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A Review on "A Study of Thermo-Mechanical Analysis of SMAW, SAW and its Related Welding Parameters"

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***Abstract*-Thermo-mechanical analysis of SMAW and SAW evaluate the thermal and mechanical properties of weld joint experimentally and numerically using software and compare it .The thermal properties of Weld metal such as heat input, peak temperature ,thermal stress or residual stress in HAZ are calculated practically and also define the temperature profile during thermal modeling. The effect of welding parameter like as welding voltage, current, speed and heat input on SMAW welding process. The mechanical properties of weld metal are increase as in increase in welding current and also increase in heat input. The effect of heat input on micro hardness of weld metal are to be analyzed .for better hardness and toughness of weld metal a low heat input are required in HAZ during SMAW and SAW welding process.**

Keywords: **SMAW, SAW, HAZ, residual stress, heat input**

I. INTRODUCTION

Welding is a process, to joint one piece of metal to another piece (similar or dissimilar metal) means to weld by heating the edge of metal by an electric arc with or without of filler material and pressure, put there connect with each other and cool harden in to one piece. Joint of two similar metals with out of filler material are called as autogenous and joint with filler material called as homogenous .to weld two dissimilar metals with filler material called as heterogeneous. At the present time there are many different types of welding process are used in industries.

The melting point of filler material is always less than that of base metal, the filler material are fill the extra gap between the joint. Generally melting and cooling are involves in welding process due to heating of metal in heat affected zone and after solidification of weld metal properties of metal increase. The heat input in welding depends on arc current and voltage. Welding is most economical process and widely used in steel bridge, fabrication industries, shipbuilding and pressure vessel.

- SMAW

SMAW are also called flux shielded arc welding and refers to as stick welding, the electrode movement during SMAW are controlled by manually so it is also called manual metal arc welding (MMAW) these are widely used in fusion welding ,shipbuilding industries automobile manufacturing and all type of bend joint.

The material of work piece metal is carbon steel, ASTM 106 GRADE B and electrode E 7018 used in welding process, properties of both is similar. During SMAW first of all heat the electrode at 300 centigrade. The gap between work piece and electrode are about 2-3 mm.

The adjacent of heat effected zone and weld metal a phase transformation takes place due to heating and cooling of work piece. Due to localization of heat, distortion and residual stress are occurring near the weld joint. Both ac and dc power source used in welding.

- SAW

In Submerged arc welding continuously arc formation between work piece and electrode , the arc and molten metal are submerged in blanket of course grain fusible flux during SAW without application of pressure, the flux are protected from atmospheric air. The heat flux are generate at outer surface of weld metal due to heating of metal. The flux coating on the surface of weld metal is mg oxide, silica, lime and other compound.

The both ac and dc power source are used for making a weld with single wire electrode and all welding parameter are same as SMAW , material are also same but application are different from SMAW .

- Thermal analysis

The study of material properties of metal and non-metal, thermal capacity, coefficient of thermal expansion, thermal conductive, enthalpy, mass change, and heat input with change in temperature and in solid state chemistry to study of solid state reaction, phase transformation during thermal analysis.

The effect of welding parameter on thermal and mechanical properties of material to be analyzed during thermal analysis and also used for study of heat transfer through structure, measure the heat capacity and thermal properties. The temperature and thermal stress in heat effected zone and heat transfer due to conduction in weld metal to formulate in thermal analysis.

Thermal analysis is the function of temperature which gives the information of change in mechanical and thermal properties of material with temperature and also correlates the stress at different temperature of weld metal.

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- Technique used for measure the properties of material are
  Thermal analysis is the technique for measuring the properties of material with change in temperature.
- Mass and volume
- Thermogravimetric analysis
- Dilatometry
- Temperature and heat flow
- Differential scanning calorimeter
- Differential thermal analysis
- thermocouple
- Thermal properties
- laser flash analysis
- dynamic mechanical analysis
- Other parameter (ex. Length)
- thermomechanical analysis
- thermos optical analysis
- thermos dilatometer analysis

II. EXISTING RESEARCH EFFORTS

Ch.Indira Priyadarsini et. al. [1] the main issue or main difficulties in the large industries are, the residual stress and overall distortion has been formulated. The main aim of this topic is reduce the residual stress and distortion effect. For experimental study of this thesis SAW has been chosen, thermal effect of submerged arc are depend on the electric arc flux and temperature of work piece material . The SAW is simulated by FEM and ANSYS for the optimization of process parameter material temperature decreased and distance of center point increased.

J.O Olawale et.al [2] these investigations are established the correlation of SMAW and heat treatment on some mechanical properties of carbon steel. The sample is weld together by using AWS E6013electrode .during welding voltage are constant and current are varying, correlate voltage and current. The sample is subjected to heat treatment operation at different temperature. As it is found that with increase in current increase in hardness and UTS of weld metal .after heat treatment operation impact strength increase while UTS and hardness reduced.

B.S Praveen kumar et.al [3] the present work of this paper during SMAW process the design parameter are perform experimentally to insure leak profile joint. The SMAW welding parameter are current, voltage, welding speed , electrode angle these parameter are calculated by ANOVA and experimentally result are conducted according to orthogonal array.

Maridurai T et.al [4] to investigate that the tensile properties of carbon steel P91 when root pass was carried by using TIG welding and then SMAW and SAW welding to be perform .the study of characteristics of fracture , toughness and tensile properties of P91 material in SAW process. The fracture, toughness and tensile properties of base metal are evaluated by using crack tip opening displacement and properties are measure at room temperature, the range of temperature during welding is 400-600 degree centigrade.

Dae-Won Cho et. al. [5] the main area of this single wire submerged arc welding is the effect of heat transfer and torch angle current density are to analyzed .In this paper CFD numerical model are used in single electrode SAW process. To develop the arc model such as electromagnetic force, arc heat flux is adopting able inversion method with CFD compare for DC and AC polarities. The CFD numerical method is used to comparison of experimental result.

Harmeet singh et. al. [6] In this paper work transient temperature and residual stress are evaluated when two dissimilar metal are joint by SMAW process due to presence of residual stress ,life of joint will be decrease for evaluate the residual stress and transient temperature can be evaluated by using FEM and ANSYS software during welding process . Tensile stress is occurring inside the cylinder, peak circumferential stress is outside the cylinder. The residual stress is influenced by the inside and outside weld FEM.

J Dutta et.al. [7] This paper deals with the variation of temperature in heat effect zone in weld joint these properties depend on material properties. Temperature are measure by experimental at predefined location of the plate during welding by mounting of thermocouple. The heat transfer in heat effect zone are carried out convection, radiation and radiation heat transfer are main role of heat losses due to moving plate heat source. The variation of temperature in heat effect zone is 300°c to 600°c.

Rohit jha et.al [8] to study the welding characteristic of different types of weld design and weld metal, the types joint design are v, flat surface to joint by SMAW welding process , varying welding current in all cases. Evaluate all mechanical properties like as % of elongation, tensile strength, yield strength of weld metal and it also show the effect of current on welding speed, yield strength experimentally .the UTS and YS are maximum in V joint design and it conclude that before and at optimum value of UTS, current increase, UTS also increase after optimum value of UTS current increase UTS decrease.

Osman culha et.al [9] this paper are focused on to predict the design parameter like as distortion analysis, thermal stress, temperature gradient, nodal displacement on the plate during saw process. The residual stress and distortion are occurring near the HAZ by heating during welding process. The design parameter value is achieved by the analysis of thermal elastic plastic by using FEA .It also show stress- temperature distribution. During SAW process T-beam profile are used in welding.

Rohit jha et.al [10] to investigate the effect welding parameter ,welding current ,voltage ,heat input on UTS of mild steel in SMAW process and evaluate the optimum welding current . the UTS of weld metal are to be investigated by using tensile testing machine , the welding current are varying and at 120am the tensile strength of weld metal are high and after optimum value current increase ,UTS decrease.

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Y. kchaou et. al. [11] in this paper work measures the mechanical properties and microstructure of base metal of welded joint. The SMAW was performing on joining two stainless steel plates. The measurement of mechanical properties and analysis of fracture profile are show that these two materials are ductile but ductility is less in the weld metal. The hardness of base metal is indicated as micro hardness measurement as the hardness Increases in the weld bead due to rapid cooling of weld material. In ductile material the fracture surface are observed after tensile test of material .All the test of mechanical properties such as micro hardness ,yield strength, tensile strength are in good agreement.

Swapnil R. Deogade et. al. [12] the main purpose of this paper work are thermal analysis it show temperature and residual stress distribution on welded plate. The analysis of residual stress in heat effect zone and welded zone are carried out. The temperature and residual stress are to be simulated by ANSYS. This paper deals the SMAW welding in ferrite stainless steel by using of FEA. In 3-d finite element model the predicted value of temperature and residual stress distribution are obtain.FEA analysis of residual stress are carried out ANSYS.

Abhishek B.P et. al. [13] In this paper the main aim to reducing distortion and residual stress of dissimilar plate to avoid fracture failure they are effect many parameter such as heat source, material welding parameter like as voltage, current these effect can be minimize to controlling heat input . The temperature distribution in weld joint can be investigated by using FEM and ANSYS software. The temperature profile is nearly similar to experimental result.

Abhijit Sarkar et. al. [14] In the submerged arc welding process the difficult is defend the temperature profile in SAW it show that heat input increase then higher temperature of heat source are also increased and compare the numerical and experimental value for implementing the temperature of a moving heat source model based on crucial by using mat MATLAB code and mathematical model of thermal profile are predicted. The maximum error between numerical and experimental data and it conclude that temperature profile increase, welding speed decrease and current increase.

J.dutta et. al. [15] the difficulties on mechanical properties of SMAW and GTAW due to heat source, the temperature of heat source has been obtain by experimental work the effect of heat source on SMAW and GTAW has been judge by optical and scanning electron micrograph in weld joint of different region. In experimental work the peak temperature of GTAW is75degree centigrade higher than the peak temperature of SMAW are more durable than SMAW.

Vijayesh Rathi et.al [16]the effect heat input, heat effected zone and micro hardness of weld metal to analyzed and calculated. The present work of this paper are established the relationship between micro hardness and various parameter such as voltage, current welding speed. It shows that when heat input is low micro hardness of weld metal decrease and parameter directly effect on HAZ. For better hardness and toughness during SMAW process a low heat input are preferable, as hardness of weld metal are increase then cooling rate are also increase. At higher heat input a cracks are found in HAZ in weld metal.

M.A Bbodule et.al [17] the effect of welding parameter such as current ,voltage welding speed on mechanical properties of low carbon steel in SMAW and oxyacetylene welding process. The mechanical properties of weld metal, UTS, YS, hardness are reduced with increase in heat input and it is found that mechanical properties of v grooved are better as compare to straight edge surface of weld metal. If tensile strength and hardness reduce then toughness is increased.

Table 1 summarizes above research efforts depicting the contribution made, work piece material used, welding process used and software or technique used.

TABLE 1 Existing researchers contributions for the Thermal analysis on SMAW&SAW

Name of Researchers / Contributors	Year	Contribution	Work piece Material	Welding Process	Software/Technique
Ch.Indira Priyadarsini	2012	Experimental And Numerical Analysis Of Temperature Distribution In Submerged Arc Welding Process	ASTM A516 Carbon steel	SAW	FEM through ANSYS
J. O. Olawale	2012	Correlation between Process Variables in Shielded Metal-Arc Welding (SMAW) Process and Post Weld Heat Treatment (PWHT) on Some Mechanical Properties of Low Carbon Steel Welds	Low carbon steel	SMAW	Experimental & numerical analysis
B.S.Praveen Kumar	2012	Selection Of Optimum Process Parameters Of Shielded Metal Arc Welding (SMAW) To Weld Steel Pipes By Design Of Experiments	carbon steel	SMAW	ANOVA

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Maridurai T	2012	Analysis Of Tensile Strength And Fracture Toughness Using Root Pass Of Tig Welding And Subsequent Passes Of SMAW And Saw Of P91 Material For Boiler Application	Carbon steel P91	SMAW& SAW	Crack tip opening displacement
Dae-Won Cho	2013	Analysis of submerged arc welding process by three-dimensional computational fluid dynamics simulations		SAW	CED numerical analysis
Harmeet Singh	2014	Thermal Stress Analysis in Butt Welded Thick Wall Cylinder	ASTM A516 CARBON STEEL	SMAW& SAW	FEM&ANSYS
J. Dutta	2014	A Parametric Study of Temperature Dependent Properties Influenced due to Transient Temperature Field Developed in Arc Welded Steel Butt Joints	AISI 1040 CARBON STEEL	SMAW	VINOKUROV S EXPERIMENTAL
Rohit Jha	2014	Investigating the Effect of Welding Current on the Tensile Properties of SMAW Welded Mild Steel Joints	Mild steel plate	SMAW	Experimental & numerical analysis
Osman Culha	2014	Finite Element Modelling Of Submerged Arc Welding Process For A Symmetric T-Beam	AH 36	SAW	FEM
Prof. Rohit Jha	2014	Influence of Welding Current and Joint Design on the Tensile Properties of SMAW Welded Mild Steel Joints	Mild steel plate	SMAW	Experimental & numerical analysis
Y. Kachaou	2014	Micro structural, compositional and mechanical investigation of Shielded Metal Arc Welding (SMAW) welded super austenitic UNS N08028 (Alloy 28) stainless steel	AISI 304L	SMAW	Experimental & numerical analysis
Swapnil R. Deogade	2015	Finite Element Analysis of Residual Stresses on Ferritic Stainless Steel using Shield Metal Arc Welding	Stainless steel	SMAW	FEA through ANSYS
Abhishek B P	2015	Experimental And Finite Element Analysis Of Thermally Induced Residual Stresses For Stainless Steel 303grade Using GMAW Process	Carbon steel	SMAW& GMAW	FEM through ANSYS
Abhijit Sarkar	2015	Numerical Approach For Modeling Thermal Profiles And Effects Of Process Parameters On It In Submerged Arc Welding Of Asia 1518 Grade Steel	Carbon steel AISI 1518	SAW	Experimental & numerical analysis
J. Dutta	2015	Thermo mechanical and Metallurgical Analysis of SMA and GTA Welded Low Carbon Steel Butt Joints	Carbon steel AISI1020	SMAW& GTAW	Experimental & numerical analysis
Vijayesh Rathi	2015	Analyzing the Effect of Parameters on SMAW Process	Carbon steel	SMAW	Experimental & numerical analysis
M. A. Bodude	2015	Studies on Effects of Welding Parameters on the Mechanical Properties of Welded Low-Carbon Steel	Low carbon steel	SMAW	Experimental & numerical analysis

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III. CONCLUSION

In view of above literature it can be concluded that the thermal and thermo- mechanical analysis of various welding process such SMAW, SAW, GTAW and GMAW are most useful at present time.

This thermal and thermo- mechanical analysis is done on the basis of welding parameters like arc voltage, arc current, mechanical properties of base metal. The simulated attempted in the literature is basically related to peak temperature of heat source and residual stress in heat effect zone are to be analyzed by using FEM,FEA and ANSYS software model the experimental and numerical work are to compare to find out accurate result.

The effect of welding parameter such as current , heat ,voltage on mechanical properties of base metal and it seen that if welding current and heat input are increased then mechanical properties also increase. From above literature review we are take temperature thermal stress produce due to temperature within HAZ and also study the effect of temperature inside HAZ of carbon steel ASTN 106 GRADE B.

The field application of this work is in pressure vassal, heat exchanger manufacture industries etc.

REFERENCES

[1] Ch.Indira Priyadarsini, N.Chandra Sekhar, Dr.N.V.Srinivasulu "Experimental and Numerical Analysis of Temperature Distribution In Submerged arc Welding Process" International Journal of Advanced Research in Computer Engineering & Technology Volume 1, Issue 6, August 2012.

[2] J. O. Olawale, S. A. Ibitoye, K. M. Oluwasegun, M. D. Shittu, R. C. Ofoezie "Correlation between Process Variables in Shielded Metal-Arc Welding (SMAW) Process and Post Weld Heat Treatment (PWHT) on Some Mechanical Properties of Low Carbon Steel Welds" Journal of Minerals and Materials Characterization and Engineering, 2012, 11, 891-895 Published Online September 2012.

[3] B.S.Praveen Kumar, Dr.Y.Vijaya kumar "Selection Of Optimum Process Parameters Of Shielded Metal Arc Welding (SMAW) To Weld Steel Pipes by Design of Experiments" International Journal Of Engineering Research And Applications (IJERA) ISSN: 2248-9622 , Vol. 2, Issue 5, September- October 2012, Pp.377-381.

[4] Maridurai T,Shashank Rai, Shivam Sharma, Palanisamy P "Analysis of Tensile Strength And Fracture Toughness Using Root Pass of Tig Welding And Subsequent Passes of SMAW And Saw of P91 Material For Boiler Application" International Journal of Mechanical Engineering and Technology (Ijmet), Issn 0976 – 6359, Volume 3, Issue 2, May-August (2012), Pp. 594-603

[5] Dae-Won Cho, Woo-Hyun Song, Min-Hyun Cho, Suck-Joo Na "Analysis of submerged arc welding process by three-dimensional computational fluid dynamics simulations" Journal of Materials Processing Technology, ScienceDirect 213 (2013) pp-2278– 2291.

[6] Harmeet Singh, Som Kumar, Nimo Singh Khundrakpam, Amandeep singh "Thermal Stress Analysis in Butt Welded Thick Wall Cylinder" ISO 9001:2008 Certified International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, April 2014.

[7] J. Dutta, Narendranath S. "A Parametric Study of Temperature Dependent Properties Influenced due to Transient Temperature Field Developed in Arc Welded Steel Butt Joints" International Journal of Advances in Engineering Sciences Vol.4, Issue 3, April, 2014.

[8] Rohit Jha, A. K. Jha "Investigating the Effect of Welding Current on the Tensile Properties of SMAW Welded Mild Steel Joints" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181 Vol. 3 Issue 4, April – 2014.

[9] Osman Culha "Finite Element Modelling of Submerged Arc Welding Process For A Symmetric T-Beam" ISSN 1580-2949 Original scientific article/Izvirni znanstveni ~lanek MTAEC9, 48(2)243(2014).

[10] Prof. Rohit Jha, Dr. A.K. Jha "Influence of Welding Current and Joint Design on the Tensile Properties of SMAW Welded Mild Steel Joints" Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 4, Issue 6(Version 4), June 2014, pp.106-111.

[11] Y. Kachaou, Nader haddar, Gilbert Henaff, Khaled Elleuch "Micro structural, compositional and mechanical investigation of Shielded Metal Arc Welding (SMAW) welded super austenitic UNS N08028 (Alloy 28) stainless steel" Article in Materials and Design · November 2014 Impact Factor: 3.5 · DOI: 10.1016/j.matdes.2014.06.014.

[12] Swapnil R. Deogade, Prof. Sachin P. Ambade, Dr. Awanikumar Patil "Finite Element Analysis of Residual Stresses on Ferritic Stainless Steel using Shield Metal Arc Welding" International Journal of Engineering Research and General Science Volume 3, Issue 2, March-April, 2015 ISSN 2091-2730.

[13] Abhishek B P, Anil kumar G ,Madhusudhan.T "Experimental And Finite Element Analysis of Thermally Induced Residual Stresses For Stainless Steel 303grade Using GMAW Process" International Research Journal of Engineering and Technology (IRJET), ISSN: 2395 -0056Volume: 02 Issue: 02 | May-2015.

[14] Abhijit Sarkar, Aparesh Datta, Prasenjit Dey, R.N.Rai, S. C Sasha "Numerical Approach For Modeling Thermal Profiles And Effects of Process Parameters on It In Submerged Arc Welding of Asia 1518 Grade Steel" Journal of Thermal Engineering Yiddish Technical University Press, Istanbul, Turkey Vol. 1, Special Issue 3, No. 6, pp. 505-516, May, 2015.

[15] J. Dutta, P. Pranith Kumar Reddy "Thermo mechanical and Metallurgical Analysis of SMA and GTA Welded Low Carbon Steel Butt Joints" World Academy of Science, Engineering and Technology International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering Vol: 9, No: 7, 2015.

[16] Vijayesh Rathi, Hunny "Analyzing the Effect of Parameters on SMAW Process" International Journal of Emerging Research in Management &Technology ISSN: 2278-9359 (Volume-4, Issue-6).

[17] M. A. Bodude, I. Momohjimoh "Studies on Effects of Welding Parameters on the Mechanical Properties of Welded Low-Carbon Steel" Journal of Minerals and Materials Characterization and Engineering, 2015, 3, 142-153 Published Online.