the planing face and planer, and the interface shall be clear and visible.

6.5.2 Check if the milling cutter is designed with travelling limit and a safety protection device that only started when the milling cutter is above the base framework.

6.5.3 The gap of fusing surface: two sections of pipes with the maximum diameter are milled by butt fusion welding machine (It is listed in table 3 of the maximum diameter within the range of each size), and the cutter milling force applied on the end of the pipe shall be 0 before the completion of cutter milling.

After milling cutter removed, the applied force shall as long as overcome frictional force and two pipes end faces shall be closed. The maximum gap between the pipes end faces shall be measured by a feeler gage when the two pipes end faces contact each other.

6.6 Heating device inspection

6.6.1 Check whether heating device may be removed easily by a single person during in fusing process, and whether heating device of fully automatic fusion welding machine may be removed automatically during fusing process.

6.6.2 Heating plate material and surface treatment: inspect the comprehensive performance by visual inspection. The heating plate coating keeps under 270 °C at least 1 h. The coating characteristics shall not change if cooled to ambient

temperature and then heated to fusing temperature.

6.6.3 Surface roughness inspection of heating plate

The procedures for measuring the roughness of both sides of heating plate are listed as following:

—Put heating plate in normal vertical working state, and draw all circles that the diameters is the outer diameter of fusible pipes designed for the base framework, which are around the center of the heating plate on the heating plate;

—Draw horizontal axis, vertical axis and two diagonal lines 45 degrees from the horizontal axis through the center of heating plate;

—Measure the surface roughness Ra of the intersections of each pipe circumference and four axes.

6.6.4 Shape and size of heating plate

6.6.4.1 Measure the value "X" of heating plate by a steel ruler, and the value shall be accurate to 1 mm.

6.6.4.2 Measure the flatness of the heating plate shall in accordance with in GB/T 11337 or other methods.

6.6.4.3 Measure the thickness deviation of the heating plate at the point with same surface roughness by the vernier caliper with the accuracy of 0.02 mm or other appropriate measuring tools, and then calculate the deviation.

6.6.5 Temperature display accuracy inspection; make the heating plate in a vertical state at the environment of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and without wind, then take the test of this section and 6.6.6, 6.6.7 after the test of 50 times heating and cooling cycle of the heating device between the environment temperature and the working temperature. Proper surface temperature instrument shall be used in the test (such as thermocouples or other suitable instruments), which is not lower than $\pm 0.5\text{ }^{\circ}\text{C}$ of the measurement accuracy. Inspect the temperature of each side of the heating plate at the points as the same surface roughness, record and calculate the temperature display deviation.

6.6.6 Temperature uniformity inspection: calculate the temperature uniformity of the heating plate with the measurement data of 6.5.5.

6.6.7 Heat conduction efficiency and heat capacity inspection: conduct heat conduction test on the surface of pipes when the pipes are connected. The thermocouple shall be installed on the end face of the planing pipe and it is not higher than the end face.

Note: it is suitable for the thermocouple of small self-adhesive pad, or small bead type, or other similar instrument which is installed and fixed on the end face by fusing the surface area of the pipe with electric soldering iron. Thick wire thermocouples or thermally welded couples are

not suitable because the heat will lose much more along the conducting line.

According to the standard requirements, the pipe of maximum diameter and maximum wall thickness are chosen within the fusing range of the welding machine, then measure the time of the temperature from 5 °C to 180 °C on the pipe interface with a stopwatch.

6.7 Pressure transmission device inspection

6.7.1 Check whether the welding machine may directly display the interface force generated by pipe/pipe (pipe fitting) and plate interface during the fusing process, and record the displayed value.

6.7.2 Check whether the movement of moving clamp is continuous and stable.

6.7.3 Preset the maximum fusing pressure designed for the welding machine, keep the pressure for 2 h and record the value of pressure variation.

6.7.4 Operate the welding machine correctly referring to the operating instructions and corresponding equipment parameters given by the manufacturer, check and record displayed values of fusing pressure and measured values of the welding machine. The precision of the measuring instrument is 0.01 MPa.

6.7.5 Measure frictional resistance of butt fusion welding machine for three times, record the measured value and calculate the average value which is taken as the measured value of frictional force of the butt fusion welding machine itself, and also recorded and calculated the maximum variation value of frictional resistance of butt fusion welding machine.

6.8 Fully automatic control system inspection

6.8.1 Environmental temperature measurement and inspection

Measure and record the ambient temperature near the sensor by the temperature measuring instrument with accuracy of 0.1 °C. At the same time, record the ambient temperature displayed values of control system and compare them.

6.8.2 Parameters input device inspection

Read a set of barcodes with known parameters settings into the welding machine by scanning gun of the electric fusion welding machine to see whether the set values displayed on the screen are consistent with the known set parameters.

6.8.3 Temperature measurement and inspection of heating plate

Preset a temperature value on the controller, and then check the accuracy of displayed temperature values of control system by a thermometer (with accuracy of 0.1 °C) after that the temperature of heating plate is steady for 10 min.

6.8.4 Pressure measurement inspection

Connect a digital pressure gauge with accuracy of not less than 0.01 MPa in series in the hydraulic circuit, and then preset a pressure value on the controller to check

whether the pressure displayed by the control system is accurate.

6.8.5 Displacement measurement inspection

Set the displayer with accuracy of $0.01 \mu\text{m}$ for displaying the displacement that connect independently to the displacement measuring element, and set the moving state of the displacement measuring component on the base framework of fully automatic butt fusion welding machine, and check whether the values displayed by the control system are consistent with the values displayed on the displayer.

6.8.6 Display screen inspection

Observe the display screen in bright and soft light to observe whether the display is clearly visible, whether it supports Chinese display, and whether the response speed is fast.

6.8.7 Data transmission interface

Connect the electric fusion welding machine to the storage or other electronic equipment through the interface, and check the consistency of downloaded data and actual data.

6.8.8 Control process inspection

Take a complete operation process by full automatic fusion welding machine, and inspect whether all requirements are met. Check whether the number of stored welding joints is consistent with the actual number within several welding processes.

6.8.9 Monitoring and alarm inspection

During the operation process, check whether it is alarm when the analog monitoring quantity is out of tolerance.

6.8.10 Data records inspection

Print or download a complete data record to inspect that the items are complete.

6.8.11 Mechanical properties

Mechanical properties of electrical components of fully automatic control system are tested as following:

a) Impact test shall be in accordance with GB/T 2423.5. The test conditions are as following:

- 1) peak acceleration: 50 g;
- 2) Pulse duration: 8 ms–15 ms;
- 3) Impulse waveform: semi-sinusoidal pulse;
- 4) Impact times: three times in each direction along the X , $-X$, Y , $-Y$, Z and $-Z$ axes (18 times in total).

b) Vibration test shall be in accordance with the requirement given in GB/T 2423.10. The

test conditions are as following:

- 1) vibration grade: 2.186 RMS (average acceleration);
- 2) Frequency range: ① (1.25–10) Hz, +20 dB/oct; ② (10–20) Hz, 0.1 g²/Hz; ③ (20–500) Hz, -4.2 dB/oct;
- 3) Duration of durability test: 10 min in each axial direction (X, Y, Z).

6.9 Power test

Supply power to fusion welding machine by using an adjustable transformer, and make the supply voltage 85%, 100% and 115% of the input voltage rating. Operate the fusion welding machine normally and inspect whether the fusion welding machine is working normally.

Supply power to fusion welding machine by using a generator, and make the input frequency is 98%, 100% and 102% of the rated value. Operate the fusion welding machine normally and inspect whether the fusion welding machine is working normally.

7 Inspection rules

7.1 Inspection classification and inspection items

7.1.1 Inspection classification

The inspection of butt fusion welding machine includes ex-factory inspection and type inspection.

7.1.2 Ex-factory inspection

Each welding machine shall be inspected by the manufacturer's inspection department in accordance with the requirements given in Table 6, and pass the factory inspection.

Table 6 — Inspection items

Serial number	Inspection items	Ex-factory inspection	Type inspection	Clause and subclause number of technical requirements	Clause and subclause number of test methods	
1	Appearance	√	√	5.1	6.2	
2	Safety requirements	End closure protection class	—	√	5.2.1	6.3.1
3		Input cable connector	—	√	5.2.2	6.3.2
4		Safety gap of clamp closure	—	√	5.2.3	6.3.3
5		Handle temperature	—	√	5.2.4	6.3.4
6		Safety signs	√	√	5.2.5	6.3.5
7		Base framework	Clamp	—	√	5.3.1
8	Changeover time		—	√	5.3.2	6.4.2
9	Rigidity of a guiding element under pressure		—	√	5.3.3	6.4.3
10	Rigidity test of a guiding element under bending		—	√	5.3.4	6.4.4
11	Pipe rerounding function		—	√	5.3.5	6.4.5
12	Milling cutter	Double-sided milling. Spalling easy to be separated	√	√	5.4.1	6.5.1
13		Milling stroke limit, Safe start	√	√	5.4.2	6.5.2
14		Welding surface gap	√	√	5.4.3	6.5.3
15	Heating device	Single removal and automatic removal during welding	√	√	5.5.1	6.6.1
16		heating plate material and surface treatment	√	√	5.5.2	6.6.2
17		Surface roughness of heating plate	√	√	5.5.3	6.6.3
18		Shape and size of heating plate: shape, X value,	√	√	5.5.4	6.6.4

		thickness and flatness				
19		Heating device: accuracy of temperature displayed	√	√	5.5.5	6.6.5
20		Heating device: temperature uniformity	√	√	5.5.6	6.6.6
21		Heat transfer efficiency and heat capacity	—	√	5.5.7	6.6.7
22		Pressure display assembly	√	√	5.6.1	6.7.1
23	Pressure transmission device	Smooth and continuous movement of moving clamp	√	√	5.6.2	6.7.2
24		Retention of welding pressure	√	√	5.6.3	6.7.3
25		Interface force: deviation	√	√	5.6.4	6.7.4
26		Self-frictional resistance of butt fusion welding machine	√	√	5.6.5	6.7.5
27		Environmental temperature measurement inspection	√	√	5.7.1	6.8.1
28		Parameter input system inspection	√	√	5.7.2	6.8.2
29	Fully automatic control system	Heating plate temperature measurement inspection	√	√	5.7.3	6.8.3
30		Pressure measurement inspection	√	√	5.7.4	6.8.4
31		Displacement measurement check	√	√	5.7.5	6.8.5
32		Display inspection	√	√	5.7.6	6.8.6
33		Data transmission	√	√	5.7.7	6.8.7

		interface inspection				
34		Control process inspection	√	√	5.7.8	6.8.8
35		Monitoring and alarm inspection	—	√	5.7.9	6.8.9
36		Data record inspection	√	√	5.7.10	6.8.10
37		Mechanical properties: impact and vibration test	—	√	5.7.11	6.8.11
38	Power test		—	√	5.8	6.9

Note: “√” in the table indicates the mandatory item, and “—” indicates the optional item.

7.1.2 Type inspection

7.1.2.1 Type inspection items

Type inspection items see Table 6. After the product is put into production, type inspection shall be carried out within half a year; In case of any following circumstances, type inspection shall also be conducted:

- a) When new or old products manufactured by another factories;
- b) After running normally, under the condition of some factors affecting the performance of the product, such as structure, material and process;
- c) When the product resumes production after long-term suspension of production;
- d) When there is a big difference between the factory inspection result and the last type inspection result;
- e) When the national quality supervision agency puts forward the requirements of type inspection;
- f) When the user requires type inspection.

7.1.2.2 Type inspection judgement

Product shall be judged in accordance with the requirements given in Clause 5. If one of the items does not comply with the requirements of this standard, another double quantity of products or components shall be selected from the same type of products to retest the item. If it still fails, the type test is judged unqualified.

7.2 Sampling

All test items shall be carried out on the same prototype, and all test items shall pass the requirements except that components shall be provided separately for the test of the related items. If it is necessary to disassemble the prototype for

relevant tests, an additional prototype is needed.

8 Sign, packaging, transportation and storage

8.1 Sign

The following information of butt fusion welding machine and its components shall be clearly marked in the appropriate position: name of the manufacturer and/or trademark, the types of welding machine, welding machine model, the power requirements (including the input voltage and power consumption), machine number, designed outer diameter range of welding pipe, designed SDR range of welding pipe, other security information, the information provided by the other manufacturers.

The following information of the machine shall be provided in the technical documentation or operation manual: the effective piston area of the oil cylinder of the welder (if used), and the welding procedure used.

8.2 Packaging

8.2.1 Butt fusion machine and its components may be packed in plastic bags, while the outer packing may use wooden boxes. It is required to keep the machine firmly fixed and prevent damage during transportation.

8.2.2 Documents attached to the packing box include product qualification certificate, product operation manual and list of spare parts and accessories.

8.3 Transportation

Butt fusion welding machine and its components shall not be subjected to severe impact and heavy load during transportation, and it is strictly forbidden throwing during loading and unloading.

8.4 Storage

Butt fusion welding machine and its components shall be stored in a dry and ventilated room without corrosive gas.
