

Bypass Arc Welding Process for Weld Distortion Reduction

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Motivation

Current Processes:

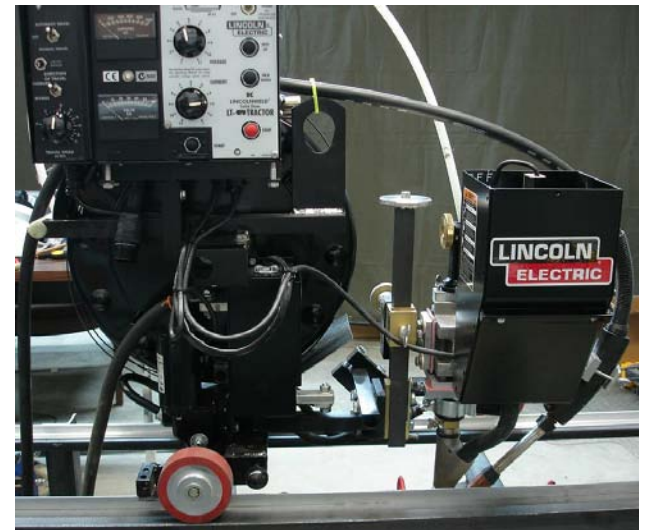
- Gas Metal Arc Welding (GMAW)
- Submerged Arc Welding (SAW)
- Flux Cored Arc Welding (FCAW)

Productivity Issues:

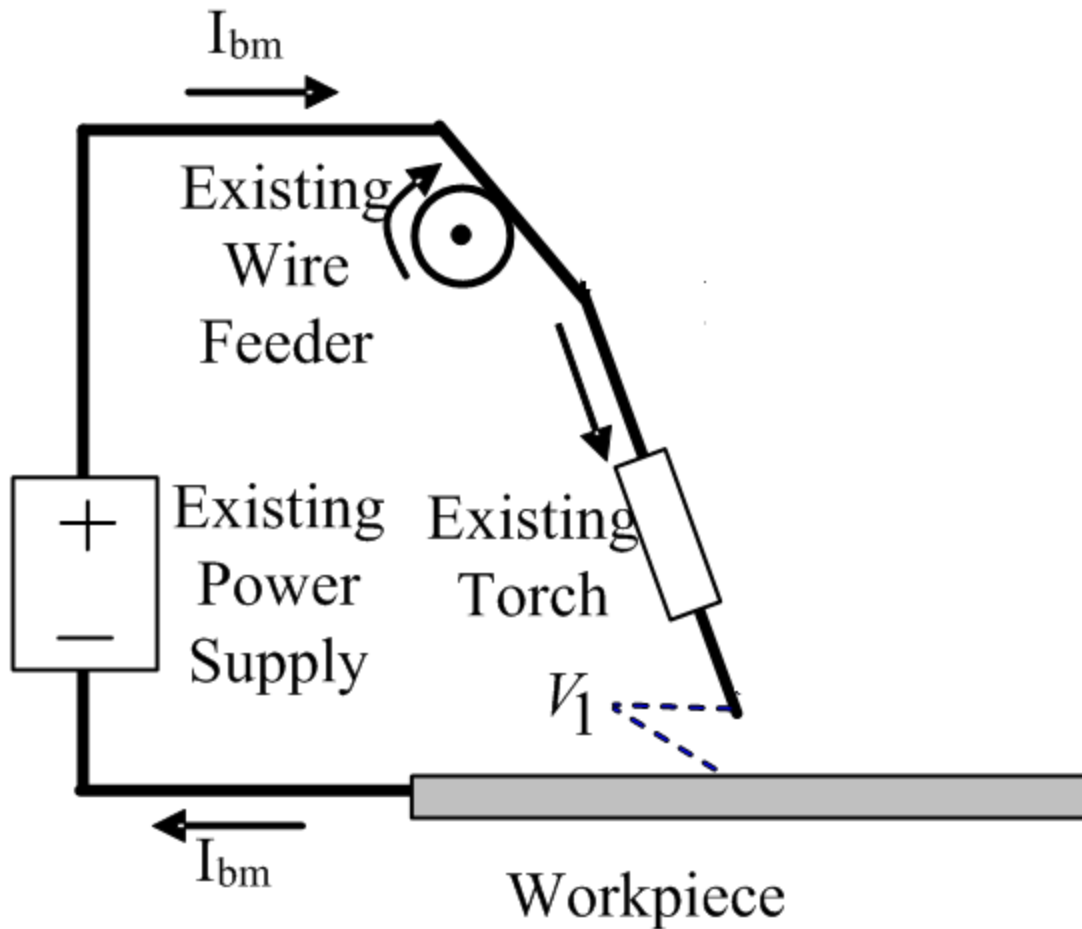
- large heat inputs cause distortion
- multiple pass two-sided needed ($>1/2$ ") panels
- large gaps require manual pre-fill

What is Needed?

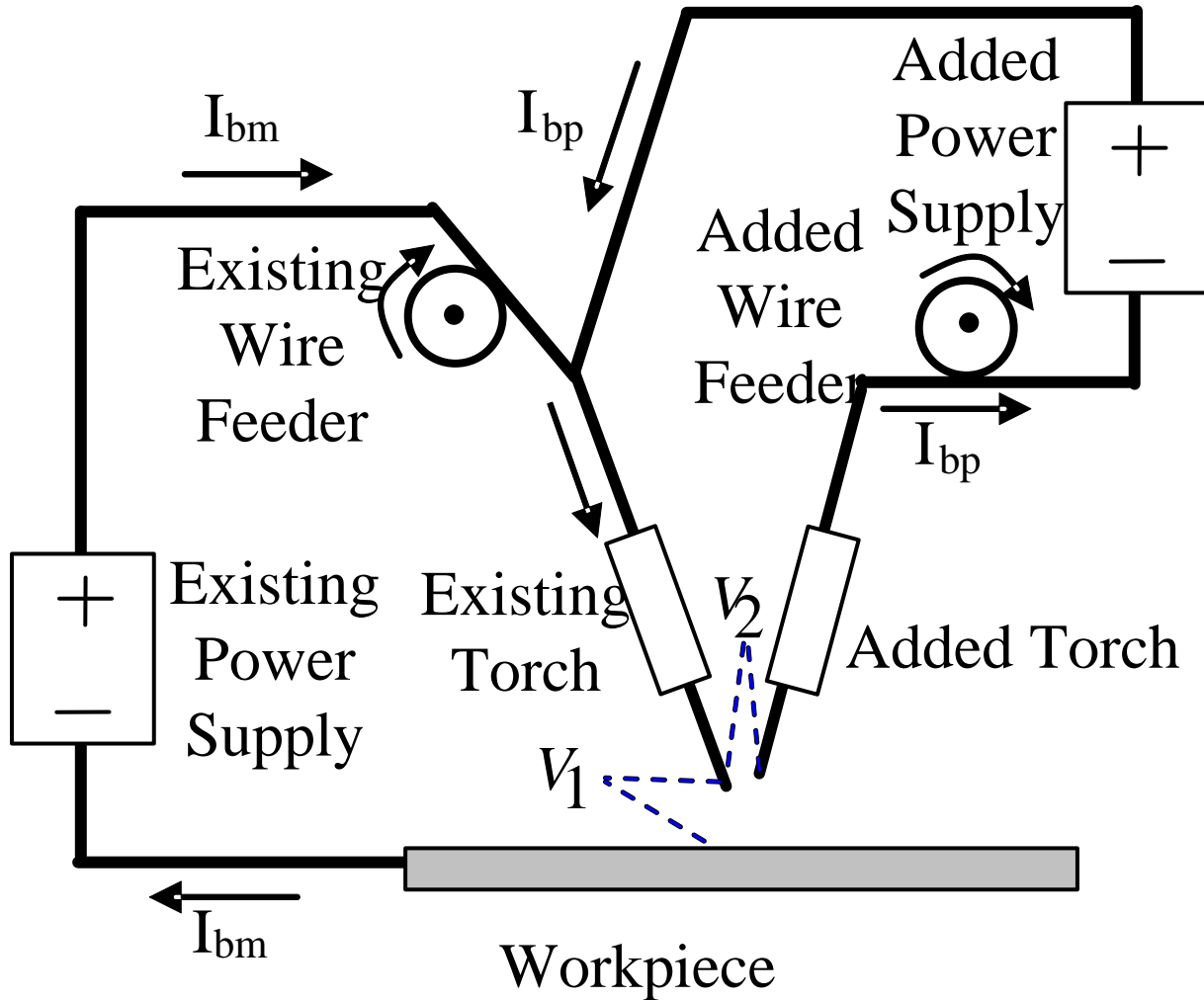
- reduced heat input and distortion
- reduced number of passes
- single side welding
- large ($1/4$ ") gaps without pre-fill



AIS Solution



AIS Solution





Proven AIS Bypass Torch Procedures

- Single-sided Single-pass Welding: up to ½ inch (can be much thicker)
- Large Gap up to ¼ inch without Pre-fill
- LT-7 Tractor with GMAW Bypass Torch → Easy transition (can be Seamer with GMAW Bypass Torch)
- Ceramic Backing (can be copper backing)

AIS Bypass SAW vs. Benchmark

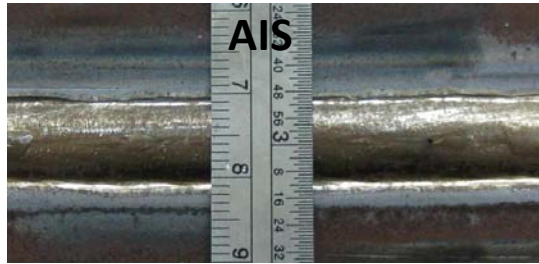
3/8 inch plate

Benchmark	Heat Input (KJ/In)	Distortion (mm)	Avg. Wb (mm)	Min Wb (mm)	Max Wb (mm)
Exp. 1	92	5	4	0	7
Exp. 2	100	8	11	6	13
Exp. 3	107	15	14	13	15

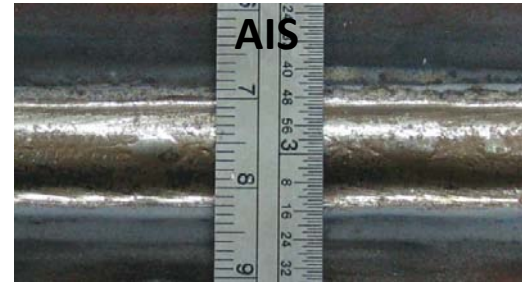
AIS Bypass SAW	Heat Input (KJ/In)	Distortion (mm)	Avg. Wb (mm)	Min Wb (mm)	Max Wb (mm)
Exp. 1	72	2	10	9	11
Exp. 2	71	3	11	10	12

Root Face Weld Comparison

3/8 inch plate comparison

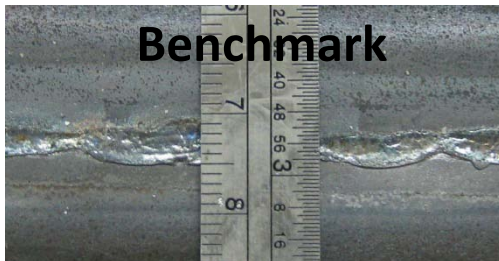


Exp #1: 72 kJ/In (2 mm)



Exp #2: 71 kJ/In (3mm)

(consistent penetration, small difference in front and root face weld width)



Exp #1=95 kJ/In (5 mm) Exp #2=100 kJ/In (8 mm) Exp #3=107 kJ/In (15 mm)
(#1 and #2: inconsistent penetration, large difference in front and root face weld width; #3: improved penetration consistence, much increased distortion)

Distortion Comparison

**3/16 Inch Plate (each plate: 4 in. wide, 3 ft long)
single-sided single-pass process**



AIS: end point distortion 38 mm

Benchmark: end point distortion 61 mm

Distortion Comparison

**3/8 Inch Plate (each plate: 4 in. wide, 3 ft long)
single-sided single-pass process**



AIS: end point distortion 2 mm

**Benchmark: end point distortion 8 mm (using a minimal acceptable one,
more consistent penetration increases distortion to 15 mm)**

Distortion Comparison

**1/2 Inch Plate (each plate: 4 in. wide, 3 ft long)
single-sided single-pass process**



**AIS: end distortion 2 mm
Benchmark: end distortion 6 mm**

State of Development

- Prototype system demonstrated at AIS
- Prototype system tested for 9 months
- New welding procedures developed. Consistent welds meeting requirements.
- Substantial heat input and distortion reduction confirmed for all thicknesses
- Substantial productivity improvement confirmed
- Shipyard evaluations: to be completed

