# GMAW variables & effects

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Variables are settings or consumables that can change within GMAW and can effect the process.

On completion of this topic you will be able to identify and describe the effects of:

Arc Voltage & Metal Transfer

Wire speed and Amperage

Gas mixtures

Wire size (Current density and Deposition rates)

Travel speed

Electrode stickout

Burn back

# Arc Voltage
# &
# Metal Transfer

# Arc voltage & Metal Transfer

A GMAW power sources allow a change in the welding voltage.

Voltage is a measurement of electrical pressure.

Increasing the voltage setting on the power source increases the heat input.

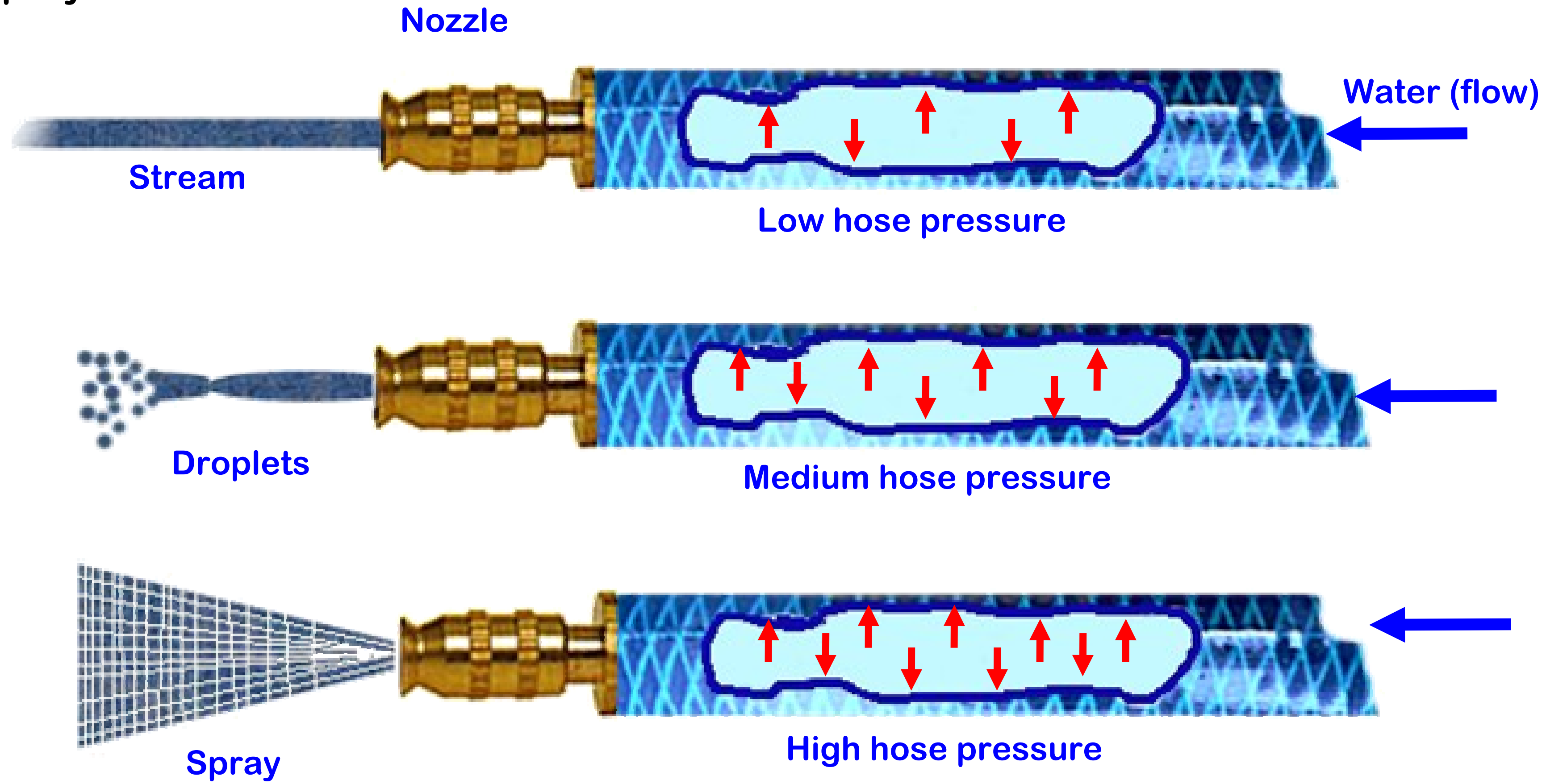
Voltage increase also changes the way molten metal leaves the electrode wire and enters the weld pool. This is known as Metal Transfer

# Arc voltage & Metal Transfer

**To see how voltage affects the metal transfer, picture a hose and adjusting the nozzle.**

**As the nozzle closes, the pressure in the hose increases.**

**Depending on the pressure, water leaves the nozzle in different forms: a stream, droplets or a spray.**



# Short arc (dip) metal transfer

Volts: 13 - 24 (LOW)

Amps: 60 - 210

Short arc transfer uses low voltage and low wire speeds (amperages).

These settings provide low heat input into the work piece, reducing the effects of heat distortion.

The electrode wire enters the weld pool whole, heats up then falls in up to 200 times a second.

The cool welds provided by short arc make it usable in all positions of welding, particularly overhead and vertical positions.

# Globular metal transfer

Volts: 20 - 28 (MEDIUM)

Amps: 200 - 280

Globular transfer sits between short arc and spray transfers. Globular transfer uses medium voltage and medium wire speeds (amperages).

Molten metal crosses the arc in small balls or globules.

Globular transfer has a better deposition rate than short arc. It is rather spattering and the resulting welds are not as smooth as those made with spray transfer.

# Spray metal transfer

Volts: 24 - 40 (High)

Amps: 200 - 400

Spray transfer uses high voltage and high wire speeds (amperages).

These settings provide high heat input, penetrating into the work piece.

Spray is only suitable in the flat position, on materials over 5mm in thickness.

High deposition flat smooth welds result from using spray transfer.

# Arc voltage & Metal Transfer

**Arc voltage and metal transfer summary.**

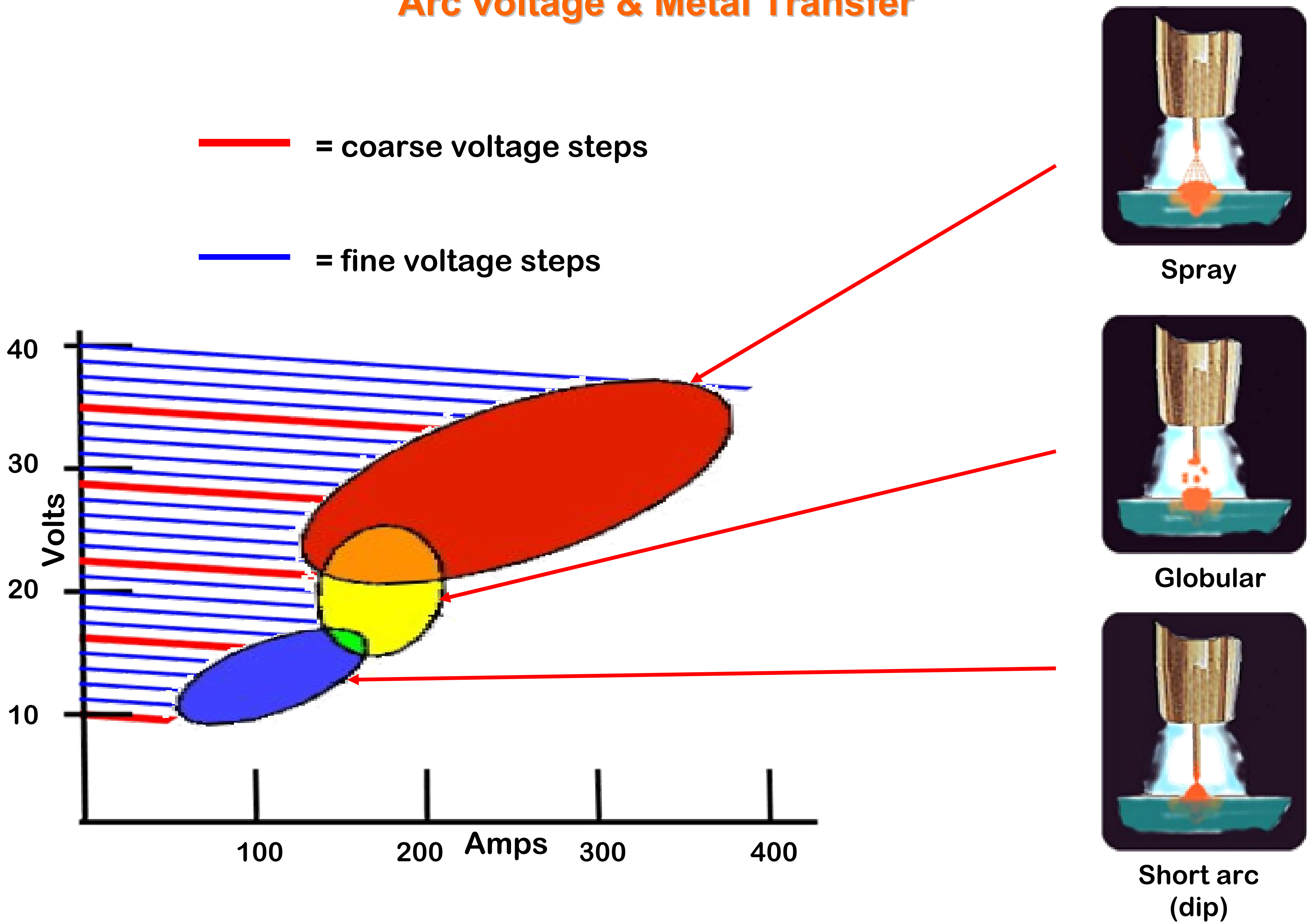
Short arc (dip)

Globular

Spray

| Transfer Type | Weld Position | Volts | Amps | Wire size | Uses |
|---|---|---|---|---|---|
| Short arc (Dip) | All | (LOW) 13 – 24 | 60 - 210 | 0.6 - 1.2mm | thin metals, root runs |
| Globular | Flat, horizontal, some overhead | (MED) 20 – 28 | 200 - 280 | 0.6 - 1.6mm | metal 3 – 5mm, capping runs |
| Spray | Flat only | (HIGH) 24 – 40 | 200 - 400 | 0.8 -1.6mm | metal over 5mm, fill runs |

# Arc voltage & Metal Transfer



# Arc voltage & Metal Transfer

Increasing the voltage :

Changes metal transfer from the arc to the weld pool.

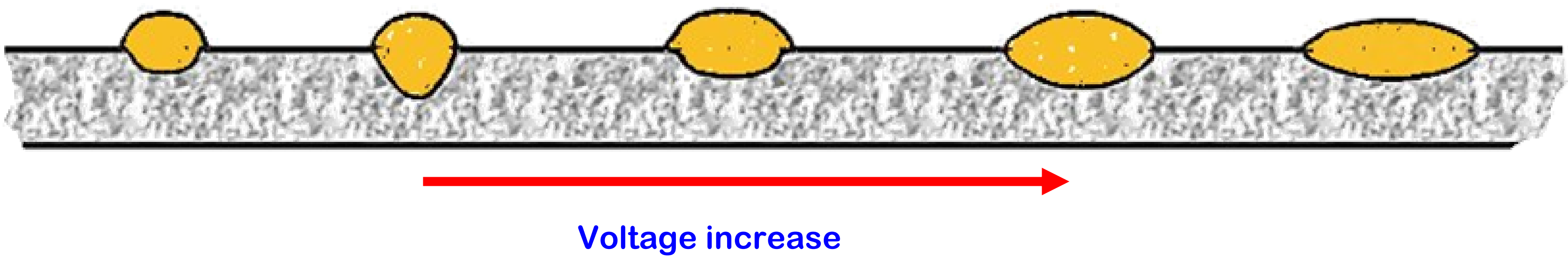
Increases the arc length and coverage.

Increases weld bead widths.

Flattens weld bead height.

Increases the heat of the arc.

The wire feed (amperage) must also be increased.



# Wire speed & Amperage

# Wire speed & Amperage

Amperage is a measurement of electrical flow.

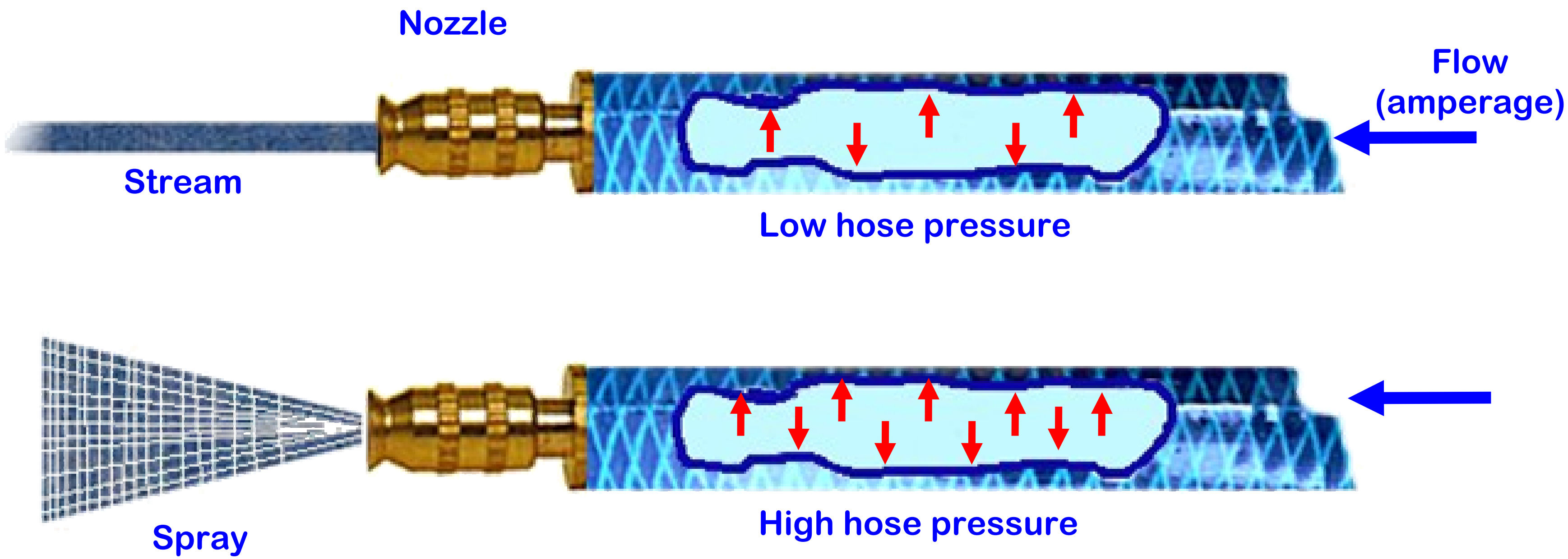
We can increase the electrical flow by increasing the wire speed.

Increasing the wire speed increases the amperage.

As the power source increases the voltage (pressure) it restricts the electrical flow.

When increasing the voltage, you must increase the wire speed (amperage).

When decreasing the voltage, you must decrease the wire speed (amperage).



# Wire speed & Amperage

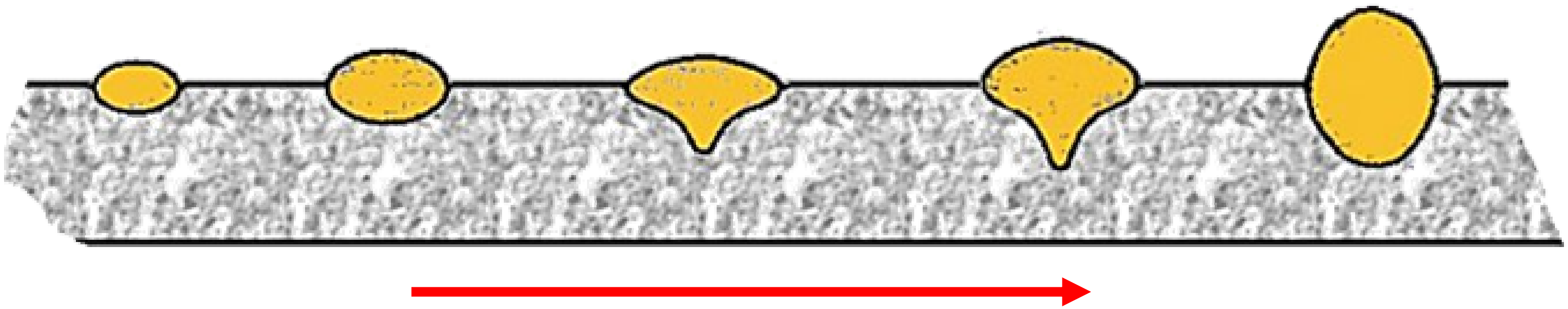
Increasing the wire speed :

Increases the amperage (electrical flow).

Increases the penetration of the weld.

Increases weld bead size.

Increases current density resulting in higher weld deposition rates.



# Wire Size (Current Density & Deposition rates)

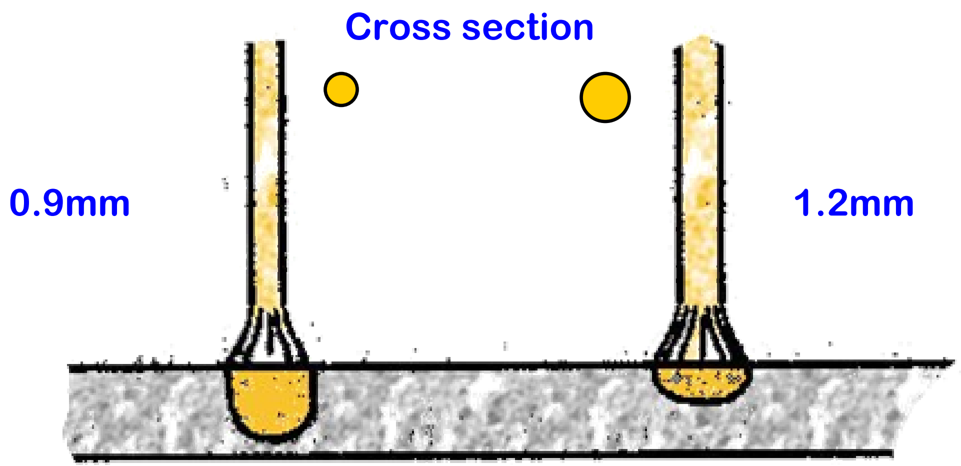
# Wire size (Current density and Deposition rates)

**The deposition rate of a wire electrode is proportional to the electrodes cross-sectional area and the current density that is passing through it.**

**The higher the current density the higher the deposition rate.**

**Calculating current densities / deposition rates, allow wires of different sizes, running at different amperages to be compared.**

**Which wire has the highest current density / higher deposition rate at 200 Amps?**



# Wire size (Current density and Deposition rates)

**Current density = Amperage ÷ Cross sectional are of the wire**

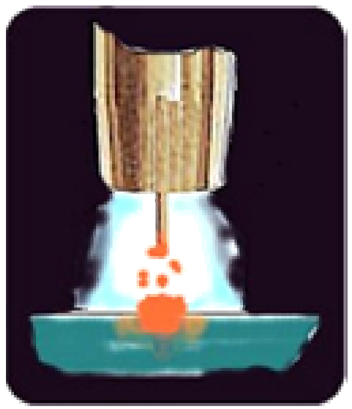
| Wire size | Cross-sectional area (diameter x π) | Current (Amps) | Current density | Deposition rate kg/hour |
|---|---|---|---|---|
| 0.9mm | 0.9 x 3.1416 = 0.636$mm^2$ | 200Amps | 200 ÷ 0.636 = 314.46 | Higher |
| 1.2mm | 1.2 x 3.1416 = 1.13$mm^2$ | 200Amps | 200 ÷ 1.13 = 176.99 | Lower |

**After the calculations it can be seen that despite using bigger wire size it does not achieve greater depositions.**

**For a 1.2mm wire to achieve deposition rate equal to the 0.9 wire, higher voltages and amperages would be required.**

**Put simply, the spray transfer settings for a 0.9mm wire when used for 1.12mm wire, will create a globular transfer. Hence lower deposition.**

**0.9mm wire diameter**
**200Amps**
**Spray transfer**
**Higher deposition**



**1.2mm wire diameter**
**200Amps**
**Globular transfer**
**Lower deposition**

# Gas Mixtures

# Gas mixtures

**Various shielding gases are available for different uses and characteristics:**

| Gas Type | Metal to weld | Bottle colour | Characteristics |
|---|---|---|---|
| **Argon** | Aluminium, non-ferrous metals | Peacock blue | Smooth weld, quick freezing, shallow penetration, not recommended for steels. |
| **$CO^2$ (carbon-dioxide)** | Low carbon steels | French grey | Reactive gas, deep penetration, high heat input, low cost, heavy spatter, requires a regulator heating unit. |
| **Argon + $CO^2$** | Low carbon steels | Peacock blue<br>French grey | Reactive gas, argon decreases spatter and protects arc, $CO^2$ increases heat and reduces costs |
| **Argon + $CO^2$ + Oxygen** | Low carbon steels | Peacock blue<br>French grey<br>Black | Reactive gas, medium penetration, good mechanical properties |

# Gas mixtures

**Choosing a different shielding gas may:**

**Control spatter levels.**

**Allow thin or thick metals to be welded better.**

**Improve bead profile (shape and smoothness).**

**Increase the depth of penetration.**

**Increase the speed of welding.**


**The recommended flow rate for the shielding gas is 14 to 18 Litres/Min.**

**High flow rates are wasteful, costly and can cause turbulence that will draw the atmosphere in to the weld area causing porosity.**

# Travel speed

# Travel speed

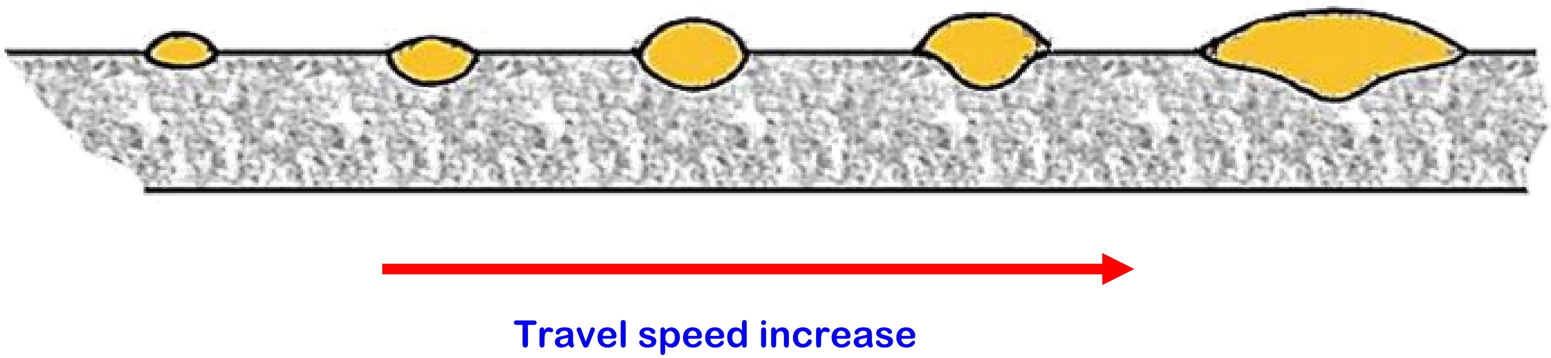
**Travel speed influences:**

**Bead height and width.**

**Heat input per metre.**

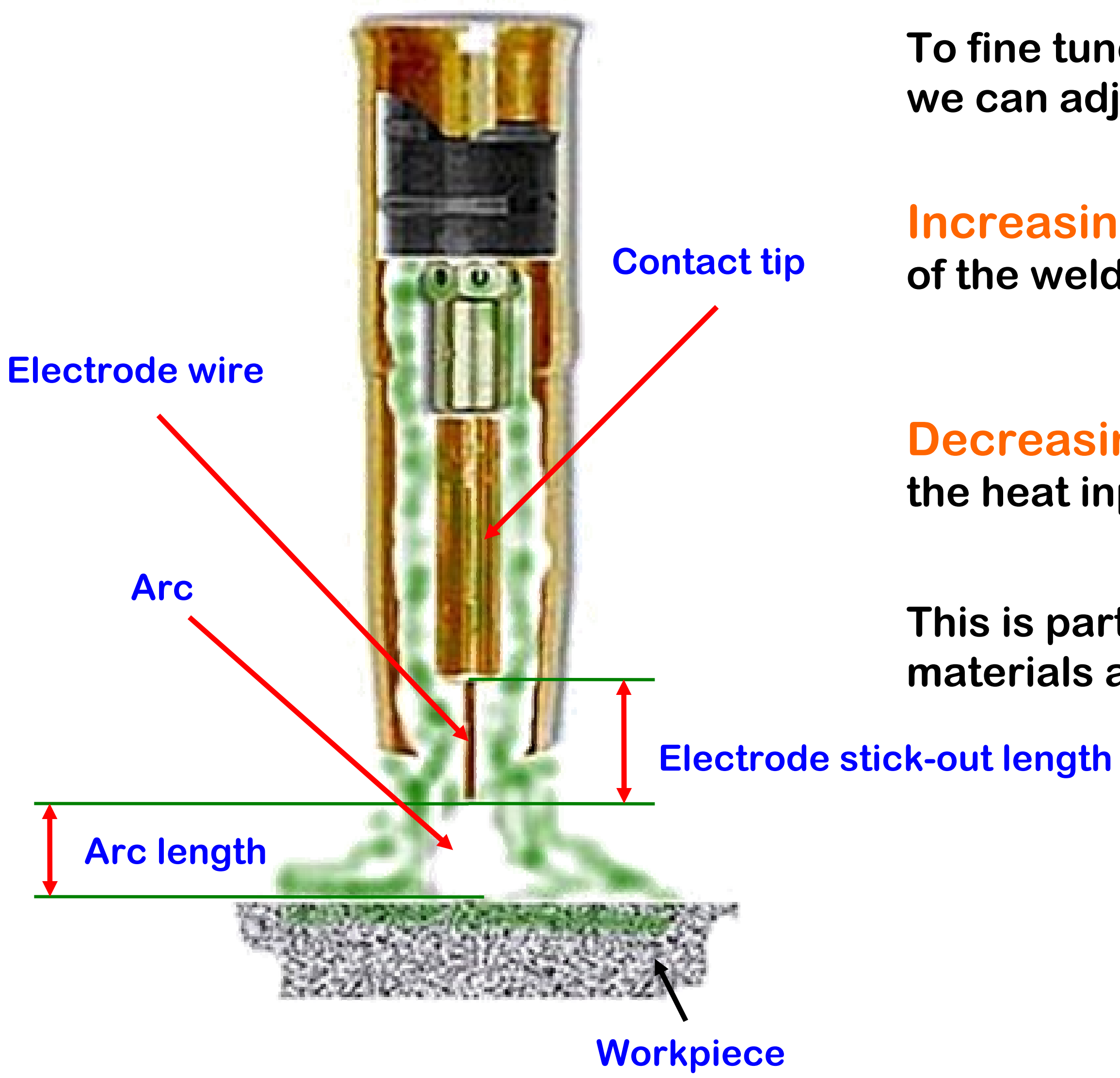
**Deposition rate.**

**Penetration and  burn-through on sheet metals.**



# Electrode stick out

# Electrode stick-out




To fine tune settings while actually welding we can adjust the electrode stick-out length.

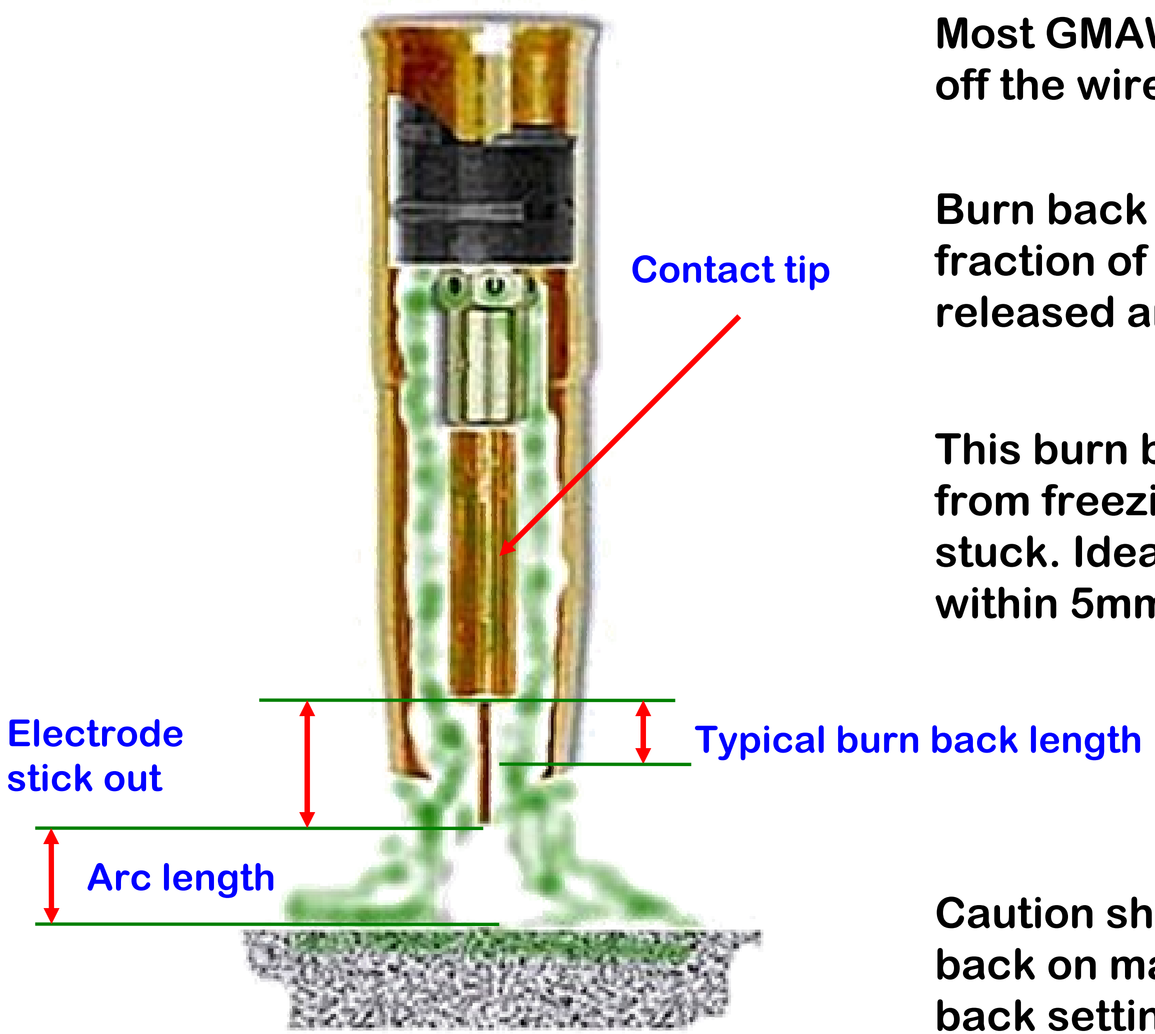
Increasing the stick-out decreases the heat of the weld pool.

Decreasing the stick-out length increases the heat input into the weld pool.

This is particularly handy for welding thin materials and preventing burn through.

# Burn back

# Burn back




Most GMAW units have automatic burn back off the wire electrode.

Burn back continues the welding current for a fraction of a second after the trigger is released and the wire feed stops.

This burn back prevents the wire electrode from freezing in the weld pool and being stuck. Ideally the wire should be burnt back to within 5mm of the contact tip.

Caution should be taken when setting burn back on machines that have manual burn back settings. To much burn back and there is a risk that the wire will burn back and fuse to the contact tip.