



Traditional Welding Processes

In The Twenty First Century

Traditional Welding Processes

- ▶ **SMAW:** Shielded Metal Arc welding (stick)
- ▶ **GTAW:** Gas Tungsten Arc Welding (tig)
- ▶ **GMAW:** Gas Metal Arc Welding (mig)
- ▶ **FCAW:** Flux Core Arc Welding (flux core)
- ▶ **SAW:** Submerged Arc Welding (sub-arc)



Types Of Welding Processes

A Few Examples

- ▶ Manual: SMAW, GTAW
- ▶ Semi-Automatic: GMAW, FCAW
- ▶ Machine: GMAW, FCAW, SAW
- ▶ Automatic: Robotic, Orbital

Process Selection Variables

- ▶ Cost reduction through increased productivity
 1. Deposition rates
 2. Heat input
 3. Process limitations: IE Material thickness position etc.
 4. Repeatability
 5. Operator comfort



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Welding Engineering Process Focus

- ▶ Increasing deposition rates while improving quality, maintaining code compliance, and improving operator comfort has a numerous benefits for your business.

Deposition Rates

- ▶ Manual Processes have generally lower deposition rates and higher heat inputs.
- ▶ **Examples:** Based on information obtained from the Lincoln Electric website. Using welding parameters in the upper range. 80% of max
- ▶ Manual SMAW and GTAW 1 / 8" typically deposit 2 to 4 Lbs./Hr. of electrode/rod.
Based on a 20%–40% operating factor.

Semi-Automatic FCAW GMAW

- ▶ Semi-Automatic FCAW GMAW 0.045" typically deposits 5 to 9 Lbs. /Hr. Based on a 50% to 80% operating factor.
- ▶ Machine SAW 3/32" typically deposits 10 to 14 Lbs./Hr. based on 80% to 90% operating factor.

Weave Bead Welding Myth

- ▶ Weaving/Oscillation slows the travel speed significantly and makes a large bead deposit.
- ▶ Many welders and welding operators mistakenly believe that the larger bead will fill the joint faster.
- ▶ The deposition rate is unaffected by the travel speed it is based on the electrical parameters.
- ▶ IE The hotter the parameters the higher the deposition rate.

Heat Input

- ▶ Heat input is an important factor in process selection. Excessive heat input can have an adverse effect on the micro structure of the welded joint and subsequently the mechanical properties.

Examples

Taken from PQR actual values used in tests.

- ▶ Heat input calculation Amps X Volts X 60 / Travel Speed = J/in.
- ▶ **GTAW** 180A X 14.6V X 60 / 3 IPM = **52,560 J/in.**
- ▶ **GMAW/** spray transfer. 240A X 27V X 60 / 12 IPM = **32,400 J/in.**
- ▶ **SAW** Machine 520 Amps X 31V X 60 / 19.5 IPM = **49,600 J/in.**

Process Limitations

- ▶ Size, diameter, material thickness, type of weld, and position are an important consideration in process selection.
- ▶ Small diameter valves and butt joints in pipe are generally welded with manual processes.
- ▶ SAW and GMAW–spray transfer are limited to flat and horizontal positions only.

Repeatability

- ▶ Understanding the process will increase your chances of repeatability and help with process selection.
- ▶ Process control documents such as Welding Procedure Specifications (WPS) can be a valuable tool to ensure repeatability.

Process Variables

- ▶ Getting the most out of GMAW
- ▶ Understanding how the process works is key to optimizing productivity and quality objectives simultaneously.

GMAW Transfer Modes

- ▶ Short Circuit (short arc)
- ▶ Globular Transfer
- ▶ Spray Transfer
- ▶ Pulsed Spray Transfer



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Process Parameters in Brief

0.035" Solid wire. 90% Argon 10% Co2

- ▶ Short circuit: 90–150 Amps 16–19 Volts
- ▶ Globular Transfer: 155–195 Amps 22–24 Volts
- ▶ Spray Transfer: 200–260 Amps 26–29 Volts
- ▶ *Pulsed Spray: 175–260 Amps 23–29 Volts

*Requires a Pulse Spray power source

Short Circuit

The Electrode makes contact

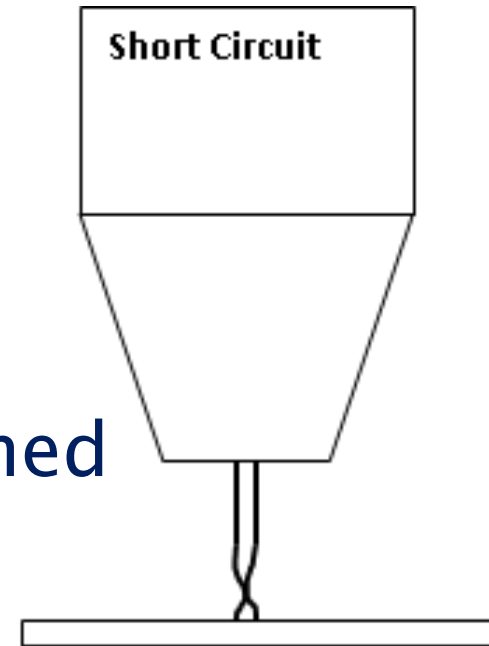
The arc ignites.

The electromagnetic field causes
a pinch effect the arc is extinguished

The wire advances and the

Arc reignites.

20 to 200 times per second.

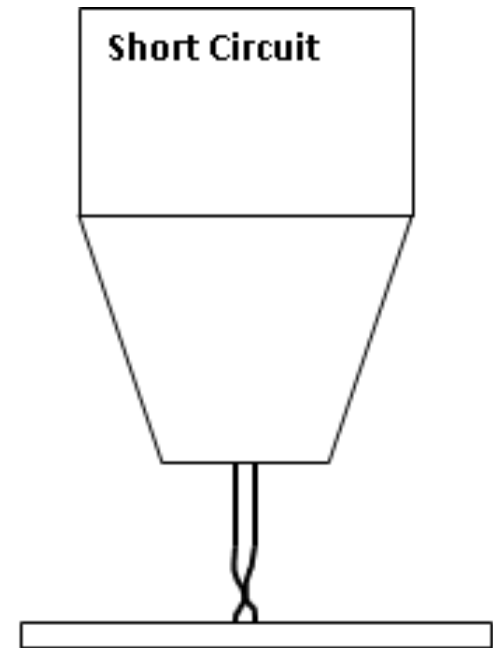


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Short Circuit

Advantages:

- ▶ Ideal for sheet applications
- ▶ Open root butt joints.

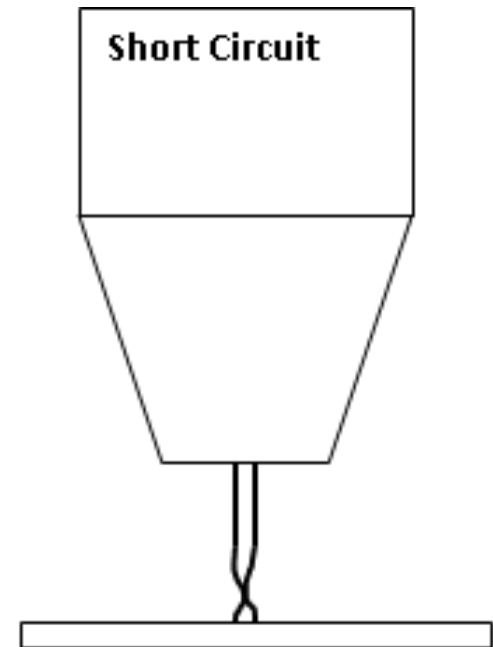


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Short Circuit

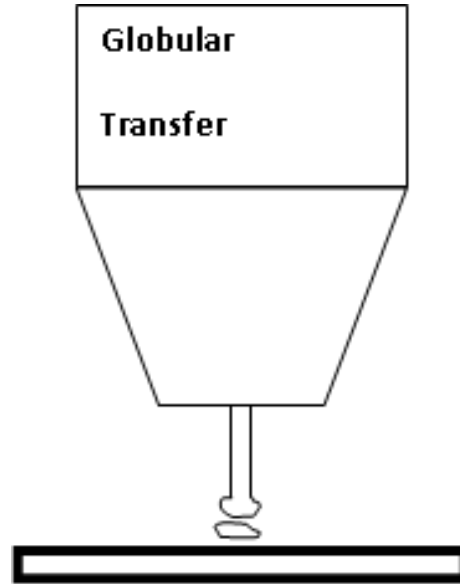
Disadvantages:

- ▶ Limited Penetration
- ▶ Limited thickness
- ▶ ASME IX limits range qualified to 1.1t in lieu of 2t.



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Globular Transfer



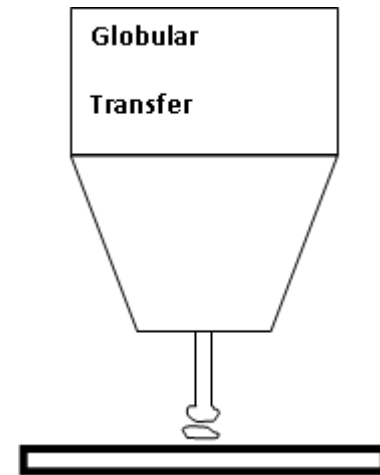
- ▶ The electrode is melted across an open arc and the electrode is transferred to the molten puddle in droplets larger in than the diameter of the wire.



Globular Transfer

Advantages:

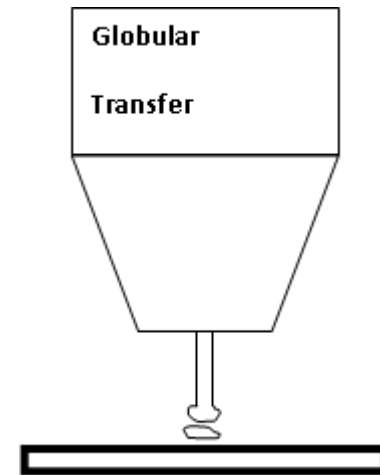
- ▶ All position welding
- ▶ Shallow wide penetration that is good for overlay and hot pass.



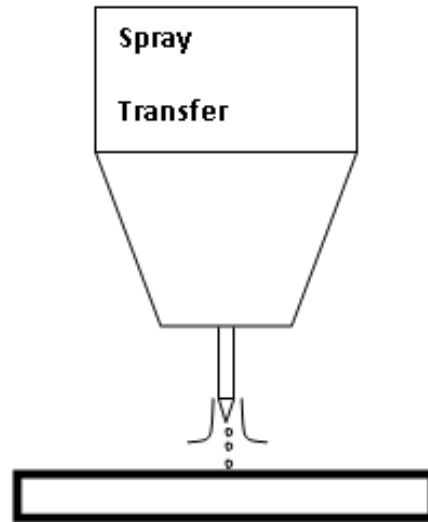
Globular Transfer

Disadvantages:

- ▶ Excessive spatter
- ▶ Fusion discontinuities in multi-layer welding
- ▶ Arc instability = operator discomfort



Spray Transfer

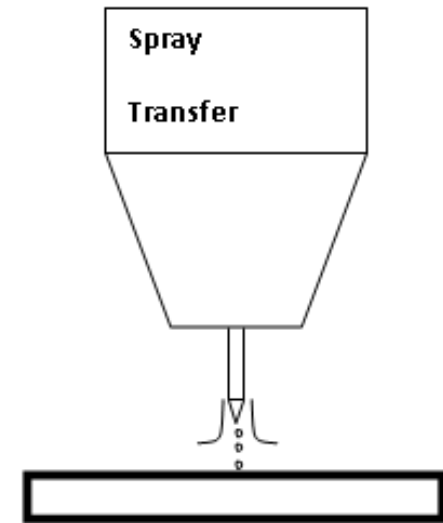


- ▶ The electrode is melted across an open arc and the electrode is transferred to the molten puddle in droplets smaller in than the diameter of the wire.

Spray Transfer

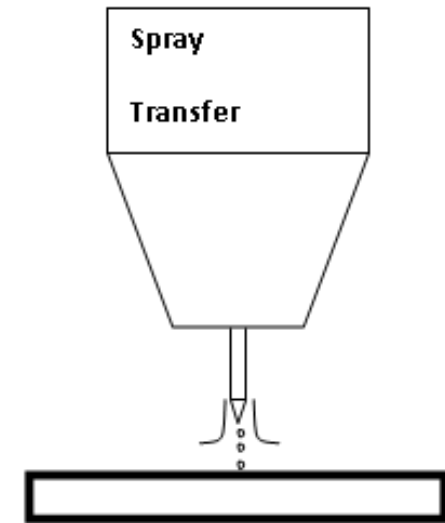
Advantages:

- ▶ No Spatter
- ▶ High deposition rates for build up and repair welds.
- ▶ Deep Penetration profile less chance of fusion discontinuities.



Spray Transfer

Disadvantages:

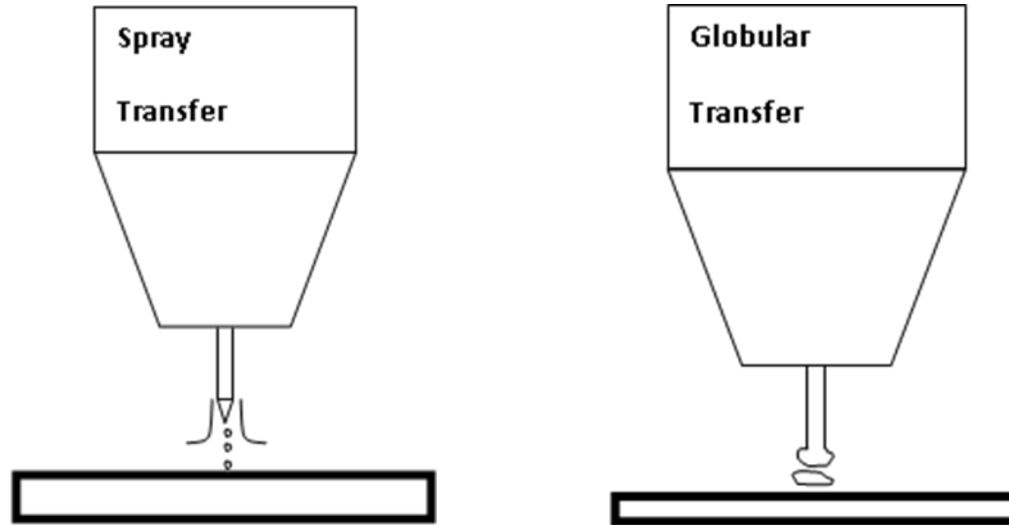


- ▶ Requires 85% to 95% Argon for best results.
- ▶ Flat and Horizontal only
- ▶ Thicker materials to prevent burn through.



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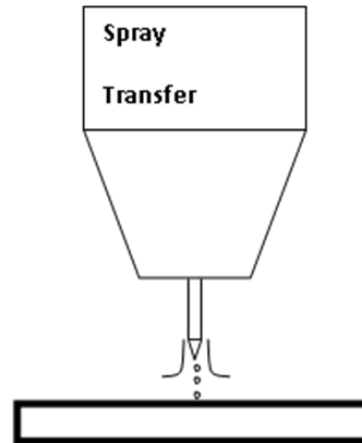
Pulsed Spray Transfer



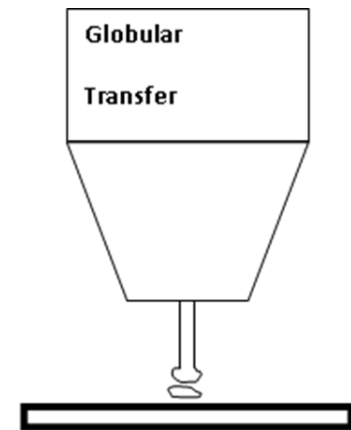
- ▶ The current vacillates between spray and globular transfer.
- ▶ The background current provides short intervals of globular transfer.

Pulsed Spray Transfer

- ▶ Advantages:

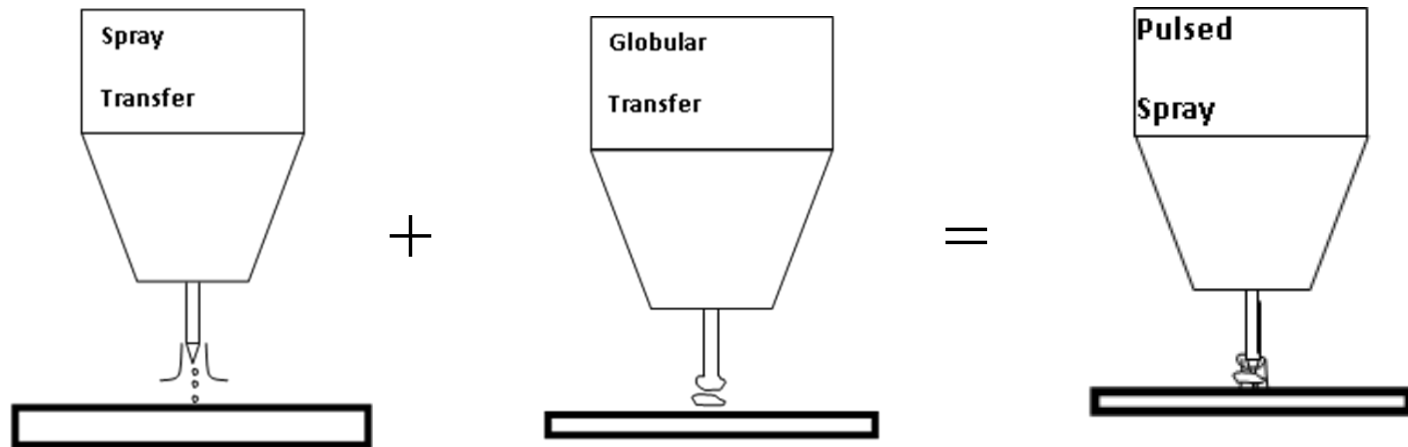


- ▶ All position welding.
- ▶ High deposition rate.
- ▶ Arc stability



Pulsed Spray Transfer

- ▶ Disadvantages:



- ▶ Operators often find it difficult to balance the amperage/ wire feed speed, with the voltage, and adjust the background current to an appropriate setting.

Conclusion

- ▶ Knowledge of optimum process parameters and capabilities can be profitable for the following reasons:
- ▶ 1) Maximum deposition rates give us faster weld times
- ▶ 2) Controlling heat input reduces stress, warpage, and harmful grain growth.
- ▶ 3) Understanding the process capabilities can save thousands of dollars by avoiding expensive and unnecessary “advanced” Equipment





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