HOBART BROTHERS

Metal core Process

Basics of Welding

Metal Cored Wires
AWS Metal Core Classification

AWS A5.18

E 70 C-6 M

Electrode

Tensile (ksi)

Composite

Impact Strength
3=20 ft. lbs. @ 0 F
6=20 ft. lbs. @ -20 F

Shielding Gas
C= CO2
M= min. 75% Ar, Balance=CO2
What is Metal Core?

A composite tubular electrode consisting of a metal sheath and a core of various powdered materials, producing no more than slag islands on the face of the weld bead.
Hybrid: Characteristics & Benefits of Solid Wire & Flux-Cored Wire
How Is Metal Core Manufactured?

- Metal Powders
- Hopper
- Metal Powder Drop
- Closing Dies
- Continuous Metal Strip
- Shaping Dies
- To Drawing Operation
WHAT ARE SOME OF THE MAJOR CHARACTERISTICS OF METAL CORE?
Metal-Cored vs. Solid Wire

Metal-Cored Wire Has Higher Current Density

Metal-Core has greater ability to bridge gaps without burn through
Metal-Cored vs. Solid Wire

**Metal-Cored Wire**
- Ability to weld thin materials at high amperage w/o burn through

**Solid Wire**
- Able to use one or two electrode diameter larger than solid wire w/o burn through
Metal-Cored vs. Solid Wire

Spatter is almost non-existent with high argon levels

Metal-cored wire has wider projection area giving excellent side wall penetration
Metal-cored wire has higher current density, so, with the same electrode diameters at the same operating parameters (amperage), metal core typically has a higher deposition rate, resulting in higher travel speeds for the same size weld.
Nugget Profile
Cross Sections

METAL CORE WIRE

SOLID WIRE
14.9 Lbs./Hr. Deposition

.045” Diameter

Higher wire feed speeds for a given arc current giving higher deposition rates

13.2 Lbs./Hr. Deposition
SOLID WIRE

30% more

METAL CORE

SOLID
Wire Feeders / Drive Rolls

- Wire feeders have either two or four drive rolls to help push the wire through the liner.
- Proper type of drive is dependent upon the type of wire used:
  - U-grooved
    - Soft solid wires, eg. Aluminum
  - V-grooved
    - Hard solid wires, eg. Mild steel, stainless steel
  - V-knurled
    - Flux cored wires, Metal cored wires
Proper size drive rolls are important for good feeding.

Proper pressure on wire is also important for good feeding.

- Too much pressure deforms the wire.
- Too little pressure causes slippage resulting in erratic feeding and wear spots that can jam in the contact tip.

Wire Feeders / Drive Rolls
Contact Tips

- The main function of the contact tip is to transfer the electrical energy to the wire.
- Contact tips are made of copper for the following reasons:
  - Good conductivity
  - Can dissipate heat quickly
- Unfortunately, copper is a soft metal and the contact tips will wear over time.
- Use tight tolerance tips for Metal core.
Why is correct contact tip size so important?

Correct tip size maintains electrical contact at all times between the contact tip and the welding wire.

Oversize tips create potential condition where arc can initiate between the contact tip and the welding wire.
Metal Core Wire Set-up
Setting Welding Variables

- Gun angle
- Wire feed speed
- Voltage
- Contact Tip to Work Distance (stick-out)
- Travel speed
- Gas flow rate
- Whipping
**Welding Variables**

**Gun Angle**

Recommended technique:
- Lean gun 15°-20° into direction of travel

For Metal Cored Wires –
- Use forward (push) technique

**Direction of Travel for Metal cored wires**
- Forward (push) technique
Gun angle is also used to control bead appearance and weld quality

As seen on following slide, gun angle affects bead width, bead profile and penetration

Incorrect gun angle can cause weld defects such as:

- Undercut on fillet welds
- Lack of penetration
Welding Variables

Gun Angle Effect on Penetration

(A) Forehand (Push) Technique

(B) Torch Perpendicular Technique

(C) Backhand (Drag) Technique
Wire feed speed (WFS) is generally set at the wire feeder. WFS is proportional to the average amperage. Amperage translates to penetration. WFS is also a measure of the deposition rate. Units of WFS:

- inches per minute (ipm) or meters per minute (m/min)

The correct WFS is generally determined by:

- size of weld bead required
- weld position and thickness of material
Voltage is generally set at the power source.

Voltage is the force that causes current (amperage) to flow.

Voltage is also a measure of the heat into the weld.

Changes in voltage affect:

- Arc length
  - Arc length determines how well the weld puddle will flatten (wet) out.
- Weld bead width
- Weld bead profile
Increasing voltage will tend to increase arc length.

For example (at constant wire feed speed):

\[ X = 25 \text{ Volts} \]
\[ Y = 28 \text{ Volts} \]
Increasing voltage will tend to increase bead width.

For example (at constant wire feed speed):

\[ X = 25 \text{ Volts} \]
\[ Y = 28 \text{ Volts} \]
Welding Variables
- Correct Technique – Voltage

- Smooth consistent arc, minimal spatter, easy to manipulate arc
- Flat bead appearance, smooth transition between weld and base metal
- Good penetration at the root of the weld
Changes in the wire feed speed (WFS) and voltage settings can change the way that molten metal droplets are transferred from the end of the electrode to the weld pool.

There are three common modes of metal droplet transfer:

- **Short circuit transfer mode**
  - Lower WFS and voltage
- **Globular transfer mode**
  - Medium WFS and voltage
- **Spray transfer mode**
  - Higher WFS and voltage
Droplet Transfer Modes
Short Circuit Transfer Mode

**Features**
- Low Voltage (less than 22 volts)
- Low Amperage
- Low Heat Input
- Spatter is Common

**Applications**
- Thin Materials
- Out of Position Welding

![Graph showing Short Circuit Region with Amperage and Volts axes.](image-url)
Droplet Transfer Modes
Short Circuit Transfer Mode

Mechanics of Short Circuit Transfer Mode
Droplet Transfer Modes

Globular Transfer Mode

Features
- Medium Voltage (22 - 26 volts)
- Medium Amperage
- Low Heat Input
- Gross Spatter is Common
- Little Penetration

Applications
- Overlay
- Hardfacing
**Features**
- High Voltage (over 26 volts)
- High Amperage
- High Heat Input
- No Spatter is Common
- Fingernail-like Penetration

**Applications**
- High Deposition
- High Production Welding
- Welding Thick Materials
- Typically used for flat and horizontal fillet welding

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**Droplet Transfer Modes**

**Spray Transfer Mode**

Recommended Mode for Metal-Core Wire
Welding Variables

Contact Tip to Work Distance (stick-out)

- The tip to work distance is commonly called stick out
- The tip to work distance is the combination of the electrode extension and the arc length
- When welding, the tip to work distance should be kept relatively constant
- Changes in the tip to work distance affect the quality and appearance of the weld
Welding Variables
Contact Tip to Work Distance (stick-out)

Base material

5/8' - 3/4" Electrode stick-out

1 wire diameter from joint root
Welding Variables

Travel Speed

- For a given WFS and voltage setting an optimum travel speed is obtained for different weld sizes.
- Increases in travel speed will:
  - Decrease penetration
  - Reduces weld size
  - Reduces heat input
Welding Variables

Gas Flow Rate

- Proper shielding gas flow rate must be maintained to ensure that the molten weld puddle is protected from the atmosphere.
- Too low or too high of a gas flow can have detrimental effects on the weld quality:
  - Too low can cause lack of proper shielding.
  - Too high can cause turbulence which pulls in outside air.
- Care should be taken to protect the weld area from external drafts.
- Correct gas and or gas mixtures should be used.
- Correct nozzle diameter should be used.
Advantages of Metal core

• More parts per hour
• Better control of weld deposit
• Less spatter
• Less clean up
• Faster weld travel speeds
• Potential for less burn through
• Improved quality of parts
Questions?

• Thank You for Your Time!