

## DOWN TO THE WIRE

A guide to troubleshooting the most common self-shielded FCAW problems.

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### SELF-SHIELDED FLUX CORED ARC WELDING (FCAW)

has proven itself as a viable welding process for structural steel erection and bridge construction, among other uses. It offers high deposition rates, a wide range of mechanical properties, and good weldability, among other desirable features and benefits.

This doesn't mean that it's free of challenges and difficulties, however, as there are common pitfalls to be encountered during the normal course of self-shielded FCAW. But armed with some practical information and tips, you can avoid—or fix—these problems and maintain a high quality of welding work.

#### Wire-Feed Problems

Wire feed stoppages and malfunctions—birdnesting and burnback—are among the most common FCAW issues, especially on construction sites. More than just an annoying source of downtime, they can prematurely extinguish the welding arc and create irregularities that may weaken the weld bead.

**Birdnesting** is a tangle of wire that halts the wire from being fed. Incorrect drive rolls, tension settings, blockages in the liner, improperly trimmed liners (too short/burred/pinched), or the wrong liner (too small or large for the electrode diameter) are all sources of birdnesting.

For example, FCAW wire is a tubular consumable and therefore is much softer than GMAW solid wire. The correct drive rolls for FCAW wire are knurled V groove drive rolls. With the correct drive roll, the correct tension must also be used. Too much tension will flatten the wire and will not allow the wire to feed through the contact tip, causing a “bird's nest.”

To set the proper tension, a good technique is to start by releasing the tension on the drive rolls. Increase the tension while feeding the wire into the palm of your welding glove and continue to increase the tension one-half turn past wire slippage. Blockages in the liner can also cause birdnesting, so replace the liner if you find

a blockage. Always trim the liner according to the manufacturer's direction, and be certain you are using the correct size liner for your electrode.

When birdnesting does occur, the situation can be fixed by flipping up the drive roll and pulling the wire back out of the gun, then trimming off the affected wire and re-threading it through the feeder and back to the gun.

**Burnback** is the formation of a weld in the contact tip that occurs when the wire feed speed is too slow or if the gun is held too close to the work piece. Correcting this problem is easy: increase wire feed speed and the distance from the gun to the work piece (the contact tip should be no further than 1¼ in. from the metal). Also remember to replace the contact tip if burnback occurs.

#### Gas Discontinuities

Another set of problems with welding relates to gas. **Porosity**, for example, is a small pocket of gas caught in the weld metal that can appear at any specific point on the weld or along its full length. This discontinuity, whether internal or on the surface of the weld bead, significantly weakens the structural integrity of any weld.

A dirty work piece can cause porosity, so be sure to clean the surface of the base metal to remove rust, grease, paint, coatings, oil, moisture, and dirt prior to welding. You can also use filler wire with added deoxidizers to “clean” the weld.

Additional causes of porosity include welding wire that extends too far from the contact tip (the wire should extend no more than 1¼ in. beyond the contact tip). Impurities in the base metal, such as sulfur and phosphorous in steel, are yet another cause, but the situation can be remedied by changing the base metal to a different composition (where specifications allow).

Another gas-related problem is **worm tracking**: marks on the surface of the weld bead that are caused from the gas that is created by the flux in the core of the wire. It occurs when there is ex-



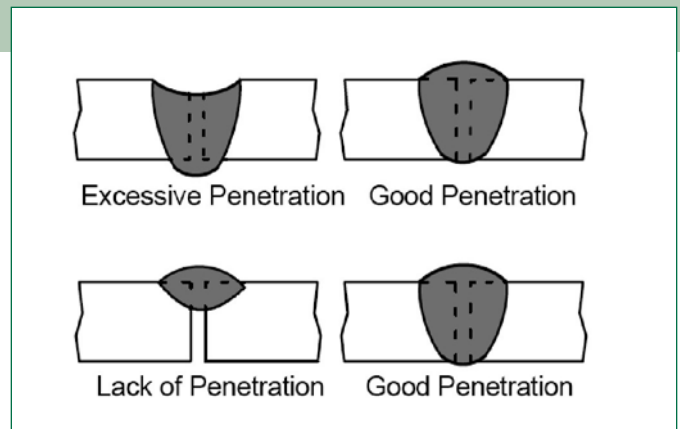
Often resulting from incorrect drive roll tension, birdnesting, as seen here, can be a frustrating source of downtime.



Caused by slow travel speed or holding the tip too close to the weld, burnback requires the contact tip to be replaced.



This image shows a combination of worm tracking and porosity, both outcomes of too much voltage. Worm tracking is both easily diagnosed and easily corrected by lowering your voltage. Porosity, seen on the face and cross section of this weld, can significantly weaken the structural integrity of the weld.



In addition to using increased current and a slower travel speed, a beveled joint can greatly reduce the occurrence of incomplete penetration.

cessive voltage for a given wire feed setting/ amperage. To prevent worm tracking, use the manufacturer's recommended parameters for a given wire diameter. If it does occur, reduce your voltage by increments of one-half volt until it no longer appears.

### Slag Inclusions

Slag is a naturally occurring part of FCAW, caused when the molten flux from the core of the wire solidifies on top of the weld. **Slag inclusions** happen when the slag gets trapped inside of the weld metal, creating the potential for weakened weld components and reduced serviceability. These inclusions can be caused by incorrect weld bead placement, incorrect travel angle, low heat input, or poor interpass cleaning.

Weld bead placement is critical when making multiple passes on thick sections of metal, especially on the root passes of plug welds or wide V-groove openings. Careful consideration must be paid to providing sufficient space in the weld joint for additional passes, particularly on root joints requiring multiple passes.

The travel angle of self-shielded FCAW can also cause slag inclusions. In general, if slag inclusions are caused by incorrect travel angle, you should increase your drag angle. In the flat, horizontal, and overhead positions, your drag angle should be between 15° and 45°. In the vertical up position, your drag angle should be between 5° and 15°.

If welding heat input is too low, this may also cause slag inclusions. Always use the manufacturer's recommended parameters for a given wire diameter. If slag inclusions still occur, increase the voltage until the inclusions cease.

### Fusion Issues

Improper fusion is another area of concern. One such problem, **undercutting**, occurs when a groove melts in the base metal next to the toe of the weld and is not adequately filled by the weld metal. This discontinuity creates a weaker area at the toe of the weld and can lead to cracking. To correct this problem, reduce the welding current, decrease the welding arc voltage, and adjust your electrode angle as needed. Reduce travel speed so that the weld metal completely fills the melted-out areas of the base metal and/or pause at each side of the weld bead when using a weaving technique.

Another fusion issue is **incomplete fusion** (or lack of fusion), the failure of the weld metal to fuse completely with the base metal or the preceding weld bead in multipass applications. Incorrect electrode/work angles that cause the weld metal to get ahead of the arc can be the culprit and should be adjusted accordingly.

To prevent incomplete fusion, place the stringer bead in its proper location at the joint, adjusting the work angle or widening the groove to access the bottom during welding. Keep the arc on the trailing edge of the welding puddle and remember to use a correct gun angle drag of 15° to 45°. If using a weaving technique, momentarily hold the arc on the groove sidewalls when welding.

If correcting the electrode/work angle does not remedy the problem, check to see if the electrode is getting ahead of the welding puddle. Simple adjustments, such as increasing travel speed or using a higher welding current, will correct the problem.

A dirty work piece can also be the cause of the problem. Always clean the surface of the base metal prior to welding to re-

move contaminants. If you suspect insufficient heat input could be contributing to incomplete fusion, select a higher voltage range and/or adjust the wire feed speed as necessary.

### Proper Penetration

Lastly, penetration is another factor in accomplishing a quality weld. **Excessive penetration** occurs when the weld metal melts through the base metal and hangs underneath the weld; it is often caused by excessive heat input. To correct the problem, select a lower voltage range, reduce wire feed speed, and increase travel speed.

At the other end of the spectrum is **lack of penetration**, the shallow fusion between the weld metal and the base metal. An obvious cause is insufficient heat input. Increasing wire feed speed, selecting a higher voltage range, and/or reducing travel speed are viable remedies.

Lack of penetration can also be caused by improper joint preparation and/or from the material being too thick. Joint preparation and design must permit access to the bottom of the groove, while also allowing you to maintain proper welding wire extension and arc characteristics.

### Quality Welds

Quality self-shielded flux cored arc welds are the result of good welding technique, the proper choice of parameters, and the welder's ability to identify a problem quickly and rectify it. Armed with some basic information, you can aggressively tackle the most common problems without sacrificing time or quality.

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