Casting Forming and Welding Lab (ME39007)
Experiment No. 2: Gas Metal Arc Welding (GMAW or MIG)

Objectives

- To study the characteristics of GMAW process
  - The effect of heat input on bead parameter
  - Influence of process parameters on the weld quality
- To study the importance of pulsed DC in an arc welding process

Equipment:

- GMAW machine
- Argon cylinder with Argon gas,
- Trolley to mount the work piece which moves in at variable speeds,
- Vernier callipers, Microscope

Theory

Gas metal Arc welding uses a continuously fed electrode wire to deposit weld bead in the inert gas atmosphere such as Argon. The GMAW machine can be operated in two modes. Either normal mode or Pulsed mode.

- Consumable wire electrode is fed continuously and automatically from a spool through the welding gun
- Inert shielding gas: protects the arc and the molten or hot, cooling weld metal from air. Also, provides desired arc characteristics through its effect on ionization
- No electrode coating
- No flux or additional filler
- DCRP used (electrode +ve, work –ve)

Pulsed DC in Arc welding

In normal mode the machine is operated at constant voltage and current. In Pulse mode the heat input is supplied in the form of short pulses at the period in milli seconds. In the pulse mode the machine is operated at peak current to melt the electrode wire for a very short period of time.

After the melting period the voltage and current are lowered to a very low value which can sustain the arc but not used in melting the electrode .This voltage and

current termed as back ground voltage and background current. During this background period cooling of the weld bead takes place. The process of applying peak and background pulse are repeated during the welding process.

- Pulsed GMAW result in a very good bead shape with less amount of residual stress due to pulsing of current and voltage.
- The higher pulsing rates increase puddle agitation → a better grain molecular structure within the weld
- High speed pulsing constricts and focuses the arc; Increases arc stability, penetration and travel speeds
- Reduces arc blow (created by influence of magnetic field)
- A smaller heat-affected zone
- 4 Variables: peak amperage, background amperage, peak time and pulse rate

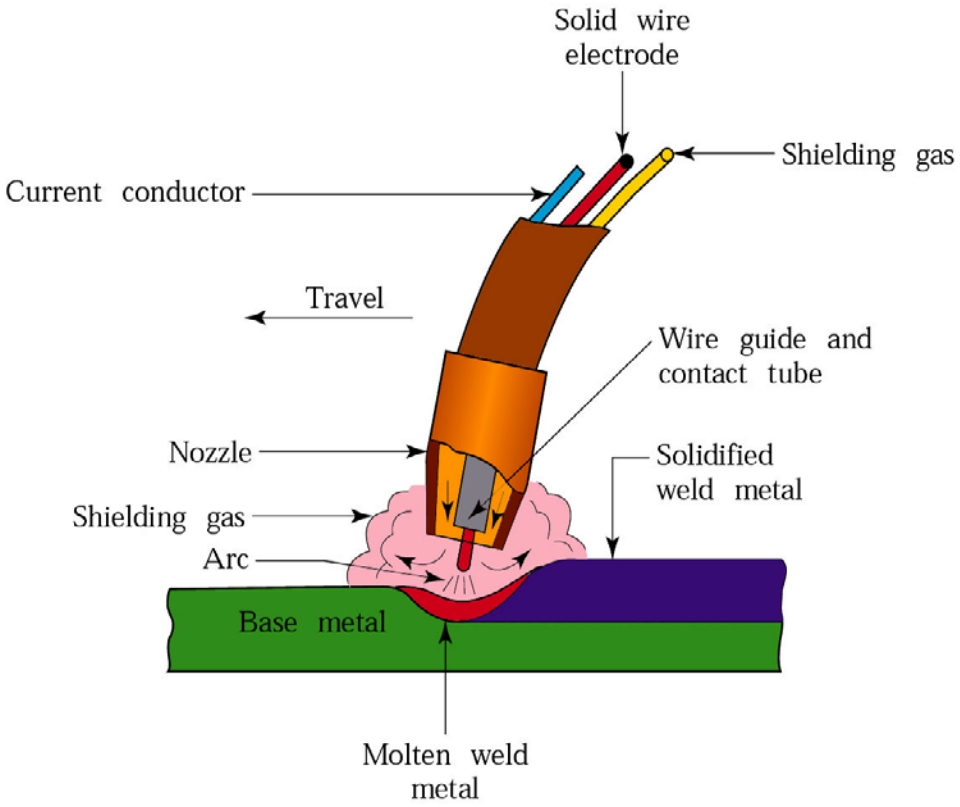

Figure 1. Schematic of Gas metal Arc Welding (GMAW)

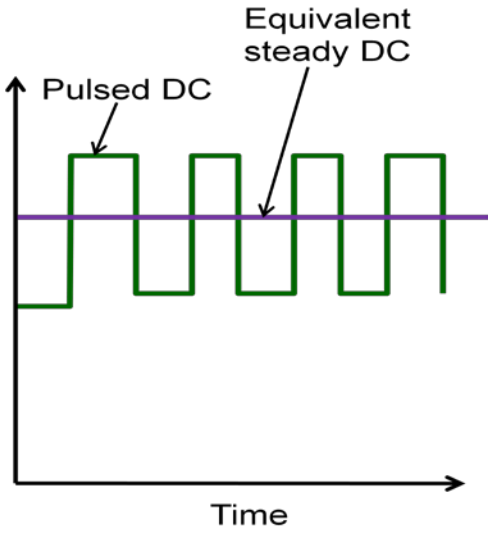

Figure 2. Pulsed DC

Experimental procedure

The GMAW machine has a control panel by which it can be operated either in normal mode or in pulse mode. Derived parameters like peak voltage, background voltage, pulsing time, arc pressure and wire feed rate can be set before welding. These parameters can also be stored in different programs which can be later used depending on application.

Once welding parameters are set they are locked and welding can be started. The workpiece is mounted on the welding can be started. The workpiece is mounted on the trolley which is set at required welding speed. Before striking the arc the inert gas supply is turned on at the desired flow rate and also cooling water supply. Bead is deposited for stipulated time, average current is recorded and welding is stopped. The experiment is to continue at different welding speeds at constant peak voltage background current, arc pressure and welding wire feed rate. After the depositing the weld beads the average bead heights and widths are measured by a Vernier.

Observations

1. Peak voltage V_p = V
2. Background voltage V_b = V
3. Welding wire feed rate = mm/sec
4. Frequency = Hz
5. Gas flow rate = L/min

Table 1

Sl. No	Feed rate/ Welding Speed (mm/s)	Average Bead width(mm)	Average Bead Height (mm)

Heat Input = $\eta \frac{VI}{\vartheta}$ J/mm

Where,

η= Efficiency of welding.

V= Average voltage (V)

I= Average Current (A)

ν= welding speed (mm/sec)

Efficiency calculations

Electrode Material = Cu coated Mild steel

Diameter d = 1.2 mm

Density ρ = 7.84 gm/cc

Heat capacity Cp = 620 J/gmK

Latent heat L =275 J/gm

Heat Input = $\frac{\pi d2}{4}\rho[Cp\Delta T + L]$ (in J per unit length)

Table 2

Sl. No.	Feed rate/ Welding Speed (mm/s)	Average Voltage V	Average Current I	Efficiency (%)

Some Points for Discussion

- Why do we use a constant voltage supply?
- Which mode (normal or pulse) gives better bead quality?
- Influence of welding speed / feed rate on the bead quality?
- What are the factors affecting the efficiency?

Appendix

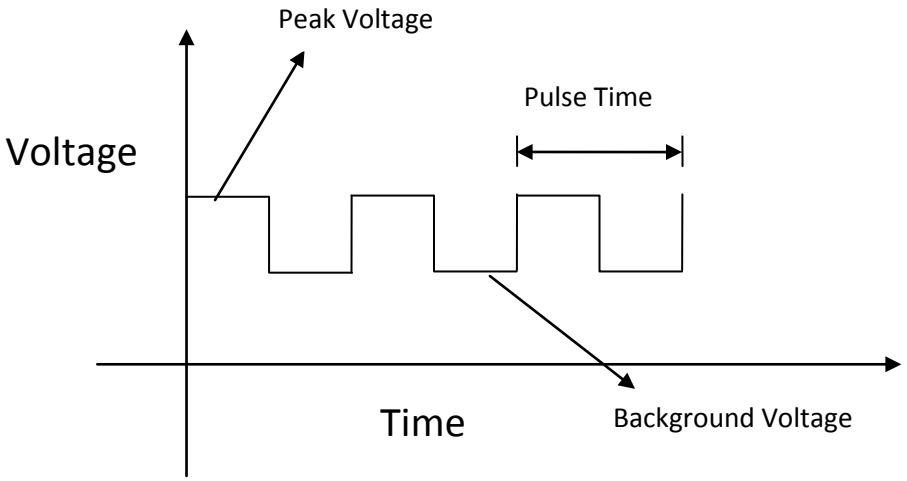

Fig 3- Time vs Voltage plot.

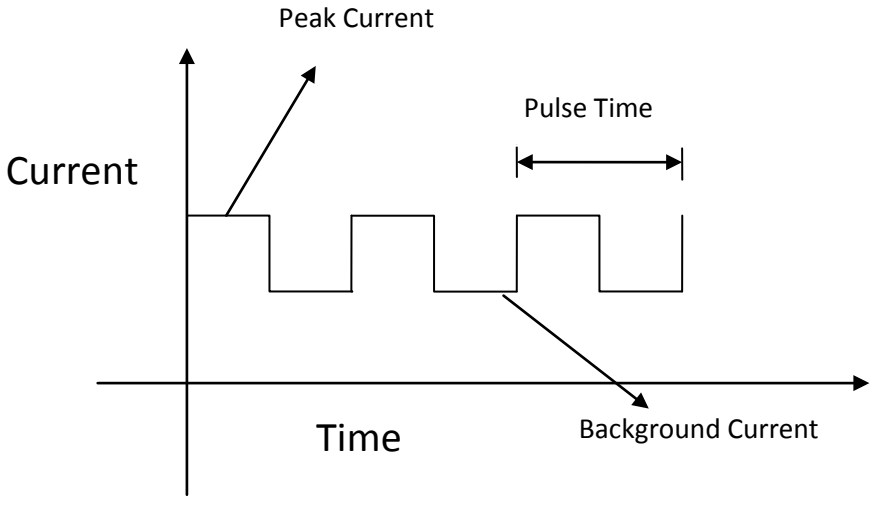

Fig 4 - Time vs Current plot.