Effect of welding parameters on temperature distribution using Finite Element Simulation

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Abstract In welding process heat is required for welding which is mostly taken form electric arc. Electric arc is generated from electric current. Depending upon heat different mechanical properties were obtained so it is always desired to know the heat flow and effect of heat input in welding. The important process parameters which are required to be considered in any welding are heat source, welding speed, heat input, temperature dependent material properties etc. Temperature distribution is affected by the process parameters like welding speed, current etc selected during the welding. In this paper attempt has been made to simulate the effect of welding parameters of submerged arc welding on temperature distribution so as to determine the cooling rates in different directions with respect to weld axis.

Key words: Submerged arc welding, ANSYS, process parameters

Introduction: Submerged arc welding is a type of arc welding in which consumable electrode is used. Temperature distribution depends upon current, voltage, welding speed, Material to be welded, composition of material to be welded. In welding heat flows from welding source to work piece and after this heat flow into the work piece by conduction. Heat loss is also occurred due to convention and radiation. Since this heat which flow into the body of work piece is responsible for changes in mechanical properties and microstructure it is important to know the amount heat produce at certain critical points. In this paper, varying the welding speed on temperature distribution was simulated using finite element (FE) techniques to analyze the effect. For this simulation ANSYS software package program was used[1,2]. The main objective of the present work is to simulate the general behavior of the butt joint weld under different parameters process parameters.
Effect of material properties on Temperature distribution: (a) Co efficient of Thermal Expansion: it is the property of material to expand and contract higher the thermal expansion more the is the distortion.(b)Thermal conductivity: Indicates how the heat is spread throughout the material low thermal conductivity causes high thermal gradient (c) Yield strength: Higher the yield strength means the more force is required for plastic deformation and it produces more stresses and cause more distortion.(d)Modulus of elasticity: Indicates about the stiffness of material more modulus of elasticity it can resist more distortion.[3]

**Fig1:** Temperature dependent property of material thermal conductivity used in ANSYS

**Fig2:** Thermal flux

**Objective:** 1) To simulate the effect of temperature distribution in a work piece during submerged arc welding using ANSYS software

2) To study the relationship between SAW process parameters and welding performance
**FEA Methodology:**

![Diagram of FEA Methodology]

**Literature review** Bag et al [6] have developed a two dimensional FEA model to analyze heat transfer process using a combination of heat flux and volumetric heat source. Calculated various result of weld pool by varying heat source in laser welding. Goldak equation[7] used by the author fairly matches with result. Process parameter can easily be set up by analyzing with FEA. It has also been found out that due to symmetry along faces two dimensional problems is sufficient instead of three dimensional and gives simplicity and easy to apply boundary conditions.

Choobi et al states that non uniform heating and cooling results produces undesirable residual stresses and deformation in weld joint. [8]

**Fig 4: Finite element mesh along with boundary condition shown [6]**
Result and Discussion In this three dimensional model was generated using ANSYS for simulating the performance of butt weld. Program generated by ANSYS give temperature distribution profile of process parameters. In SAW welding moving heat source, Arc travel speed, current and voltage, deposition of filler material are important parameters in which temperature distribution depend. Temperature profile is obtained for the parameter such as welding current, welding speed, size and position of the plates which was executed using ANSYS. For the solution of the problems, one half of the cross-section is considered, because of symmetry. Symmetry was selected as it reduces calculation time. As found from results when the process parameters is 8mm plate, welding speed is 0.45 m/min and current 450 A maximum temperature reached is 1642 °C. Keeping all parameters constant and when welding speed is increased from 0.45 m/min to 0.50 m/min temperature reached is 1425 °C. Hence increasing the welding speed cause reduce in maximum temperature.

Fig 5: Nodes and elements
Fig 6: Temperature distribution of process parameters 8mm thickness, welding speed 0.45m/min, and current 450 A

Fig 7: Temperature distribution of process parameters 8mm thickness, welding speed 0.50m/min, and current 450 A
Fig8: Heat effected zone

Conclusion: Three dimensional model was developed using FEA software ANSYS. Submerged ARC welding process parameter is simulated to analyze the effect on butt welding. Program was developed will help to choose optimal parameter. Program generated will help in time saving and reduce cost. The results showed in graph that the welding speed have significant Temperature distribution. Increase in welding speed results in reduces in maximum temperature. Maximum temperature noted was 1642 when welding process parameters are 8mm plate thickness, welding speed 0.45 m/min, and current 450 A.

References:

1) T.Stolarski, Y Nakasone, S Yoshimoto “Engineering Analysis with ANSYS software,“  
