Gas Shielded Welding Processes

Plasma Arc Welding (PAW)
PAW: Process Fundamentals

- In PAW the heat source is an arc maintained between a non-consumable electrode and the workpiece.
- The arc is constricted by a cooled orifice that surrounds the electrode.
- Inert gas is supplied separately to the orifice and to a surrounding low-velocity shielding flow.
PAW: Comparison with GTAW
PAW: Effect of Arc Constriction

GTAW  PAW  Arc Temperatures

- >24000K
- 18000 - 24000 K
- 14000 - 18000 K
- 10000 - 14000 K

200 A, 15 V
PAW Modes

CONSTRUCTING NOZZLE

ORIFICE GAS

SHIELDING GAS

TRANSFERRED ARC

NON-TRANSFERRED ARC
PAW: Keyhole technique
PAW: Welding Procedures

Keyhole welding of stainless steel sheet

![Graph showing relationships between T, B, C, and A](image)

- **T** = Material Thickness
- **B** = Upper Clamp Spacing
- **C** = Back-up Bar Spacing
- **A** = Weld Current
PAW: Backing for Keyhole Welding
PAW Welding Equipment

START/STOP SWITCH

COOLANT CIRCULATOR

TORCH

ORIFICE GAS

SHIELD GAS

POWER & COOLANT IN

POWER & COOLANT OUT

WORK

WELDING POWER SOURCE

GAS

REMOTE CURRENT CONTROL

Lecture 5
PAW Applications

- Very thin sheet (down to 0.1 mm), wire and mesh sections in microplasma mode
- Full penetration welding of sheet and plate up to about 5mm thick in single pass keyhole mode.
- Keyhole mode usually in flat position, rarely for tube and pipe welding
- Melt-in mode applications similar to GTAW
## PAW Capabilities & Limitations

<table>
<thead>
<tr>
<th>+ Higher intensity heat source than GTAW</th>
<th>- Little tolerance for joint misalignment</th>
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<tr>
<td>- higher welding speeds</td>
<td>- Torch orifice must be well maintained for consistent weld quality</td>
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<td>- reduced heat input and distortion</td>
<td>- PAW torches are more bulkier and more difficult to manipulate manually than GTAW</td>
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<td>+ Insensitive to torch stand-off distance</td>
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<tr>
<td>+ Applicable to almost all metals</td>
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<tr>
<td>+ Adaptable to precision mechanized applications</td>
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Electron Beam
&
Laser Welding
EBW, LBW Fundamentals

- Heat source is radiant energy from focused beam of electrons or photons (light)
- Shielding from atmospheric contamination by welding in vacuum chamber (EBW), inert gas shield (LBW)
## LBW, EBW Capabilities and Limitations

| + Very high energy density heat sources | - Little tolerance for joint misalignment |
| + Very deep penetration in "keyhole" mode | - EBW requirement for vacuum chamber limits maximum size that can be welded |
| + Narrow welds and HAZ | - Equipment is complex and costly. |
| + High welding speed | |
| + Reduced heat input and distortion | |
| + Adaptable to precision mechanized applications | |