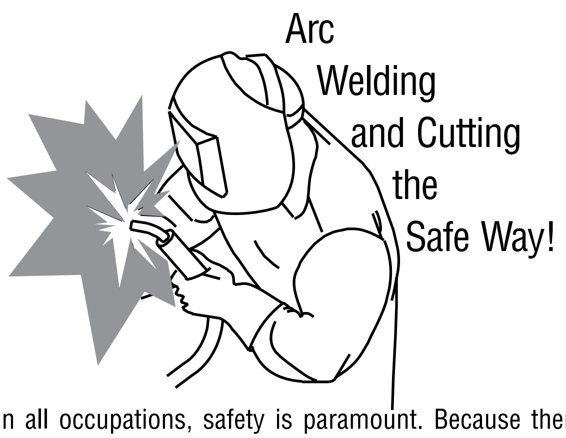
HOBART FILLER METALS

Topic E.

Welding Process Training Series

Aluminum

SAFETY



As in all occupations, safety is paramount. Because there are numerous safety codes and regulations in place, we recommend that you always read all labels and the Owner's Manual carefully before installing, operating, or servicing the unit. Read the safety information at the beginning of the manual and in each section. Also read and follow all applicable safety standards, especially ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes.

ANSI Z49.1:, Safety in Welding, Cutting, and Allied Processes is available as a free download from the American Welding Society at: http://www.aws.org

Here is a list of additional safety standards and where to get them.

Safe Practices for the Preparation of Containers and Piping for Welding and Cutting, American Welding Society Standard AWS F4.1, from Global Engineering Documents (Phone: 1-877-413-5184, website: www.global.ihs.com).

National Electrical Code, NFPA Standard 70, from National Fire Protection Association, Quincy, MA 02269 (Phone: 1-800-344-3555, website: www.nfpa.org and www. sparky.org).

Safe Handling of Compressed Gases in Cylinders, CGA Pamphlet P-1, from Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151 (Phone: 703-788-2700, website:www.cganet.com).

Safety in Welding, Cutting, and Allied Processes, CSA Standard W117.2, from Canadian Standards Association, Standards Sales, 5060 Spectrum Way, Suite 100, Ontario, Canada L4W 5NS (Phone: 800-463-6727, website: www.csa-international.org).

Safe Practice For Occupational And Educational Eye And Face Protection, ANSI Standard Z87.1, from American National Standards Institute, 25 West 43rd Street, New York, NY 10036 (Phone: 212-642-4900, website: www.ansi.org).

Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, NFPA Standard 51B, from National Fire Protection Association, Quincy, MA 02269 (Phone: 1-800-344-3555, website: www.nfpa.org.)

OSHA, Occupational Safety and Health Standards for General Industry, Title 29, Code of Federal Regulations (CFR), Part 1910, Subpart Q, and Part 1926, Subpart J, from U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 (Phone: 1-866-512-1800) (There are 10 OSHA Regional Offices—phone for Region 5, Chicago, is 312-353-2220, website: www.osha.gov).

Booklet, *TLVs, Threshold Limit Values*, from American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, OH 45240 (Phone: 513–742–3355, website: www.acgih.org).

Towing a Trailer – Being Equipped for Safety, Publication from U.S. Department of Transportation, National Highway Traffic Safety Administration, 400 Seventh Street, SW, Washington, D.C. 20590

U.S. Consumer Product Safety Commission (CPSC), 4330 East West Highway, Bethesda, MD 20814 (Phone: 301-504-7923, website: www.cpsc.gov).

Applications Manual for the Revised NIOSH Lifting Equation, The National Institute for Occupational Safety and Health (NIOSH), 1600 Clifton Rd, Atlanta, GA 30333 (Phone: 1-800-232-4636, website: www.cdc.gov/NIOSH).

Prepared by the Miller Electric Mfg. Co. Training Department.

⚠ WARNING

This document contains general information about the topics discussed herein. This document is not an application manual and does not contain a complete statement of all factors pertaining to those topics.

The installation, operation, and maintenance of arc welding equipment and the employment of procedures described in this document should be conducted only by qualified persons in accordance with applicable codes, safe practices, and manufacturer's instructions.

Always be certain that work areas are clean and safe and that proper ventilation is used. Misuse of equipment and failure to observe applicable codes and safe practices can result in serious personal injury and property damage.

Welding Process and Filler Metals Training Series:

Welcome to the Welding Process and Filler Metals Training Series. This training series was developed for the purpose of providing a basic set of educational materials that can be used individually or in a classroom setting.

The topics covered in the series are:

Filler Metals

- **Topic A.** Introduction To Metals
- **Topic B.** Tubular Wires
- **Topic C.** Low Alloy Steel
- **Topic D.** Stainless Steel
- **Topic E.** Aluminum
- **Topic F.** Hard Surfacing

Welding Processes

- **Topic 1.** Introduction To Welding
- **Topic 2.** Welding Safety
- **Topic 3.** Basic Electricity For Welding
- **Topic 4.** Welding Power Source Design
- **Topic 5.** Engine Driven Power Sources
- **Topic 6.** Shielded Metal Arc Welding
- **Topic 7.** Gas Tungsten Arc Welding
- **Topic 8.** Gas Metal Arc Welding
- **Topic 9.** Flux Cored Arc Welding
- **Topic 10.** Metal Cutting
- **Topic 11.** Troubleshooting Welding Processes
- **Topic 12.** Submerged Arc Welding

Please note, this series was not developed to teach the skill of welding or cutting, but rather to provide a foundation of general knowledge about the various processes and related topics.

Table of Contents

Wire Feedability and Drive Roll Adjustment

All too often the incorrect choice of drive rolls is a major cause of aluminum welding wire feedability problems. Drive roll selection and adjustment is very important to ensure proper wire feeding. Using the wrong type and size of drive roll for aluminum will result in down time, unnecessary maintenance costs, and potential weld flaws that require costly rework. The majority of these problems are caused by aluminum wire shavings that originate from poor fitting, and incorrectly designed drive rolls.

The wrong drive roll can cause the wire to be deformed which limits the ability of the welding current to transfer into the wire at the contact tip. The deformed wire can also shave, producing a dust or small shavings. This is an indication of incorrect drive roll selection or adjustment. These shavings or flakes can clog the liner causing poor feedability of the wire. The poor feedability of the wire will result in inconsistent welding amperage and create an inconsistent welding arc. This is a potential weld failure as well as a maintenance issue. Both problems cost additional time and materials that could be eliminated by using the correct drive roll and adjustments.

Most wire feeders allow for two main adjustments of the drive rolls: side-to-side adjustment and drive pressure. The side-to-side adjustment ensures that the wire is feeding straight into the inlet guide of the gun. If this adjustment is off, then unnecessary flaking or shaving of the wires will occur even if the correct drive roll is selected. The most important adjustment and the most abused adjustment is the drive roll pressure.

Drive roll pressure can cause a number of problems when it is not properly adjusted. Adjusting the pressure too tight deforms the wire, causes shavings, leads to birds nests, and creates unnecessary pressure on the gear shaft which prematurely wears out the gear box or drive motor. All of these problems lead to down time, maintenance costs, or potential weld defects. Adjusting the drive pressure too loose causes inconsistent feeding of the wire, resulting in potential weld defects and unnecessary repairs.

The correct drive roll pressure will consistently feed the wire and allow the drive rolls to spin on the wire and not cause a birds nest if the wire is stopped. Making this adjustment can take time and experience so be sure to make the adjustment correctly.

Recommended Drive Roll Design

Drive rolls for feeding aluminum wires require special attention to ensure consistent feedability and to reduce down time. A rough surface finish produces fine shavings and aluminum buildup in the groove. Sharp edges and misalignment of the rolls can shave the wire. Aluminum drive rolls should be polished to a very smooth finish where the wire comes in contact with the drive roll groove surface. Figure 14 shows a guideline for designing drive rolls to feed aluminum wire.

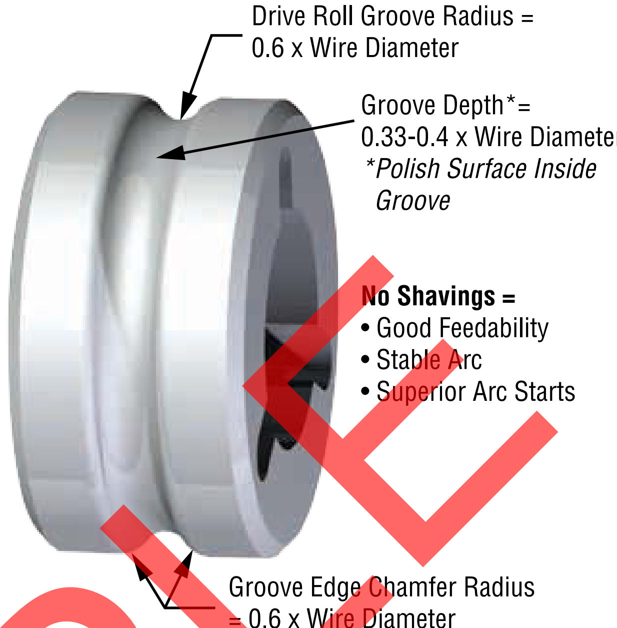


Figure 14 – Polish All Groove Surfaces, Ensure Both Rolls Are Aligned, And Always Use The Lowest Drive Roll Pressure Capable Of Feeding The Wire In Order To Prevent Deformation Of The Wire During Feeding.

Porosity

Porosity is a void in a weld caused by trapped gases. The voids are usually round in shape and can be on or under the surface of the weld.

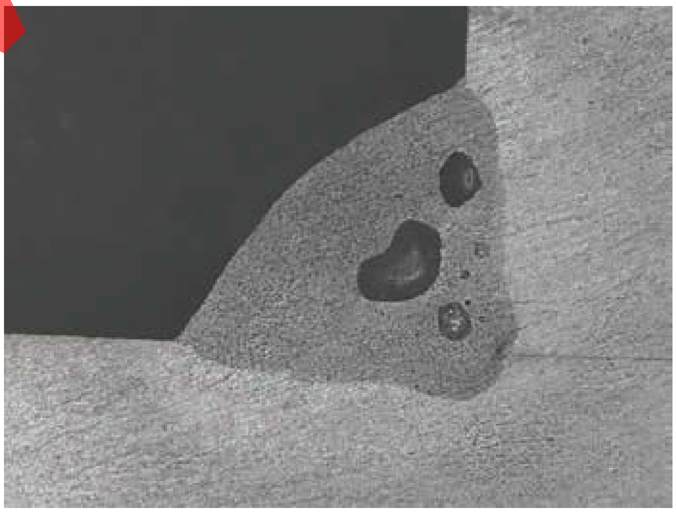


Figure 15 – Macro Etch Of Fillet Weld Showing Large Irregular Shaped Porosity.

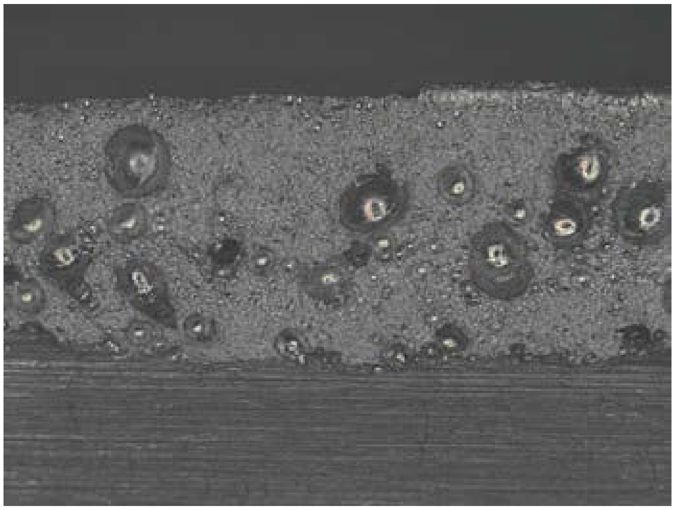


Figure 16 – Scattered Porosity Found In The Internal Structure Of An Aluminum Weld After Nick-Break Testing.

Producing a weld with low porosity is the responsibility of both the electrode manufacturer and the welder. The electrode manufacturer must supply an electrode that is contamination free and has been tested to show that it is indeed capable of meeting the low porosity standards of AWS A5.10. The welder must incorporate the practices and procedures of codes like AWS D1.2/D1.2M:2008 to ensure that porosity is not introduced into the weld pool. Before welding, process engineers must determine which porosity standard of the applicable code the welded structure is required to meet.

All weld porosity results from the absorption of hydrogen during melting and the expulsion of hydrogen during solidification of the weld pool. The solubility of hydrogen in aluminum increases dramatically after the material reaches its liquid stage. When aluminum is heated to temperatures above its melting point it becomes very susceptible to hydrogen absorption (see hydrogen solubility chart Figure 17). The hydrogen can then form bubbles in the molten aluminum as it solidifies and these bubbles are then trapped in the metal causing porosity.

Hydrogen gas from these sources can become trapped within the weld deposit and create porosity:

- Hydrocarbons – In the form of paint, oil, grease, other lubricants and contaminants.
- Hydrated aluminum oxide – Aluminum oxide can absorb moisture and become hydrated - the hydrated oxide will release hydrogen when subjected to heat during welding.
- Moisture (H_2O) – Moisture within the atmosphere can be a serious cause of porosity under certain circumstances - see the calculation of dew point table on page 22. Moisture from other external sources such as compressed air, contaminated shielding gas, or from pre-cleaning operations must also be considered.

Hydrogen Solubility in Aluminum

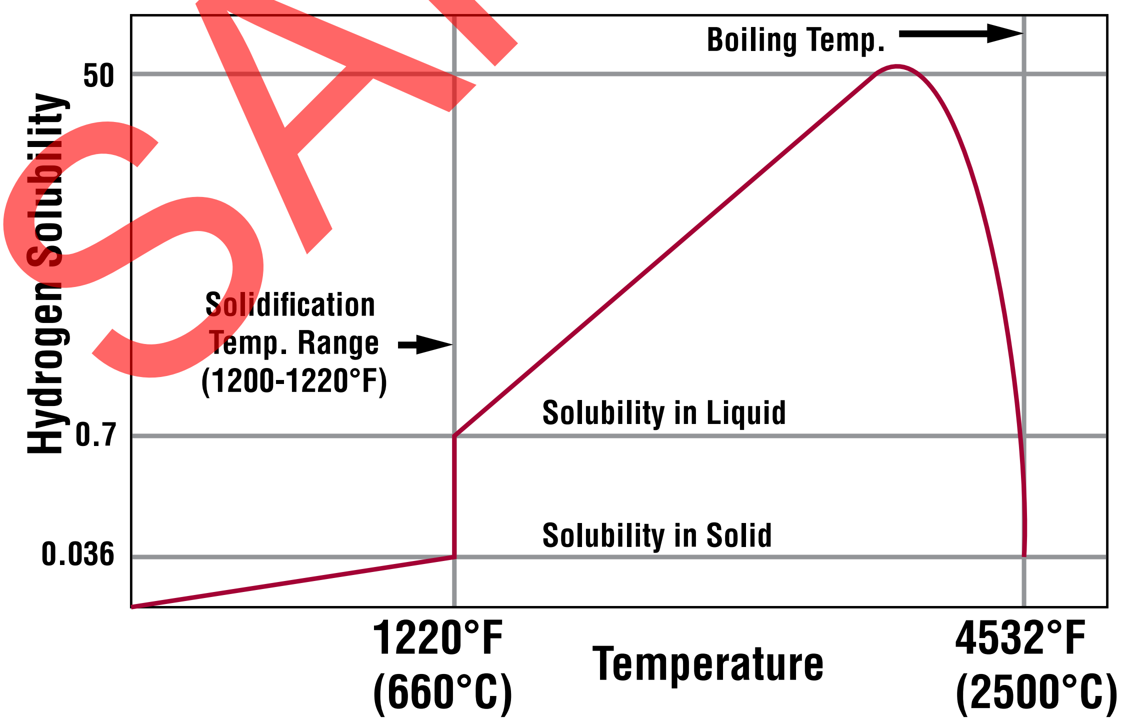


Figure 17 – Hydrogen Solubility In Aluminum