A Study of Different Parameters of the Seam Welding Process for Reducing Welding Current

Shaikh Ozair[1], Dr.N.H.Deshpande[2]

[1]P.G. Student, Dept. of Mechanical Engineering, Government College of Engineering Karad, Maharashtra, India
[2]Adjunct Professor, Dept. of Mechanical Engineering, Government College of Engineering Karad, Maharashtra,

---

Abstract – *Resistance seam welding process uses the heat generated from the resistance to the flow of current. This heat is used to obtain the weld. Seam welding process requires continuous flow of current. Hence, large current consumption is one of the drawback of this process. In this paper we study various parameter that affect the welding current. The experimentation work was carried out at Viraj Engineering Company located in Satara. The company manufactures storage tanks. Different parameters of the seam welding process are studied and ways to reduce the current consumption of the seam welding machine is given in this paper. The objective of this project is to reduce the power consumption of the company by limiting the current usage of the seam welding machines used in the company.*

***Key Words*: Seam welding, Welding current, Transformer efficiency, Power factor, Contact area, Electrode coating…**

1. INTRODUCTION

1.1 Resistance Welding Process

Resistance welding is a group of welding processes wherein coalescence is produced by the heat obtained from resistance of the work to the flow of electric current in a circuit of which the work is a part, and by the application of pressure. There is no external heat source. Heat is developed in the part to be welded and pressure is applied by the welding machine through the electrodes. No fluxes or filler metals are used. Current for resistance welding is usually supplied through a welding transformer which transforms the high-voltage, low-amperage power supply to usable high amperages at low voltages. Pressure, or more properly, the electrode force, is supplied either by air or oil pressure through cylinders, mechanically by cams, manually by foot or hand levers through linkages or some other means.

1.2 Heating Fundamentals

In an electrical conductor, any current flow creates heat. The three factors that affect the heat generated in resistance welding are expressed in the formula

$$H = I^2RT$$

where
H = heat generated in joules
I = current in amperes
R = resistance of the work in ohms
T = time of current flow in seconds

The formula shows that the heat generated is proportional to the square of the welding current and directly proportional to the resistance and the time. The total heat generated is partly used to make the weld and partly lost to the surrounding metal.

1.3 Literature Review

Xiaodong Wan et al. (2014) in his experiments for welding current variation found that nugget size and shape are highly dependent on welding current. Feng Chen et al. (2016) presents that the welding and holding time have virtually no effect on peak load, however they determine average grain size in HAZ (Heat Affected Zone), the peak load depended on weld nugget size. Hessamoddin Moshayedi et al. (2014) concluded that Welding current has more effect on residual stresses in comparison with welding time. Maoai Chen et al. [2016] showed that as the weld current or weld duration increases the weld width and penetration increases noticeably. Tumuluru et al. [2010] discussed the weld expulsion can be reduced by increasing electrode force and larger diameter tips have a higher current carrying capacity and provide for lower current density. Khosravi et al. (2013) in his research showed that with increasing the welding current, grain size increased and as a result, the brittle fracture increased. Prof. Suraj Patil et al. (2014) delivered an innovative way to prevent the electrode wear by plating the surface of electrode and reducing the current requirement.

2. EXPERIMENTAL WORK

2.1 Scope of work

This experimental work aims at reducing the power consumed by the seam welding machines by reducing the current consumption of the machines. It is carried out at "Viraj Engineering Company" in Satara. The investigations are carried out to identify the parameters that are causing the increase in the power consumption of the machine. After identifying the required parameters we try to optimize the parameters by making suitable changes in the seam welding machine. Hence the objectives for this study are listed as follows

1) Investigate whether all the systems of the seam welding machine like the pressure gauge, control panel are working properly.

2) Identify the parameters that are causing the increase in current consumption of the seam welding machine.

3) Reduce the current consumption of the seam welding machine

Thereby reducing the penalty charges suffered in the hands of MSEDCL (Maharashtra State Electricity Distribution Co. Ltd.).

2.2 Properties of CRCA material

The material used for the manufacturing of the storage tank is CRCA (cold rolled cold annealed) steel Grade 513D having thickness 1.5 mm. Hence, thickness for seam welding operation is 3mm. The composition and the properties of the CRCA sheets are given in the following table

Table -1: Metal composition of CRCA steel sheets

%C	%Mn	%Si	%S	%Al	%P	%B
0.02-0.06	0.1-0.25	0.03	0.01	0.021-0.06	0.02	0.02

2.3 Experimental set-up

The experimental set up consists of a longitudinal seam welding machine used to seam weld storage tanks used for oil storage in tipper trucks.

Fig -1: Mechelonic seam welding machine

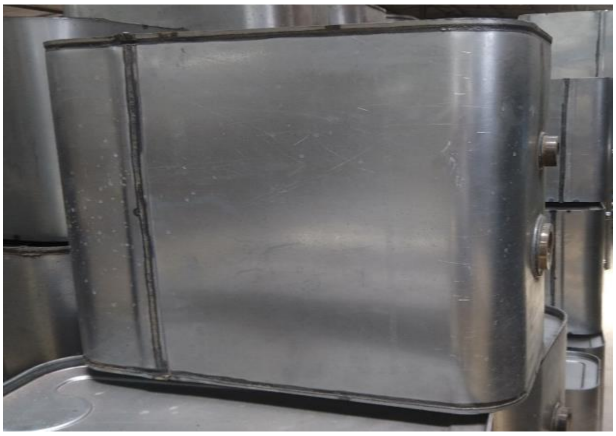

Fig -2: Seam welded storage tank

2.4 Effect of area of contact on welding current

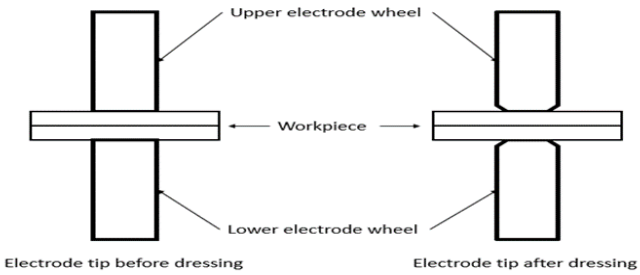

Fig -3: Effect of electrode tip dressing

Area of contact is the contact area between the seam welding electrode wheel and the workpiece being welded. The large contact area results in low current density and low contact resistance. Hence, the current is inversely proportional to the contact area between the electrodes and the workpiece. The contact area is reduced when the electrode dressing is done for removal of impurities accumulated on the electrode wheel. Electrode tip dressing after every 75 tanks are welded. As the contact area between the electrode wheel and the workpiece was reduced, the current density increased with increasing the contact resistance. Hence, as the contact area was reduced, the current required for completion the weld increased.

2.5 Effect of cooling of weld on welding current

Cooling water for seam welding wheels can be either internal or external. Initially, the seam welding machine internally cooled. Due to improper cooling the scales of the oxides formed because of improper heat dissipation increased the contact resistance thus increasing the current required for seam welding operation. The company now uses external cooling system for the seam welding machines. The cooling done is satisfactory and results in proper dissipation of heat although certain black scales are seen on the electrodes. The operator must know which areas to target to get optimum quality of weld. The benefits obtained external cooling include:

- Thermal damage to the weld surface and any coatings was reduced, so the weld ability improved.
- Weld distortion was reduced.
- Fume emission was reduced.
- Wheel cleanliness improved, because water was directly applied to the hottest point on the wheel, producing a cleaning action on the wheel surface.

2.6 Effect of electrode force on welding current

The air pressure is required to clamp the workpiece and apply proper electrode pressure to obtain satisfactory weld. The air pressure required by the seam welding machine is 4.2 – 6.5 kg/cm2. Electrode conveys the force and welding current to desired location. According to theoretical analysis, large of electrode force may easily induce surface expulsion. Small electrode force will result in improper clamping of the workpiece and disruption to the current flow resulting in increased usage of current. The measure of electrode force have been fixed initially by the manufacturers of the seam welding machines. The pressure gauge of the seam welding machine was malfunctioning giving improper or at times no reading. The pressure gauge was recalibrated according to the given requirement of company resulting in proper clamping of the workpiece.

2.7 Effect of electrode coating on welding current

Electrode coating is an innovative way to prevent the electrode wear. From the research conducted by Prof. Suraj Patil et al. (2014) it was found that nickel and chromium plating were suitable for CRCA steel sheets welded using copper electrode. Plating of these materials is easily available and inexpensive. It is investigated from the study that Ni plating and Cr plating requires less current to weld compared to non-plated electrodes. This is due to increase in resistance of the weld system due to plating which requires less current as resistance of the weld system is increased.

The copper electrode used in the seam welding machine was replaced by Class 2 Alloy – Chrome Copper Alloy C18200.

Table -2: Chemical composition of RWMA Class 2 Alloy

%Chromium	%Lead	%Iron	%Silicon	%Copper
0.6-1.2	0.05	0.1	0.1	Balance

2.8 Effect of silver contact present between machine shaft and bearings

The machine shaft is attached to the rotating electrodes. Hence, the machine shafts imparts the rotational motion to the electrode wheel and supports it. This machine shaft is mounted on the ball bearings. There is a silver contact present between the ball bearing and the machine shaft which enables the smooth motion of the shaft against the bearings. If this contact is not perfect the motion of the shaft is affected due to friction. The shaft is the unable to properly transfer the rotational motion to the electrode wheel. Required pressure is not obtained for clamping of workpiece for welding. To compensate for this the operator increases the current of the machine or double welds it. The silver contact of the seam welding machine was found deteriorated and was replaced a new silver contact. This resulted in proper clamping and transfer or motion to the electrode wheel. No energy was being lost due to friction and increase in usage of current was stopped.

Fig -4: Deteriorated silver contact

2.9 Transformer efficiency

Seam welding transformer used in the Mechelonic seam welding machines is a core type moulded transformer having capacity 400kv. It has three taps for DC supply. The range for tap 1 is 1kA to 19kA. For tap 2 the range is from 2kA to 23kA. Tap 3 ranges from 3kA to 26kA. The company requirement is of 17.3kA, hence the transformer is generally operated through tap 1. The transformer on investigation was found to be earthed. Hence, it was not transferring the current with full efficiency. The power factor of the transformer was less than 1. The industry was facing the power factor penalty charges from MSEDCL as it was unable maintain power factor of 1. Hence the transformer was replaced and the problem of lower efficiency was solved and desired power factor was achieved.

2.10 Effect of lubrication on welding current

An additional problem was discovered of lubrication. Company used ordinary oil for the seam welding machines. As the seam welding is a high temperature operation, use of ordinary oil led to formation of small lumps of oil at the high temperature regions. Required level of lubrication was not achieved leading to friction which contributes to increase in current consumption to compensate for it. Also the lubricant being non-conductive when came in contact with the electrode wheel reduces the conductivity of the wheel. Hence, more current had to be utilized. It was replaced by an industrial grade lubricant known as conductivity graphite grease. It operates satisfactorily at high temperatures and being conductive does not affect the conductivity of the electrode wheel of any other conducting part. As a result the current utilization was reduced.

3. CONCLUSIONS

Table 3: Average power factor and penal charges

Month	Average power factor	P.F(Power Factor) penal charges in rupees
December 2017	0.626	61,666.85
January 2018	0.820	20,702.92
February 2018	0.954	0

From table 3 it can be seen that the power factor for the three months increased to the desired value and the penalty charges suffered by the company were reduced to zero. This was possible because of the various modifications that were done to the seam welding machine that includes

•Proper electrode tip dressing.
•Application of external cooling system.
•Recalibration of the pressure gauge.
•Chromium coating of electrodes.
•Replacing the silver contact present between the bearing and the machine shaft.
•Installing a new core type molded transformer
•Use of conductivity graphite grease for lubrication.

Similar problem investigation was done for remaining seam welding machines and the solutions were simultaneously applied.

It was found that the increase in power factor in the month of January was caused by the changing of the transformer and the silver contact. The power factor increased by 0.194 and the decrease in penalty charges were 62.47%.

Other parameters like coating of electrode, use of conductive grease had major contribution in increasing the power factor by 0.134 and decreasing the penalty charges by 33.57%.

Recalibrating pressure gauge, use of external cooling system and proper electrode dressing ensured that the seam welding machine maintained the required level of process parameters.

ACKNOWLEDGEMENT

The authors gratefully appreciate the CEO of the Viraj Engineering Company Mr.Digvijay Patil for timely help and motivation.

REFERENCES

[1] Maoai Chen, Dong Zhang, Chuansong Wu, “Current waveform effects on CMT welding of mild steel”, Journal of Materials Processing Technology, 2017.

[2] Feng CHEN, G.Q. Tong, Zhenwu Ma, XiaoKang Yue, “ The effects of welding parameters on the small scale resistance spot weldability of Ti-1Al-1Mnthin foils”, Materials and Design Journal, 2016.

[3] Xiaodong Wan, Yuanxun Wang, Peng Zhang,“ Modelling the effect of welding current on resistance spot welding of DP600 steel”, Journal of Materials Processing Technology, 2014.

[4] Hessamoddin Moshayedi, Iradj Sattari-Far, “Resistance spot welding and the effects of welding time and current on residual stresses”, Journal of Materials Processing Technology, 2014.

[5] Prof Suraj Patil and Prajakta Patil, “Resistance Spot Welding of CRCA Steel sheets using surface modified electrodes”, International Journal of Innovative Research in Advanced Engineering, Volume 1 Issue 6 (July 2014).

[6] Alireza Khosravi, Ayyub Halvaee, and Mohammad Hossein Hasannia, “Weldability of electro galvanized versus galvanized interstitial free steel sheets by resistance seam welding”, Materials and Design, 44, 2013, 90–98.

[7] Murali D. Tumuluru, Hong yang, Zhang, and R. (Bob) Matteson, Procedure Development and Practice Considerations for Resistance Welding, ASM Handbook, Welding Fundamentals and Processes, 6A, 463-485.

[8] “Resistance Welding: Theory and Use”, Prepared by Resistance Welding Committee, American Welding Society, Reinhold Publishing Corporation, New York, 1956, pp. 102.

[9] Resistance Seam Welding by The ASM committee on Resistance Welding of Steel, ASM handbook, 6, Welding, Brazing and Soldering, 425-436.K. Elissa, “Title of paper if known,” unpublished.