Gas Arc Welding - GMAW and GTAW

Advisory Consultants

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OBJECTIVES

- Obtain uniform welds with minimum porosity.
- Minimize weld spatter.
- Use customary, easily obtained consumables.

EVALUATION PROCEDURE

SCS samples of thickness 0.079" and 0.101" were welded using common shielding gasses and filler wire/rod. No surface preparation was performed on the samples. Resulting welds were examined for uniformity, porosity and spatter and recommendations formulated.

RECOMMENDATIONS

GMAW (MIG) - Successful Parameters

- **Filler Wire: 0.035" ER70S-6**
- **Shielding Gas: Argon/ 3-5% Oxygen with flow rate of 25 - 30 CFH**
- **Wire Feed Speed and Voltages:**

400 in./min.	**24 volts**
430 in./min.	**24 volts**
460 in./min.	**25 volts**
500 in./min.	**26 volts**

The 95%Ar/5%O_2 gas achieves spray arc mode, which minimizes spatter and produces a very uniform bead, allowing for a decreased wire feed speed. To avoid porosity from the O_2 in the gas, the filler wire must have oxidizers. ER-70S-6 has high manganese content which serves this purpose.

Parameters To Avoid

- **Shielding Gas: Argon/ 10% CO_2**
  Argon/ 25% CO_2

Use of these shielding gasses resulted in a less stable arc and transfer in globular or short-arc mode. The resulting bead was less uniform with more spatter.

When wire feed speed was increased to 600 in./min. excessive spatter resulted, indicative of the wire being overdriven.

Finally, weld smoke was noticeable greater with these shielding gasses.

GTAW (TIG) - Successful Parameters

- **Filler Rod: 1/16" to 1/8" EWTh-2**
- **Shielding Gas: Argon with flow rate of 15 - 25 CFH based upon welding conditions**
- **Amperage: 50-150 based on metal thickness**
- **Voltage: 10-14 based on position/technique**

While MIG welding of carbon steels is preferable to TIG welding, SCS does TIG weld effectively because of its cleanliness. Areas to be welded must be free from moisture, oil and contaminants A filler rod MUST BE USED to avoid weld porosity. A stainless 308 rod will also produce a high quality weld.

Resistance Spot Welding

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OBJECTIVES

- Evaluate SCS suitability for spot welding.
- Evaluate quality of SCS spot welds.
- Establish recommended settings for spot welding SCS.

EVALUATION PROCEDURE

SCS samples of 0.100" thick (12 gauge) of ASME specification SA-414-99 addenda GR-6 pressure vessel quality steel were resistance spot welded, varying selected parameters to evaluate its overall weldability and establish "starting parameters" expected to yield high quality welds. Surface electrical resistivity of SCS samples was measured and compared to hot rolled black (HRB) and hot rolled pickled and oiled (HRPO) material.

RECOMMENDATIONS

Parameter	Description	Starting Point for SCS
Electrode	Varies with specific application	RWMA Class 2 pointed nose electrodes - 5/8" diameter with 3/8" diameter face
Tip Force	Weld force required in psi	2000 psi +/-100 psi
Squeeze Time	The time value for bringing electrodes together capturing parts to be welded with intimate contact prior to electronically energizing the secondary weld current power	Weld machine dependent; open tip spacing varies with welder set up
Preheat	Percent of heat lower than weld heat	5500 amperes +/-200
Preheat Time	Time in cycles (Hz) for preheat	10 Hz
Upslope	Percent of heat lower than the weld percent to ramp of weld heat	Often used with coated materials. Not normally required for SCS or HRPO.
Upslope Time	Time period for ramp up	
Weld (Heat)	In percentage of weld transformer output at a given tap switch position *Note: if constant current feature is available this will be set in desired amperage value.*	12,000 amperes +/-300
Weld Time	Time of weld function	5-10 Hz
Weld Pulsation	Number of pulses	4 pulses (this weld pulse is at the 12,000 amp weld heat setting)
Pulsation Time	Time duration of pulse	10 Hz
Pulsation Cool	Off time between pulses	4 Hz
Downslope	Power ramp down	Often used with coated materials. Not normally required for SCS or HRPO.
Downslope Time	Time period for power ramp down	
Quench Time	Off time used with or in place of squeeze time for permitting the weld to cool prior to post heat	15 Hz
Post Heat	Percent of heat lower than the weld setting for annealing the weld and the heat affected zone	3100 amp +/-200
Post Heat Time	Time period for above sequence	30 Hz
Hold Time	Time applied at end of welding to assure full nugget solidification prior to releasing air pressure tip force and allowing the upper weld electrode to return to its neutral position.	5-10 Hz

Resistance Spot Welding (continued):

ELECTRICAL RESISTIVITY RESULTS

- SCS: 15 - 30 ohms
- HRPO: 15 - 30 ohms
- HRB: 10 - 100 ohms

Surface oxides resulting from contaminants (including oil and dirt) are non-conductive and are detrimental to the welding process. In the case of resistance spot welding, it requires additional electrical power to break through these surface contaminants and expel the refuse so as to prevent entrapment within the weld metal nugget.

The electrical resistivity results show that SCS processed material has no more resistance to spot welding than does HRPO and in fact has considerably less resistance than HRB.

Spot welding SCS-processed steel requires regular cleaning of the electrodes, but oxide pick-up when spot welding SCS is considerably less than HRB or HRPO (without cleaning, the SCS surface oxide will accumulate on the electrode faces causing misshaped weld nuggets). Electrode life when welding SCS is equivalent to life when welding HRPO.

General Rules for Making Good Spot Welds

1. Too short squeeze time can result in metal expulsion, overheating electrodes, bad welds, marked work.
2. Too long weld time will shorten electrodes life, cause excessive indentation at surfaces and cause internal cracks in the weld nugget.
3. A peel destructive test on test strips of the same material and combination is recommended.
4. Too short weld time will result in low weld strength, in proportion with weld heat.
5. Too short hold time can result in surface expulsion, electrodes sticking, and internal cracks in the weld nugget.
6. Weld pressure too low can result in expulsion of metal, electrode sticking, short electrode life, and possible internal cracks in the weld nugget.
7. Weld pressure too high can result in variable weld strength, excessive weld current requirements, mushrooming of electrodes, and excessive indentation.
8. With all other settings correct, adjust weld current to meet weld quality standards using recommended starting points.
9. Electrode contact face too small will result in too small a spot, excessive electrode mushrooming, and excessive indentation. Too large an electrode contact area will result in too large a weld (assuming current is set accordingly). Use RWMA charts for electrode manufacturer recommendations.
10. Electrodes misaligned/mis-matched will result in expulsion, and displaced weld nugget and excessive electrode wear.
11. Insufficient cooling will result in mushrooming and short electrode life. Adequate water cooling of the welding system is crucial.