JOURNAL OF MULTIFUNCTIONAL MATERIALS & PHOTOSCIENCE
12(2), December 2021, pp. 167-171

Research on Butt Submerged Arc Welding Technology of 09MnNiDR Plate

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Abstract: At the beginning of the 21st century, China's petrochemical industry developed rapidly, and rapid progress was made in the manufacturing of low-temperature pressure vessels for the storage of nitrogen, ethylene and other gases.09MnNiDR is a very suitable material for manufacturing low temperature pressure vessel. Compared with the American standard low temperature container plate SA537CL1, the low temperature impact requirement of 09MnNiDR produced in China is-70!, and both mechanical performance and application range are better than SA537CL1. Therefore, the buried arc welding process of 09MnNiDR is a very topic worth studying.Through the analysis of the welding parameters, we select specific welding parameters (welding wire number, welding wire diameter, welding current, welding voltage and welding speed). After obtaining a series of welding products, conduct process evaluation test: tensile test, bending test and impact test.The test results show that the resulting weld and heat impact area samples meet the process standards, and the welding parameters selected in this experiment are suitable for plate docking embedded arc welding of 09MnNiDR steel.

Keywords: 09MnNiDR steel; welding parameters; process qualification test; weld and heat affected zone

1. Purpose and significance

Since entering the 21st century, China's economy and science and technology have developed rapidly, and great progress has been made in the technology and equipment of the petroleum and chemical industries.Among them, low temperature pressure vessels used to store dry gas, nitrogen, hydrocarbons, ethylene, etc. are widely used.

09MnNiDR is a new type of steel plate material, the main manufacturing material of low temperature pressure vessels, which has a very low carbon content and is a typical low carbon alloy structural steel.Among them, Mn,Ni in 09MnNiDR means the alloy elements manganese and nickel in 09 MnNiDR material, and manganese enhances the hardness of the material through the solid solute reinforcement phenomenon, and nickel can reduce its cold and brittle transition temperature and enhance its toughness(1,2).09 The main tissue component of MnNiDR steel is fertin with a small

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amount of bead light.Because of the effect of fierce alloy elements and nickel, 09MnNiDR steel has excellent strength and low temperature shock toughness, which can be used in the manufacturing of petrochemical equipment deethane, carbon dioxide absorber, deethanzer, reabsorber, compressor housing, medium pressure flash tower, cooler, propane low temperature storage tank and other products.

This project welded the 09MnNiDR plate by a buried arc welding machine to evaluate whether the welding streets obtained by the selected welding conditions meet the standard.

Table 1.1 Chemical composition of 09MnNiDR steel

	Chemical composition (mass fraction)Wt%								
	C	Si	Mn	Ni	V	Nb	Alt	P ≤	S
09MnNiDR	≤0.12	0.15～0.50	1.20～1.60	0.3~0.8	—	≤0.04	≥0.020	0.020	0.008

2. Material Selection and Research Route and Method

Select 09MnNiDR steel produced by WuGang, delivery status: ignition, ignition+ tempering, quenching + tempering.

Table2.1 Exclusion content of 09MnNiDR was compared with other materials

Thickness(mm)	Species	impurity content/%	Al_2O_3/%	SiO_2/%	MnO/%
40	SA516Gr70	0.0015	0.0005	0.0001	0.0002
38	15MnNbR	0.0013	0.0003	0.0002	0.0001
150	SA662GrC	0.0016	0.0004	0.0001	0.0001
65	16MnDR	0.0015	0.0004	0.0002	0.0001
9	09MnNiDR	0.0013	0.0003	0.0001	0.0002

In this experiment, 09 MnNiDR plates with 9 mm plate thickness were studied to develop reasonable welding parameters.Perburied arc welding to obtain test samples of postweld and heat impact area(3).The resulting samples are then subjected to a post-weld evaluation test, including tensile test, bending test and impact test for meeting the process standards.

3. Introduction and Advantages of Submerged arc Welding

Buried arc welding is an efficient welding method, which has the following advantages: high welding parts quality, strong weld mechanical performance and stable components, obvious residue windproof protection effect, welding parameters can be adjusted by themselves, and lower welders can also operate normally(4,5).The production efficiency of buried arc welding is high. Due to the shortened conductive length of the buried arc welding wire, the welding wire deposition efficiency and the penetration depth of the arc are significantly improved.Moreover, due to the heat isolation effect of solder agent and molten slag, the welding process has basically no heat loss, and the arc splash is

also reduced. Thus, although the thermal loss of the melting solder increases, the total thermal efficiency is greatly improved.Buried arc welding has a good operating environment and is not prone to accidents. No buried arc welding during welding, the risk of workers in welding is greatly reduced.

Table 3-1 Submerged arc welding parameters

Weld bead/Welding layer	method	Filling material		welding current		arc voltage (V)	speed(cm/min)
		Brand	diameter	Polarity	electric (A)		
1-2	SAW	H09MnNiDR /SJ208DR	Φ4	DC	550-650	30-34	50-54

Welding plate 09MnNiDR / submerged arc welding. In this submerged arc welding test, we choose 550-650 A welding current, 30-34 V arc voltage and 50-54 cm/min welding speed(6).

4. Welding Process

Prepare welding wire and flux. After decontaminating, oiling and derusting the welding wire, coil it in the welding wire coil. The flux shall be baked at 250! for more than one hour. The welding joints of workpieces shall be cleaned of oil, dirt and water(7). The distance between the welding gun head and the workpiece shall not be less than 15 mm, and the length of welding wire shall not be less than 30 mm.

After the submerged arc welding machine is started, the welding wire will be automatically pulled up by the machine and then supplied in a downward direction. The welding wire and the workpiece will rub against each other to produce an arc, and the welding process can be carried out normally.

During welding, we pay attention to the changes of ammeter and voltmeter at any time and make corresponding adjustments. After welding the second layer, the water must be cooled and the voltage and current can be increased to form welding slag(8).

Stop welding and close the flux hopper door. Press the stop button on the submerged arc welding machine to stop the power transmission of the welding wire, but still burn the arc to fill the metal molten pool and repair welding. The welding surface must be cleaned before the second welding.

5. Post Weld Test and Analysis

Table 5.1 Tensile test data

	width(mm)	thickness(mm)	Tensile strength(MPa)	Fracture location and characteristics
B97-1	25	9.5	522	Plastic fracture in base metal
B97-2	25	9.6	504	Plastic fracture in base metal

Table 5.2 Test data of bending test

	Sample type	thickness(mm)	Bending center diameter(mm)	Bending angle (°)	result
B97-1	Lateral bending	10	40	180°	Intact without crack
B97-2	Lateral bending	10	40	180°	Intact without crack
B97-3	Lateral bending	10	40	180°	Intact without crack
B97-4	Lateral bending	10	40	180°	Intact without crack

Table 5.3 impact test data

	Sample size	Notch type	Notch position	Temperature (C°)	Impact absorption energy (J)	-
B97-1	10×10×55	V	weld line	-70	80	qualified
B97-2	10×10×55	V	weld line	-70	74	qualified
B97-3	10×10×55	V	weld line	-70	70	qualified
B97-4	10×10×55	V	Heat affected zone	-70	36	qualified
B97-5	10×10×55	V	Heat affected zone	-70	41	qualified
B97-6	10×10×55	V	Heat affected zone	-70	47	qualified

The bending experiment included four samples with 180 ° lateral and a bending center diameter of 40 mm, without crack.In the tensile test, the two samples did not break under tensile stress with an ultimate tensile strength of 500 – 530 mpa, located in the basal metal.For the impact test, the test condition was-70! and the six weld samples were V gaps (9, 10). The shock absorption energy of the weld sample b97-1, b97-2, b97-3 is 80,74, and 70, respectively. All welded joints meet the standard (11). The corresponding impact absorption energies of the samples b97-4, b97-5 and b97-6 in the heat-affected regions were 36 j, 41 j and 47 j., respectively The results showed that the test samples met the criteria.

6. Conclusion

This experiment uses embedded arc welding, welding parameters of 550-650 A welding current, arc voltage of 30-34 V, and 50-54 cm/min welding speed for 09MnNiDR plate according to the process standard.Reasonable selection of welding strip diameter, control the thickness of the single weld path, try to avoid welding swing, arc height and weld cleaning degree can improve the toughness of welding joints(12).

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