Effect of Welding Parameters on Mild Steel using SMAW- A Review

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Abstract— In this study, on effect of welding parameters such as welding current, welding voltage, arc gap, welding speed is to be considered on mild steel specimen which is welded by Shield Metal arc welding (SMAW. Shielded metal arc welding (SMAW) process is one of the most commonly employed material joining processes utilized in the various industrial sectors such as marine, ship-building, automotive, aerospace, construction and petrochemicals etc. The increasing pressure on manufacturing sector wants the welding process to be sustainable in nature. The SMAW process incorporates several types of inputs and output streams. The sustainability concerns associated with SMAW process are linked with the various input and output streams such as electrical energy requirement, input material consumptions, slag formation, fumes emission and hazardous working conditions associated with the human health and occupational safety. Shielded Metal Arc Welding (SMAW) or the conventional arc welding process is particularly dominant in structural joints, pressure vessels and in maintenance and repair work. This process is widely used in many industrial applications due to its versatility, simplicity and indoor and outdoor applicability. A certain level of operational skills is needed in performing the SMAW process in order to obtain a quality weldment. Further, input process parameters such as current, voltage, arc gap, welding speed, electrode orientation, etc. play a vital role in the quality of the weldment. This research especially addresses and simulate mild steel in arc welding, covering industrial applications including small scale industries.

Keywords: Mild steel, Arc welding, Welding current, welding voltage, Welding speed, arc gap

I. INTRODUCTION

Welding process remains an important process for the fabrication of ships, rail road equipment, boilers, Vehicle air craft industries, pipelines welding and construction work. It is a process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals. It is a fabrication process that joins two materials usually metals cooling becomes a strong joint with pressure sometimes used in conjunction with heat or by itself to produce the weld. The process variables in arc welding are welding current are voltage, welding speed which causes much more effect on various properties of welded joint such as strength, weld bead geometry. So in the present work the effect welding current, are voltage on mechanical properties of mild steel elements have been investigated.

II. LITERATURE SURVEY

[1] Sameer S Kulkarni (2015**)** Investigated that maintain constant voltage and current, depth of penetration varies with welding speed and maximum depth was observed at speed of 38.83mm/min for voltage 25V and current 125amps. So it can be concluded that increase in speed and by maintaining constant voltage and current, depth of penetration increase up to maximum value and if speed increases beyond the optimum value results to decrease in depth of penetration.[1]

[2] Rohit Jha and A.K. Jha (2014**)** investigated that the tensile strength has been maximum at welding current of 120amp in comparison with weld carried out of 100amp, 110amp, 130amp and 140amp. With increase in welding current which was taken as a varying parameter the ultimate tensile strength 515.185MPa was recorded. Maximum/ optimum value of tensile strength was obtained when welding speed was 145.30mm/min.[2]

[3**]** Syambabu Nutalapati, Dr. D. Azad, Dr. G. Swami Naidu (2016) investigated that at the welding current of 90amp. the tensile strength was maximum for single V joint design in comparison with weld carried out of 100amp and 110amp. With the increase in welding current which was taken as a variable parameter the ultimate tensile strength 47.78N/mm, yield strength 340.23MPa and percentage elongation of 2.63 was recorded. Maximum/ optimum value of tensile strength of single V joint design was obtained when welding speed was 179.35mm/min. Hence it can be concluded that the ultimate tensile strength in case of the single V joint was maximum as a result of correct fusion between weld metal and base metal, right joint design and edge preparation for this type of material thickness. [3]

[4] Merchant Samir Y**.** Investigated that with increase in welding current, heat input was increased. So hardness of weld metal decreases with increase in welding ampere. Due to this heat generation was increased and melting of electrode became faster hence welding time decreased. [4]

III. WELDING PARAMETERS

A. Welding Current:

Welding current is an influential variable that control melting rate of electrode, there by the deposition of electrode rate on joint. It also controls the depth of fusion, and penetration. The welding current or amperage is essential to producing welds with good appearance and the required strength characteristics. The welder controls the amperage variable by setting the amperage on the welding machine prior to welding.

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By increasing the welding current it was observed that the heat also increases as result of which the penetration also increased along with there was increase in width of weld bead. From left to the right (in figure) the current was increased due to which there was increase in width weld bead and increase in rate of fusion.

B. Welding Voltage:

Welding voltage is also called arc voltage, it is the electrical potential difference between tip of electrode and the surface of molten weld pool. It effects on shape of fusion zone, welding reinforcement, electrode melting rate etc. Welding voltage varies with the length of the arc between the electrode and molten weld metal. With the increase in arc length, the arc voltage increases because lengthening of the arc exposes more of the arc column to the cool boundary of the arc.

Increase in voltage lead to more spatter which also lead to improper weald bead. While decrease in welding voltage lead to discontinuous weld bead and with small width. Hence by maintain average voltage proper and continuous weld bead can be obtain with comparatively less spatter and with proper penetration.

C. Welding Speed

Welding speed is the linear speed at which are moves with respect to plate, along with the weld joint. If speed get increases the heat input to the joint decreases and if speed get decreases, heat input increases. And heat input rate is given by:

Heat input rate=V x I x 60/ v J/mm
Where V= Arc voltage in volts
I= Welding current in ampere
v= Speed of welding in mm/min

Speed of welding is defined as the rate of travel of the electrode along the seam or the rate of the travel of the work under the electrode along the seam. Some general statements can be made regarding speed of travel. Increasing the speed of travel and maintaining constant arc voltage and current will reduce the width of bead and also increase penetration until an optimum speed is reached at which penetration will be maximum.

In figure (from left to right) the speed was increased as a result of which it lead to improper penetration and improper weld bead. Hence due to increase in speed it caused discontinuous weld.

D. Arc Gap

When electricity is made to jump across a gap it is said to arc across the gap. In Shielded Metal Arc Welding (Stick) it is this arcing effect that creates the intense heat required for melting the electrode and the base metal together. The Arc is the term used to describe the distance from the tip of the electrode to the base metal and can be varied from lightly touching the metal at an angle sufficient to maintain an arc to a distance far enough from the base metal to extinguish the arc. Arc length should be as short as possible.

As arc gap was increased (from left to right in figure) it leads to increase in flame length which caused more spatter compared to lower arc gap. The lower arc gap at left in figure had very less spatter, improper penetration, stiff and small width of weld bead. As increasing the arc gap all these things increase proportionately.

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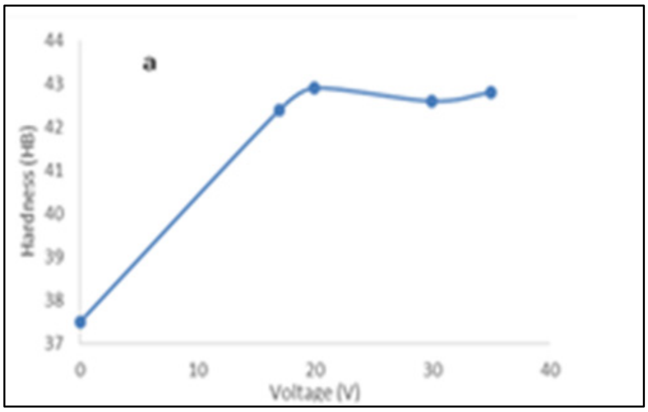
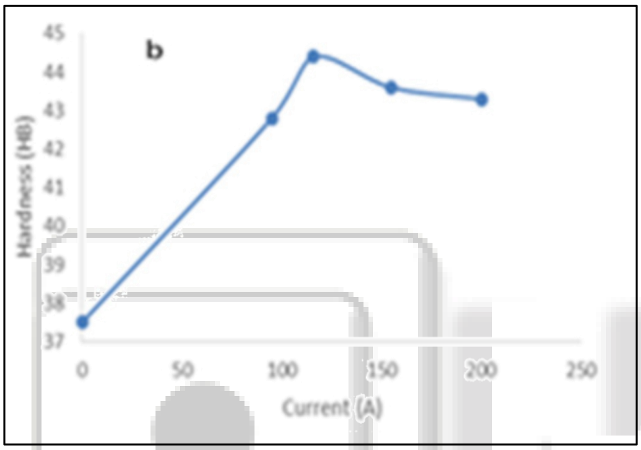
IV. EFFECT OF WELDING PARAMETER ON MILD STEEL

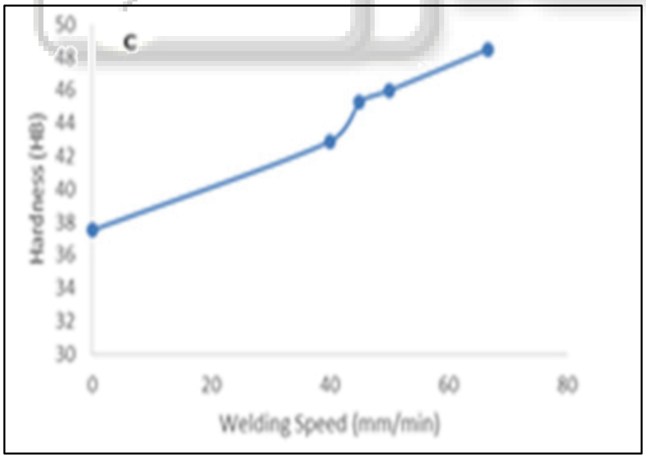
A. *Welding Voltage*



B. *Welding Current*



C. *Welding Speed*



V. PROPERTIES OF MILD STEEL

Steel is made up of carbon and iron, with much more iron than carbon. In fact, at the most, steel can have about 2.1 percent carbon. Mild steel is one of the most commonly used construction materials. It is very strong and can be made from readily available natural materials. It is known as mild steel because of its relatively low carbon content.

A. *Chemical Properties*

Mild steel usually contains 40 points of carbon at most. One carbon point is .01 percent of carbon in the steel. This means that it has at most .4 percent carbon. Most steels have other alloying elements other than carbon to give them certain desirable mechanical properties. 1018 steel, a common type of mild steel, contains approximately .6 percent to .9 percent manganese, up to .04 percent phosphorus, and up to .05 percent Sulphur. Varying these chemicals affects properties such as corrosion resistance and strength. Physical

B. *Properties: Strength*

Mild steel is very strong due to the low amount of carbon it contains. In materials science, strength is a complicated term. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.

C. *Quantitative Physical Properties*

Mild steel has a density of .248 pounds per cubic inch. It melts at 2,570 degrees Fahrenheit. It has a specific heat of around .122 British Thermal Units (BTU) per pound, per cubic inch.

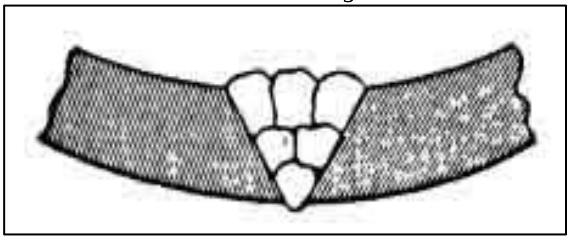
D. *Usability*

Mild steel is especially desirable for construction due to its weldability and machinability. Because of its high strength and malleability, it is quite soft. This means that it can be easily machined compared to harder steels. It is also easy to weld, both to itself and to other types of steel. It takes on a nice finish and is polishable. However, it cannot be hardened through heat treatment processes, as higher carbon steels can. This is not entirely a bad thing, because harder steels are not as strong, making them a poor choice for construction projects.

VI. PROBLEMS FACED WHILE WELDING ON MILD STEEL

A. *Distortion*

1) *Weld Distortion Troubleshooting*



Distortion Arc Weld Troubleshooting Suggestions

Why Distortion Occurs:	How to Fix It:
1) Joint over-heating	1) Allow each bead to cool
2) Slow welding	2) Use a speed tip and weld at constant speed
3) Small Pool	3) Use a triangular or larger size rod
4) Sequence is improper	4) Before welding offset pieces

1) Step 1. Check for shrinkage of deposited metal.
   1) Properly clamp parts or tack weld parts to resist shrinkage.
   2) Preform or separate parts so as to allow for weld shrinkage.
   3) Peen the deposited metal while still hot.

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2) Step 2. Check for uniform heating of parts.
    1) For heavy structures preheating is desirable.
    2) It is sometimes helpful before welding to perform removal of rolling or forming strains by stress relieving.
3) Step 3. Check the welding sequence.

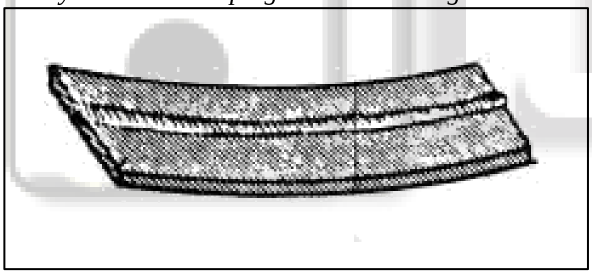
Study structure and develop a definite sequence of welding. Prevent excessive local heating by distributing welding.

2) Welding Stresses

1) Step 1. Check for excessive rigidity of joints.
    1) Slight movement of parts during welding will reduce welding stresses.
    2) Develop a welding procedure that permits all parts to be free to move as long as possible.
2) Step 2. Check the welding procedure.
    1) Use as few welding passes as practical.
    2) Use special intermittent or alternating welding sequence and back-step or skip procedures.
    3) Properly clamp parts adjacent to the joint. Use backup fixtures to cool parts rapidly.
3) Step 3. If no improper conditions exist, stresses could merely be those inherent in any weld, especially in heavy parts.
    1) Peen each deposit of weld metal.
    2) Stress relieve finished product at 1100 to 1250°F (593 to 677°C) 1 hour per 1.0 in. (25.4 cm) of thickness.

B. Warping of Thin Plates

1) Acetylene Weld Warping Troubleshooting

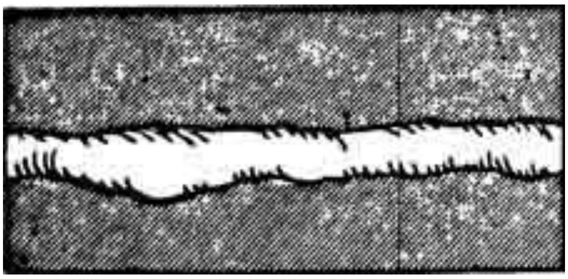


Warping Arc Weld Troubleshooting Suggestions

Why it Occurs:	Solutions:
1) Shrinkage of Material	1) Preheat Material to Relieve Stress
2) Overheating	2) Weld rapidly - use back-up weld
3) Faulty Preparation	3) Too much root gap
4) Faulty Clamping of Parts	4) Clamp parts properly- back-up to cool
	5) For multi-layer welds - allow each layer to cool

1) Step 1. Check for shrinkage of deposited weld metal.
- Select electrode with high welding speed and moderate penetrating properties.
2) Step 2. Check for excessive local heating at the joint.
- Prevent excessive local heating of the plates adjacent to the weld by welding rapidly.
3) Step 3. Check for proper preparation of joint.
    1) In the parts to be welded do not have excessive root opening in the joint between the parts to be welded.
    2) Hammer joint edges thinner than the rest of the plates before welding. This elongates the edges and the weld shrinkage causes them to pull back to the original shape.
4) Step 4. Check the welding procedure.
    1) Use special intermittent or alternating welding sequence and back-step or skip procedure.
    2) Preheat material to achieve stress.
5) Step 5. Check the clamping of parts.
- Properly clamp parts adjacent to the joint. Use backup fixtures to cool parts rapidly.

C. Poor Weld Appearance



Poor Weld Appearance Arc Weld Troubleshooting

Reasons for Poor Weld Appearance:	Solutions:
1) Uneven Pressure	1) Practice starting, stopping and finger manipulation on rod
2) Excessive Stretching	2) Hold rod at proper angle
3) Uneven Heating	3) Use slow uniform fanning motion

1) Step 1. Check welding technique for proper current and electrode manipulation.
    1) Ensure the use of the proper welding technique for the electrode used.
    2) Do not use excessive welding current.
    3) Use a uniform weave or rate of travel at all times.
2) Step 2. Check characteristics of type of electrode used**.**
- Use an electrode designed for the type of weld and base metal and the position in which the weld is to be made.
3) Step 3. Check welding position for which electrode is designed.
- Do not make fillet welds with down-hand (flat position) electrodes unless the parts are positioned properly.
4) Step 4. Check for proper joint preparation.
- Prepare all joints properly.

D. Difficulty Starting Arc

Arc Weld Troubleshooting when Welding Arc Will Not Start

Reasons for difficulty starting weld arc:	Solutions:
1) Voltage too low	1) Check the voltage
2) Torch not assembled correctly	2) Check electrodes

CONCLUSION

The effect of varied welding parameters was examined and discussed in other to be able to predict the service behavior (performance) of welded low mild steel samples. The results have shown that the selected welding parameters have significant effect on the mechanical properties of the welded samples. Increase in the arc voltage and welding current result in increased hardness values and decreased yield strength, tensile strength and impact toughness.

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