

For 9%Ni Steel and Nickel-Based Alloy

For 9%Ni Steel

For welding of 9%Ni steel, Ni-base alloys such as Ni-Cr alloy (e.g., Inconel) and Ni-Mo alloy (e.g., Hastelloy) welding consumables are commonly used to obtain sufficient notch toughness at cryogenic temperatures. 9%Ni steel is used for storage tanks for liquefied natural gas (LNG), liquefied oxygen and liquefied nitrogen, and LNG carriers. In the construction of such cryogenic temperature service equipment, automatic gas tungsten arc welding and submerged arc welding are often used to ensure consistent weld quality, as shown in Fig. 1.

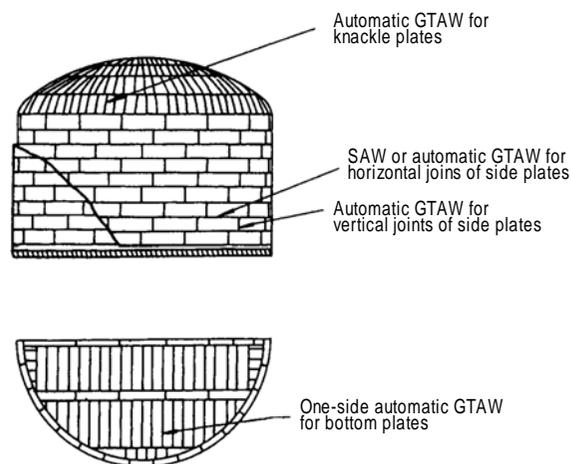


Fig. 1 Typical applications of automatic welding processes for a LNG storage tank

■ Tips for better welding results

Common to individual welding processes

- (1) Remove scale, rust, and other dirt from welding grooves beforehand by grinding or other appropriate means.
- (2) Use no preheat and control interpass temperatures at 150°C or lower.
- (3) Minimize welding currents and welding speeds to prevent hot cracking.
- (4) Use no magnetic power crane because 9%Ni steel is likely to be magnetized.

SMAW

- (1) Re-dry covered electrodes by 200-250°C for 30-60 minutes before use.
- (2) Keep the arc length as short as possible.

FCAW, GMAW

- (1) Use Ar-CO₂ mixtures with 20-25%CO₂ for shielding gas. The gas flow rates should be 20-25 l/min.
- (2) Refer to Pages 205 and 207 of the stainless steel article about power source, wire extension, protection against wind and welding fumes, and storage of welding wires.

GTAW

- (1) Use multi-pass welding because the use of single-pass welding may cause a decrease of weld metal strength affected by the dilution from the base metal.

SAW

- (1) Re-dry fluxes by 200-300°C for 1 hour before use.
- (2) Use multi-pass welding because the use of single-pass welding may cause a decrease of weld metal strength affected by the dilution from the base metal.

For 9%Ni Steel and Nickel-Based Alloy

For Ni-base alloy

Typical Ni-base alloys for welding are Ni-Cr alloy (e.g., Inconel) and Ni-Fe-Cr alloys (e.g., Incoloy). Ni-base welding consumables are used for joining these Ni-base alloys and dissimilar-metal joints consisting of Ni-base alloy and low alloy steel, stainless steel and low alloy steel, and the like.

■ Tips for better welding results for individual welding processes

SMAW

- (1) Use proper welding currents because the use of an excessive welding current causes electrode-burn and thereby usability and weld metal properties can be deteriorated.
- (2) Use no preheating for welding matching Ni-base alloys. Control interpass temperatures at 150°C or lower.
- (3) Use the backstep technique when an arc is struck in the welding groove, or strike an arc on a piece of metal outside the groove to prevent the occurrence of blowholes at the arc starting area of a bead.
- (4) Keep the arc length as short as possible.
- (5) Use flat-position welding as much as possible because vertical or overhead welding requires higher welding skill.
- (6) Minimize welding currents and speeds to prevent hot cracking.

FCAW

- (1) Use Ar-CO₂ mixtures with 20-25%CO₂ for shielding gas. The gas flow rates should be 20-25 l/min.
- (2) Refer to Pages 205 of the stainless steel article about power source, wire extension, protection against wind and welding fumes, and storage of welding wires.

GMAW

- (1) Pulsed arc welding with the spray droplet transfer mode using low currents is most appropriate, although conventional gas metal arc welding power sources can be used. DC-EP polarity is suitable.
- (2) Argon gas shielding with gas flow rates in the 25-30 l/min range is suitable. Ar-He mixture gases are also suitable.
- (3) Use no preheating and control interpass temperatures at 150°C or lower.
- (4) Minimize welding currents and speeds to prevent hot cracking.

GTAW

- (1) Use DC-EN polarity.
- (2) Argon gas shielding with gas flow rates in the 10-15 l/min range is suitable where welding currents are within 100-200A. In one-side welding, back shielding is needed to avoid oxidation of the back side bead.
- (3) Control the arc length at approximately 2-3 mm because the use of an excessive arc length may cause lack of shielding, thereby causing blowholes.
- (4) Use no preheating and control interpass temperatures at 150°C or lower.
- (5) Minimize welding currents and speeds to prevent hot cracking.