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ANALYSIS OF WELDING DEFECTS IN STBW

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Abstract--* *The number of different welding processes has grown in recent years. These processes differ greatly in the manner in which heat and pressure (when used) are applied, and in the type of equipment used. There are currently over 50 different types of welding processes. To control the Undercut, travel speed should not be too long, Welding voltage should be maintained at correct level, The chosen electrode should not have large diameter, Arcs should not be too long, Clean weld surface prior to welding, Welding current must not be too high, Electrode should not be inclined at time of welding.

To eliminate use low-hydrogen welding process, increase shielding gas flow, one pre-heat or increase heat input, clean joint faces and adjacent surfaces, change welding conditions and techniques, use copper-silicon filler metal reduce heat input, use E6010 electrodes, use electrodes with basic slugging reactions. Proper alignment of tubes in root of weld joint, Bore should be concentric at ends, Welding current should be adjusted to appropriate level, Rotation of chuck must be controlled, Wire stick out should not be too short to avoid excess Penetration.

Index Terms — Wire Stick, Chuck, E6010 electrodes, low-hydrogen welding process

I. INTRODUCTION

A *weld* is made when separate pieces of material to be joined combine and form one piece when heated to a temperature high enough to causes offtering or melting. Filler material is typically added to strengthen the joint.

Welding is a dependable, efficient and economic method for permanently joining similar metals. In other words, you can weld steel to steel or aluminium to aluminium, but you cannot weld steel to aluminium using traditional welding processes. Welding is used extensively in all sectors or manufacturing, from earth moving equipment to

the aerospace industry. The most popular processes are shielded metal arc welding (SMAW), gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW). All of these methods employ an electric power supply to create an arc which melts the base metal(s) to form a molten pool. The filler wire is then either added automatically (GMAW) or manually (SMAW & GTAW) and the molten pool is allowed to cool.

Finally, all of these methods use some type of flux or gas to create an inert environment in which the molten pool can solidify without oxidizing.

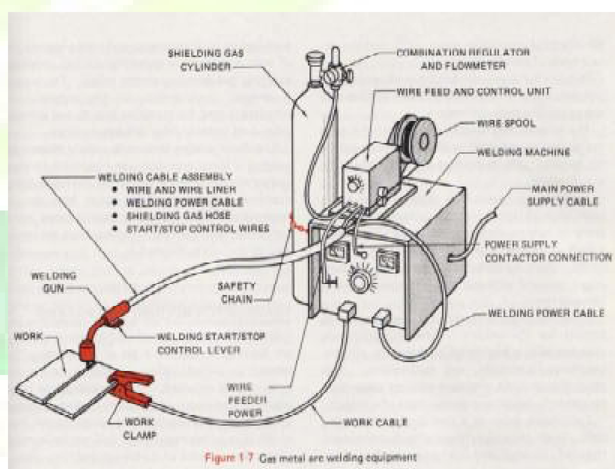

Fig.1. Gas Metal Arc Welding (GMAW)

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In the GMAW process, an arc is established between a continuous wire electrode (which is always being consumed) and the base metal. Under the correct conditions, the wire is fed at a constant rate to the arc, matching the rate at which the arc melts it. The filler metal is the thin wire that's fed automatically into the pool where it melts. Since molten metal is sensitive to oxygen in the air, good shielding with oxygen-free gases is required.

This shielding gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, GMAW is commonly known as MIG (*metal inert gas*) welding. Since fluxes are not used (like SMAW), the welds produced are sound, free of contaminants, and as corrosion-resistant as the parent metal. The filler material is usually the same composition (or alloy) as the base metal.

II. WELDING DEFECTS

- Performance & longevity of welded structure in service depends on:
- The presence or absence of defects in weld joints.
- Not possible for the welds to be completely sound
- Improper welding parameters & wrong welding procedures introduce defects in the weld metal and HAZ
- Defects impair the strength of weld joints
- A defective weld men fails under service conditions & causes damage to property & loss of human lives
- The defects in the weld can be defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination of filler metal and parent metal. It can simply be defined as:
- "Defects introduced during welding beyond the acceptance limit that can cause a weld to fail".
- A defect does not allow the finished joint to withstand the required strength (load).

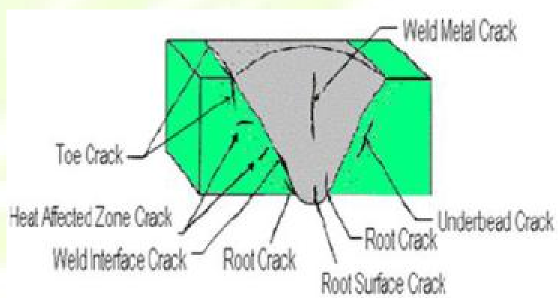
CLASSIFICATION OF WELDING DEFECTS:

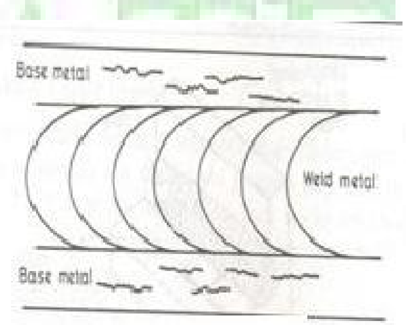
All these defects fall under two categories-

- Visual defect /Surface weld defect/External defect
- surface cracks
- over laps
- under cuts
- under fills
- excessive penetration
- surface porosity
- excessive spatter
- Arc strike, etc
- Hidden defect/sub surface weld defect/Internal defect
- lack of fusion
- lack of penetration
- sub surface blow holes/ porosity
- shrinkage cavity
- slag inclusion
- tungsten inclusion, etc.

A. CRACKS

- A hair line separation in the BM/BM-WM-bdy / WM/HAZ
- May appear:
  - –at the root or
  - –middle or
  - –In the crater
  - –surface or
  - –subsurface
- Most dangerous of all defects
  - Occurs in the WM when localized stresses exceed the UTS of material.
  - May be of microscopic or macroscopic sizes.





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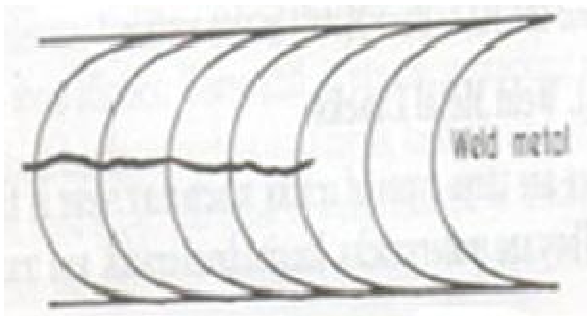

Fig.2. Cracks

Cause

- Poor ductility of base metal
- High C & S- content of BM/WM
- High contraction stresses
- Electrode with high hydrogen content

Remedy

- Pre- heating
- Mn/S ratio: 18 min.
- Use low H_2 electrode
- Avoid rapid cooling

Classification

Cracks may be grouped mainly into two categories-

- ✓ Hot crack
- ✓ Cold crack

HOT CRACKS

- Crack in the weld that occurs just after the welds are completed and some- times while the welds are being made.
  - –Develops at high temperatures
  - –Propagates between the grains of the material (intercrystalline)
  - –Occurs in the weld metal & sometimes in HAZ.
- "solidification crack " (weld metal)
- "liquation crack" (HAZ)

COLD CRACK

- Occurs after the metal has completely solidified (at temp -1000C to 2000C)
- Can occur several days after weld
- Occurs in C-steel, low & high alloy steel
  - ✓ Propagates both between grains and through grains.
  - ✓ Often associated with non-metallic inclusion (elongated MnS).
  - ✓ occurs in both weld metal and HAZ but generally in HAZ

B. CRATER CRACK/STAR CRACK

"A depression left in weld metal where the arc was broken or the flame was removed or electrode was changed".

- They are hot cracks
- Occurs at the crater of the weld
  - ✓ Usually star shaped, but may have other shapes.
  - ✓ Most frequently found in austenitic SS(high thermal coeff).

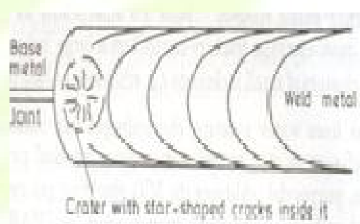

Fig.3. Star Crack

C. POROSITIES/BLOW HOLES

"Porosity is a group of small voids, whereas blow holes are comparatively bigger hole or cavity caused by entrapment of gases [gases:H2,CO,CO2,N2 &O2 from coating ingredients in the electrode or moisture, oil, grease, rust, etc on BM] within the solidified weld".

- Porosity can occur on or just below the surface of a weld.
- Porosity in the weld and HAZ may lead to cracking.

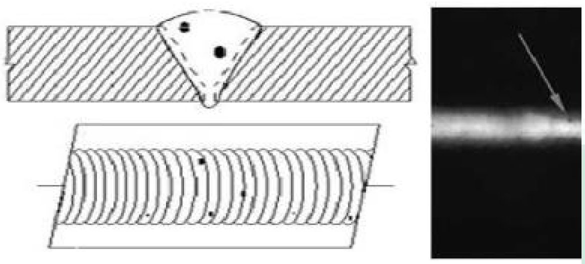

Fig 2.5

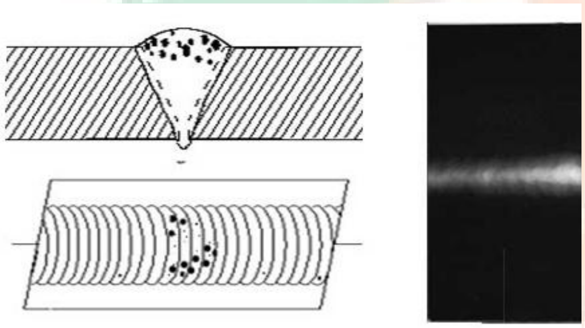

Fig.4. Blow Holes

D. UNDER CUT

"A defect that appears as a groove formed in the BM adjacent to the toe of a weld along the edge of the weld & left unfilled by the weld metal".

- Generally located parallel to the junction of weld metal & base metal at the toe or root of the weld
- Reduces the cross-sectional thickness of the base metal
- Acts as stress raiser in fatigue loading

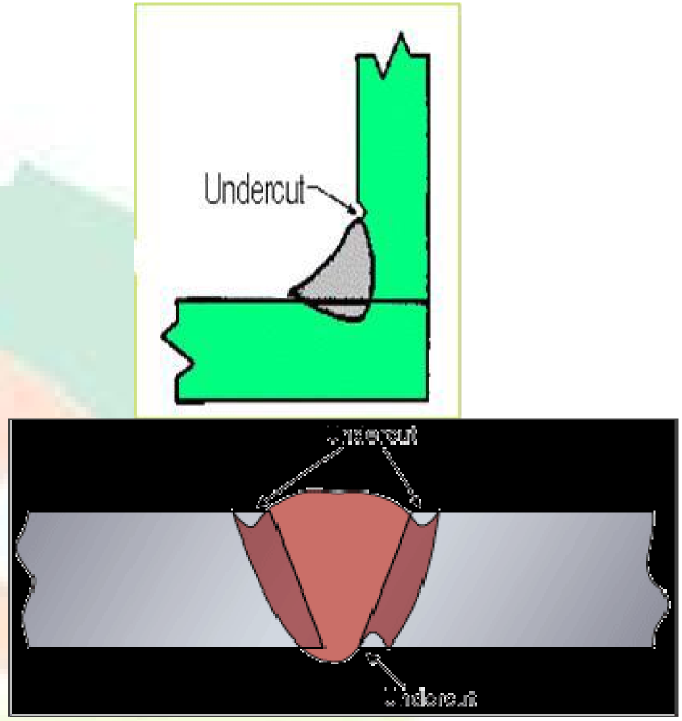

Fig.5. Under Cut

III. LITERATURE REVIEW

Tanigawa et al (2012) developed the Laser and TIG welding tools for application to the blanket hydraulic connection. For each tool, welding conditions were optimized for all position welding to horizontally located pipes. The obtained parameters such as the weld heat input, allowable misalignment, the lifetime of the tools and amount of spatter and fumes, were assessed comparatively. Considering additional aspects related to the remote handling compatibility, the preferred. Welding technique for the blanket remote maintenance was discussed. He Lin et al (2014) have analyzed the microstructures of the TIG weld joints The results indicate that the welding quality of the high boron Fe-Ti-B alloys is very good, there are no obvious defects such as cracks, lack of fusion, incomplete penetration and strip defects in the butt weld joints. However, the micro-zone composition analysis indicates that the composition of the TIG weld joint is very uniform. Tensile tests were carried out on TIG welded joints after the post weld heat-treatment. The result shows that the welds have slightly higher yield strength (YS),and lower ultimate tensile strength compared to those of the base Sathiya et al (2014) have analysed austenitic steel. In this study, the weld bead geometry such as depth of penetration (DP), bead width (BW) and tensile strength (TS) of the laser welded butt joints made of AISI 904L super austenitic stainless steel are investigated. Full factorial design is used to carry out the experimental design. Artificial neural networks (ANNs) program was developed in MatLab software to establish the relationship between the laser welding input parameters like beam power, travel speed and focal position and the three responses DP, BW and TS in three different shielding gases (argon, helium and nitrogen). The established models are used for optimizing the process parameters using genetic algorithm (GA). Optimum solutions for the three different gases and their respective responses are obtained. Confirmation experiment has also been conducted to validate the optimized parameters obtained from GA. The relationship between input parameters beam power,beam width is established. Xiangmeng Meng et al (2014) have proposed TIG–MAG hybrid arc welding process to achieve high speed welding. The influences of hybrid arc welding parameters on welding speed and weld appearance were studied through orthogonal experiment. Four levels for each parameters were chosen. Based on the number of levels and parameters L16 orthogonal array was selected and the microstructures, mechanical properties of weld were tested and compared with that of the conventional MAG weld. The mechanical properties of hybrid arc weld were not lower than that of the conventional MAG weld. The assistant TIG arc could effectively stabilize the MAG welding current and MAG arc voltage in high speed TIG–MAG hybrid arc welding process. The stable hybridization obtained by balance between TIG and MAG welding current and proper wire-electrode distance was a key factor to stabilize the welding process. The developed TIG- MAG hybrid arc welding significantly increased the welding speed for both steel plates under the condition of high quality of weld appearance. From the literature reviewed an attempt is made in this work to predict the optimized MIG welding process parameters of AA 6061. Christo Ananth et al. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased. Christo Ananth et al.[4] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

IV. ANALYSIS

The various parameters that affect the weld quality in STB are as follows.

1. Weld current
2. Arc voltage
3. Arc travel speed
4. Chuck speed
5. Gas mixture
6. Wire feed rate
7. Oscillator speed

TABLE-I

	0	1
	Low	High
V 1	90-105	105-120
V 2	20-24	24-28
V 3	400-510	510-625

	Count	SS	df	MS	Formulas for SS
T	1	0.00825	23	0.000359	=DEVSQ(D4:Q11)
A	12	0.000417	1	0.000417	=DEVSQ(V9:V10)*Y6
B	12	0.000267	1	0.000267	=DEVSQ(T11:U11)*Y7
C	12	0	1	0	=DEVSQ(V19:V20)*Y8
AB Bet	6	0.00075	3	0.00025	=DEVSQ(T9:U10)*Y9
A x B	AB-A-B	6.67E-05	1	6.67E-05	=Z9-Z6-Z7
AC Bet	6	0.000417	3	0.000139	=DEVSQ(T14:U15)*Y11
A x C	AC-A-C	0	1	0	=Z11-Z6-Z8
BC Bet	6	0.001083	3	0.00[illegible]	[illegible]
B x C	BC-B-C	0.000817	1	0.00[illegible]	[illegible]
ABC Bet	3	0.001983	7	0.000[illegible]	[illegible]
A x B x C	ABC-A-B-C-AB-BC-AC	0.000417	1	0.00[illegible]	[illegible]Z10-Z12-Z14
Error	T-all	0.006267	16	0.000392	=Z5-Z6-Z7-Z8-Z10-Z12-Z14-Z16

CONCLUSION

The number of different welding processes has grown in recent years. These processes differ greatly in the manner in which heat and pressure (when used) are applied, and in the type of equipment used. There are currently over 50 different types of welding processes. To control the Undercut, travel speed should not be too long, Welding voltage should be maintained at correct level, The chosen electrode should not have large diameter, Arcs should not be too long, Clean weld surface prior to welding, Welding current must not be too high, Electrode should not be inclined at time of welding. To eliminate use low-hydrogen welding process, increase shielding gas flow, one pre-heat or increase heat input, clean joint faces and adjacent surfaces, change welding conditions and techniques, use copper-silicon filler metal reduce heat input, use E6010 electrodes, use electrodes with basic slugging reactions. Proper alignment of tubes in root of weld joint, Bore should be concentric at ends, Welding current should be adjusted to appropriate level, Rotation of chuck must be controlled, Wire stick out should not be too short to avoid excess Penetration.

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