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Adaption of Contact Tip to Diminish Imperfection and Cost Implicated in Robot Welding

[a] S. Manikandan, [b] N.Vinoth

[a,b] Assistant Professor, Sri Venkateswara Institute of Science and Technology

Chennai, India.

Abstract

Productivity and time management are the two interrelated areas, which any industry is concerned with, in order to achieve high quality while maintaining less initial cost. This is also for better production management and optimum utilization of the resources. The process carried out in robot welding under study involves much wastage of time. This paper deals with all the drawbacks observed and reduces inconsistency and disturbances occurring during the operation. It is also useful to optimize human work that ensures less time consumption. This leads to workers safety and at the same time guarantees the finishing of job with respect to time. Results obtained in this work ensure that there is less wastage of time that indirectly leads to quality production and profit.

Keywords: robot welding, contact tip, occurrence, tool life, time saving

Introduction

Welding is a fabrication or sculptural process that joins materials. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that gets cooled and makes a strong joint with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing that involves melting of a material between the work pieces to form a bond between them, without melting the work pieces. Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction or ultrasound. In industries, welding is performed in many different environments, including open air, under water and in outer space. It is potentially a hazardous job and hence precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes and exposure to intense ultraviolet radiation. Arc welding is a type of welding that uses power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and either consumable or non-consumable electrodes. Welding region is usually protected by shielding gas, vapor or slag. Arc welding processes may be manual, semi-automatic or fully automated. The ARC Mate100Ic robot series has a process specific design that protects the weld torch cable from the wire feeder to the torch goose neck, reducing cable wear and minimizing wire feeder issues. This simplified routing prevents the interference of cables with parts and tooling and allows offline programs to be generated and tested without compensating for the torch cable. Slim wrist size enables the robot to enter into smaller openings in the work space. Robot is designed with integral utilities along with gas/air lines and an electric wire feed motor cable routed inside its arm. This offers improved reliability, reduced setup time and eliminates external cabling requirements. At the starting of the welding, robot travel speed is 32 inch per minute (ipm). In the middle of the welding, it is 36 ipm. Many applications demand copper to have higher mechanical properties and to be capable of using at elevated operating temperatures while still retaining its effective conductivity. Chromium-Copper alloy, with a small addition of Zirconium is used. Addition of Zirconium inhibits chemical reaction of copper at elevated temperatures and helps to retain the physical properties at elevated temperatures. Also, it marginally increases annealing temperature. Earlier, Bernard et al. [1] worked on arc welding and suggested modifications. Contact tip for electric arc welding using consumable wire was discussed by Manning and Wray [2]. C18150 alloy is used extensively for cap style resistance welding electrodes. It can provide less sticking and resists deformation for longer time than its chromium copper counterpart in some specific situations [3]. Hidaka and Tsukui [4] presented the performance related aspects with respect to welding contact tip and welding gun. The common defects in robot welding are spatters and blowholes.

1.1. Spatters

Small particles of non-metallic materials are expelled during the fusion of the weld and base metals. This weld spatter is considered as a serious discontinuity, when it interferes with the serviceability of the part or with an additional operation like painting. Spatter is made up of little bits of metal that are sent flying away from the welding area by welding arc. Excessive spatter can result in low-quality stick and mig welds. This also makes welding area messy and causes visibility problems. Spatters cannot be avoided in welding completely. Excessive spatters can damage the welding and contact tip too. By keeping the electrode length at 1/8-inch-diameter core, we can reduce the spatters to some extent. Figure 1 shows the spatters on contact tip that are expelled during welding. When these spatters increase, there is a chance of getting damage to the contact tip and quality of welding will decrease.

Figure 1 Spatters on the contact tip.

1.2. Blowholes

Blowholes are the cavity type discontinuities formed by gas entrapment during solidification. These blowholes lead to the damage of the material and decrease the strength of material. Figure 2 shows the presence of blowholes that are formed during the welding of the material. These reduce the life of the material.

Figure 2 Spatters on the contact tip.

1.3. Main causes and preventive measures

The main causes for defects are too little shielding gas or flux burden height, high welding amperage, moisture in coatings, fluxes or shielding gases. In order to avoid these, proper amount of shielding gas and flux burden height are to be used. Similarly, appropriate welding amperage, arc lengths and arc voltage are selected. Same is the case with refry coatings, fluxes and shielding gases.

Figure 3 Abicore Binzel contact tip with inner diameter of 1.4 mm.

2. Methodology and modification of tip

Abicore Binzel contact tip with a diameter of 1.4mm as Figure 3 is used in the robot welding that has a metal combination of copper, chromium and zirconium. A copper wire of 1.2 mm dia is used as an electrode wire for welding of materials with a clearance of 0.2 mm. By using the contact tip of the 1.4 mm dia, there is lot of inconsistency in welding leading to spatters, blowholes and even causing damage to the contact tip. In the present work, modified Bernard contact tip. Diameter of 1.3 mm is taken with the same material copper, chromium and zirconium alloys. Figure 4 shows the Bernard contact tip with inner dia of 1.3 mm. This contact tip is modified with external threading and is modelled using SolidWorks2013. By using this modified Bernard contact tip, there is reduced tendency of the above mentioned welding defects. Shielding gas is provided with 80% of argon and 20% of carbon dioxide. The primary purpose of shielding is to protect the molten weld metal from oxidation and other atmospheric gases. Due to the clearance of 0.2 mm in the robot welding, problems arise. So, the contact tip is also modified with a clearance of 0.1 mm. By using this modified contact tip in the robot welding, defects can be reduced ensuring increased quality of weld and thus production. Also, external threading on the tip is given in order to fit it the robot as shown in Figure 5.

Figure 4 Bernard contact tip with 1.3 mm inner dia.

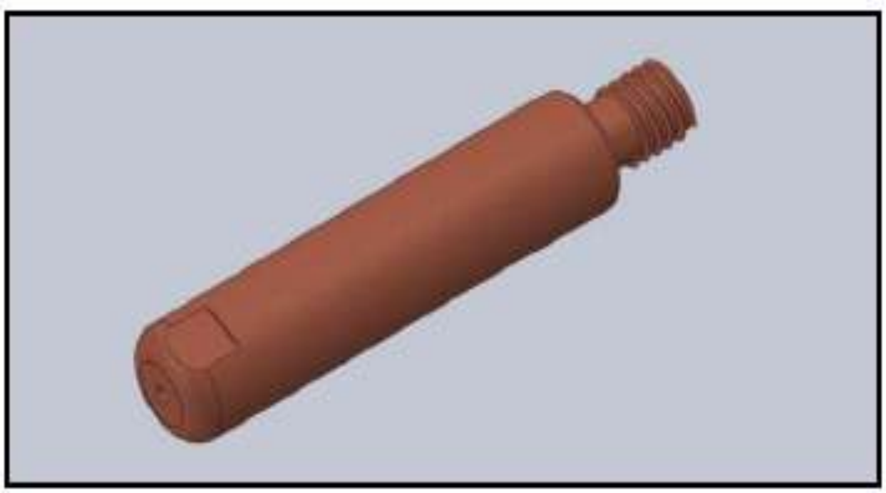

Figure 5 Bernard contact tip with external threading.

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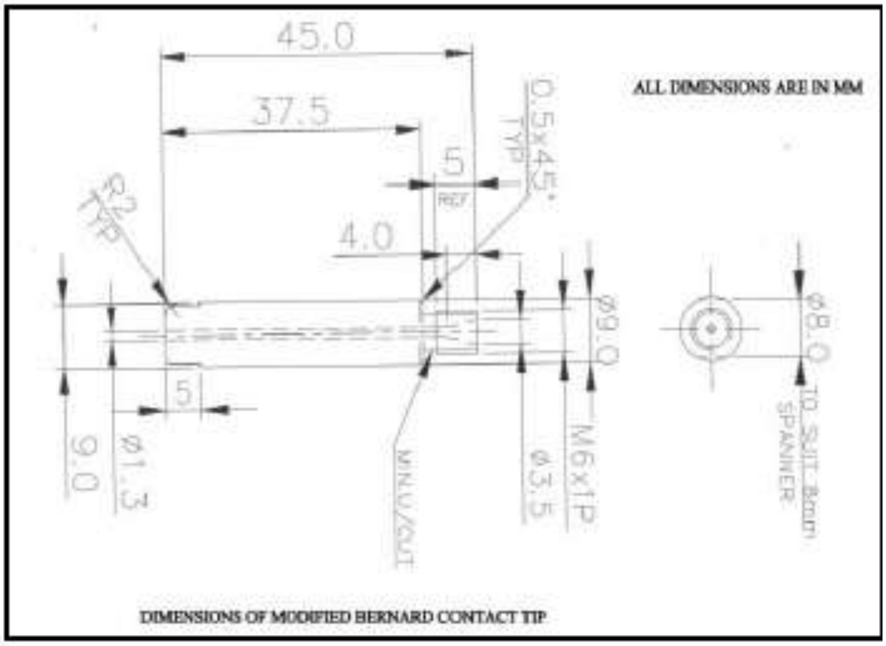

Figure 6 Dimensions of modified contact Tip.

3. Results and analysis

Calculations are made using four robots (A, B, C and D) in three shifts per day. The data is obtained for a week's time and average is taken as shown below. Production of shoes is considered in this work for analysis.

Average tool life for Abicore Binzel is 275 shoes ((317+249+335+174+314+275)/6)

Average tool life for Bernard is 1669 shoes ((1734+2536+2013+1994+2512+1238)/6)

Average sticking occurrence in Abicore Binzel is 6 times ((6+5+7+7+7+6)/6)

Average sticking occurrence in Bernard is 3 times ((3+2+2+3+3+3)/6)

Average defects obtained for Abicore Binzel is 25 times ((28+21+25+28+25+21)/6)

Average defects obtained for Bernard is 11 times ((12+8+12+13+11+9)/6)

The difference in tool life and increase in tool life are shown in Table 1. This shows that the Bernard contact tip has better tool life over the Abicore Binzel contact tip. Figure 7 represents the average tool life of both the contact tips. It is clear that the Bernard contact tip has more tool life.

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Table 1 Tool life of contact tips

Contact tip	Tool life
Overall average tool life for Abicore Binzel	275 shoes
Overall average tool life for Bernard	1669 shoes
Difference for the tool life	1669-275 = 1394
Increase of tool life	1669/275 = 6.06 = 6 times
% Increase of tool life	6*100 = 600%

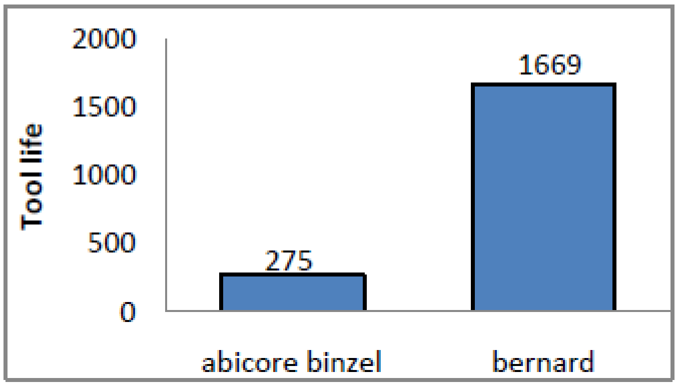

Figure 7 Tool life of contact tips.

3.2. Occurrences

The difference in occurrence and decrease in occurrence are shown in Table 2, which reveals that the Bernard contact tip has fewer occurrences over the Abicore Binzel contact tip. Figure 8 shows the occurrence of these two contact tips. When we compare the occurrence in both the cases, Bernard contact tip has fewer occurrences.

Table 2 Occurrences of contact tips

Contact tip	Occurrence
Average sticking occurrence in Abicore Binzel	6 times
Average sticking occurrence in Bernard	3 times
Difference in defect	6-3 = 3
Decrease of defect	3/6 = 0.5
% Decrease of defect	0.5*100 = 50 %

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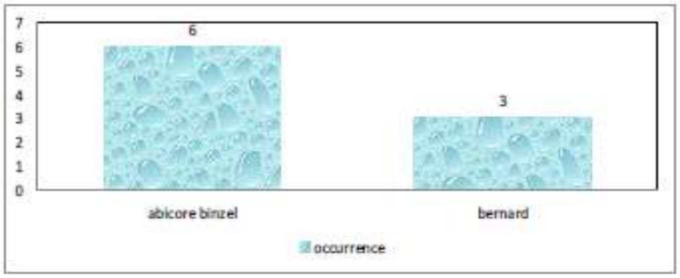

Figure 8 Sticking occurrence in both the tips.

Table 3 Cost saving

Contact Tip	Cost
Cost of Abicore Binzel contact tip	Rs. 175
Cost of Bernard contact tip	Rs. 85
Modification charge of Bernard tip	Rs. 30
Total cost of Bernard contact tip	Rs. 115
Abicore Binzel using per week	5 (avg.)
Contact tip cost for one week (abi.)	5 * 175 = 875 Rs
Contact tip cost for one year (abi)	875 * 52= 45,500 Rs
Average Bernard contact tip using per week	2
Contact tip cost for one week (ber.)	2 * 115 = 230 Rs.
Contact tip cost for one year (ber.)	230 * 52 = 11,960 Rs.
Contact tip cost saving per year	45,500 – 11,960 = 33,540 = 33,540*4 = 1,34,160Rs

3.3. Cost saving

The difference of cost savings for both contact tips are shown in Table 3. It is clear that the Bernard contact tip has fewer expenses per contact tip over the Abicore Binzel contact tip. Figure 9 shows the plot of cost savings per year. It is evident that Bernard contact tip has more cost saving. 3.4. Time saving Table 5 shows the percentage decrease of time loss i.e., 49.77%, when

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using Bernard contact tip. Figure 10 shows the time saved while changing the contact tip. About 555 minutes of time is saved while using Bernard contact tip.

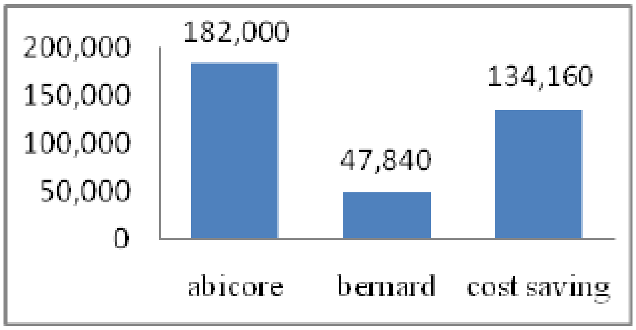

Figure 9 Contact tip cost saving per year.

Table 4 Time loss

Content	Abicore Binzel	Bernard
Tool changing time for an operator	5min	5min
Tool changing per week	5	2
Time consuming to tool change per week	5*5 = 25 min	5*2 = 10 min
Sticking repairing time of an operator	10 min	10 min
Sticking occurring per shift	6 (average)	3 (average)
Total time defect repairing per shift	10*6 = 60min	10*3 = 30min
Total time defect repairing per day	60*3 = 180 min	30*3 = 90 min
Total time defect repairing per week	180*6 = 1080 min	90*6 = 540 min

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Table 5 Time saving

Contact tip	Time saving
Total time loss for Abicore Binzel	= 1080 + 25 = 1105 min. /week
Total time loss for Bernard	= 540 + 10 = 550 min
Difference in time loss	= 1105 – 550 = 555 min
Decrease of time loss	=550/1105 = 0.4977
% Decrease of time loss	= 0.4977 * 100= 49.77%

3.5. Rework

The percentage decrease in rework is shown in Table 6. It means that there is about 44% decrement of rework while using Bernard contact tip. Figure 11 shows the reduction of rework of job. When compared to Abicore binzel contact tip, Bernard contact tip has less time consumption for rework.

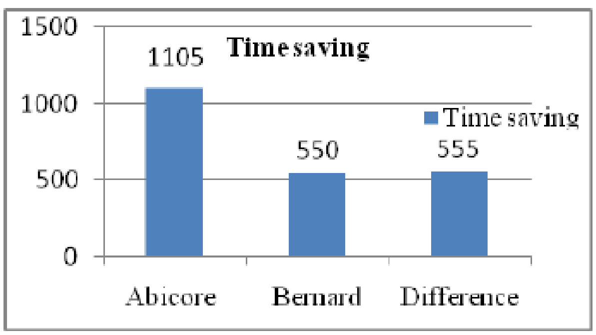

Figure 10 Time saving for contact tips.

Table 6 Reduction of rework

Contact tip	Rework
Average defects obtained for Abicore Binzel	= 25 times
Average defects obtained for Bernard	= 11 times
difference in rework	= 25-11 = 14
decreased rework	= 11/25 = 0.44
% decreased rework	= 0.44*100 = 44 %

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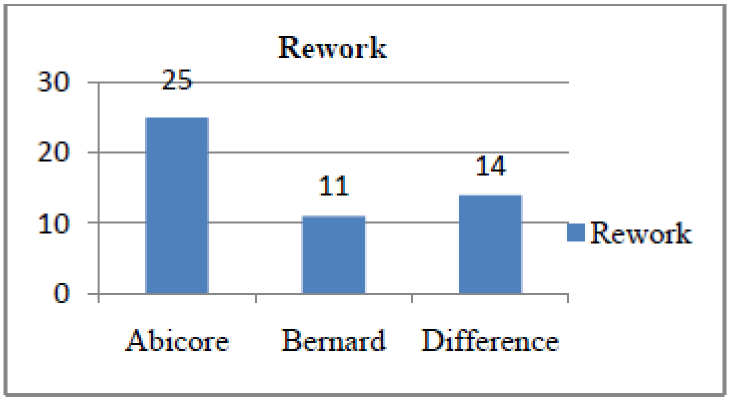

Figure 11 Reduction of rework.

3.6. Increased production

Table 7 shows the increase in production rate. Using Bernard contact tip, 550 minutes can be saved. With this, production increases up to 275 shoes per week and production can be increased up to 57720 shoes per year using 4 robots.

Table 7 Increase in production rate

Cycle time of robot	42 sec.
Job loading time for an operator	78 sec.
Total time for a job completion	120 sec = 2 min.
Time saving per week	550 min.
Production increase per week	550/2 = 275 shoes
Production increase per year	275 * 52 = 14430 shoes
Production increase for 4 robots	14430*4 = 57720 shoes

4. Conclusions

Both the contact tips are compared with respect to performance. This section summarizes all those aspects.

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4.1. Time saving

In Abicore Binzel, if the contact tip has to be changed, the time taken is more than 10 minutes. But, in Bernard the contact tip, damages are less. So, the tool changing time is saved. According to the tool life observed in both the cases, it is easy to save time in Bernard contact tip. Defects occurring in the Bernard contact tip are lesser than that of Abicore contact tip. So, the repairing time is less for the Bernard contact tip. From the above analysis, the total time saving of about 550 minutes per week can be obtained while using the Bernard contact tip.
4.2. Tool life and cost saving

According to the tool life calculations, Bernard tool does more jobs when compared to Abicore Binzel tool. The Bernard contact tip is 6 times more efficient when compared with the Abicore Binzel contact tip. Similarly, larger amount of tool changing cost is saved with Bernard contact tip. Also, the contact tip expenses are lesser for Bernard than Abicore Binzel.

4.3. Occurrence of tip

Occurrence of tip reduced in case of Bernard, when compared to the Abicore Binzel. On an average, the occurrence takes place three times a day in case of Bernard. Various aspects like defects, time consumption and tool life are studied in case of Abicore Binzel and Bernard tips. By comparing the performance of both the contact tips, it is concluded that the clearance for the contact tip and copper wire should be apt and maintained in such a way that defects must be nullified and productivity should increase. Further, by inducing the non-stick coated materials, the efficiency can be increased. Also, the diameter of the contact tip and clearance may be changed in order to find the optimum instance.

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