Implementation of Rotary Torch Welding SPM to Increase Productivity and Product Quality

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Abstract- *This research paper attempts to describe the implementation of rotary torch welding SPM to increase productivity and product quality at Gatiman auto Pvt. Ltd. which is the manufacturer of Exhaust pipes, Fuel tank & Tipper in central India. The function of SPM is to weld exhaust pipes with flange. The function of the SPM is to weld the circular exhaust pipe which is next use for automobile industry. This project efficiently helps to partially or fully automate the process of Welding. The project will provide the practical description of the system along with the flow of working of various components. The main aim of the project is to automate the MIG Welding process by using pneumatic as well as electric energy. The Special device can rotate the torch at fix rate to assist the welding process for circular components and ensure good profile and homogenous welding.*

I. INTRODUCTION

In this project step by step a detail study is being provided which is based on the number of observation taken from related department of industry, the conclusions are suggested after the number of discussion to the most experienced employee of the related departments and also with the first person who is doing the particular job himself, many discussion are done on the requirement, working method, problem being faced, feedback after micro level implementation of new methodology.

In this thesis work, a hard effort is done to make the research work from the ground level of problem. A special attention is provided in this work to prepare a project in which ideal theories are meeting to the practical working conditions of an organization or company and proposed methodology is being prepared based on the experienced during this industrial visit.

Gatiman Auto Pvt. Ltd. is established in Plot no. S-4/4, sector-1, Pithampur, Dhar, Madhya Pradesh, India. This company is manufacturer and supplier of heavy equipment like Tipper Body, Fuel Tank, Exhaust Pipes, Chassis, Fuel filling pipes and small child parts. Here the primary objective of this thesis is to establish rapid and better production system, improvement in quality and efficiency of industry. The rotary torch welding SPM can help to boost output.

Problem Formulation

Welding is a process used to join materials usually metals or thermoplastics by causing combination. This process is carried by melting the work-piece and adding a filler material to form a pool of molten material that cools to form a strong joint In implementation of "ROTARY TORCH WELDING MACHINE" we used Gas Metal Arc welding. Automation is much helpful in coast saving and to increase the productivity of the system. Basic requirement for any manufacturing company is to have effective work output. Circular welding is one of the most critical welding processes carried out manually, so we have used automated rotary torch welding process.

Problem Statement

Now, we have two alternatives to manufacture the SPM.
SPM1: Rotate work-piece around the welding torch.
SPM2: Rotate the welding torch around the work-piece (exhaust pipes).
Why to use SPM2.

Rotating the whole work-piece (long pipes) around the welding torch is not feasible due to misaligned welding points along vertical axis and horizontal plane. Hence , it is not possible to construct the SPM1(manual SPM suitable for small and straight pipes), we can use SPM2 design which will allow to manipulate the machine components as require with the work-piece (exhaust pipes). This special purpose machine (Rotary Torch Machine) is used for welding of the exhaust pipes using the CO2 MIG welding process with the help of torch. A fixture is provided on the machine for this operation. Welding torch rotates around the pipe and flange during welding. Necessary setting and adjustments are provided on this SPM to ensure smooth and safe operation of the system.

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Experimental Validation

We have implemented Rotary Torch Welding Machine, as the manual welding and other welding processes like job rotary machines facing problems for welding of circular jobs (pipes). Gatiman Auto Pvt. Ltd. facing problem in welding of long exhaust pipes assembly. Sometimes there were problem related to rotation of job. So we introduce the idea of "AUTOMATED ROTARY TORCH WELDING MACHINE". The exhaust pipe assembly includes the following parts;

- Bend pipe
- Straight pipe

II. EXISTING METHOD

Previously circular welding was considered as the most skillful and stressful join profile. This kind of welding was done manually by highly skilled workers. The skilled worker welding the circular points with a welding torch. He has to do the welding very carefully which will result in uniform welding thickness. In this case worker fatigue and personal temperature affects the quality .in existing method welding take some considerable time and increase the lead time in same manner.

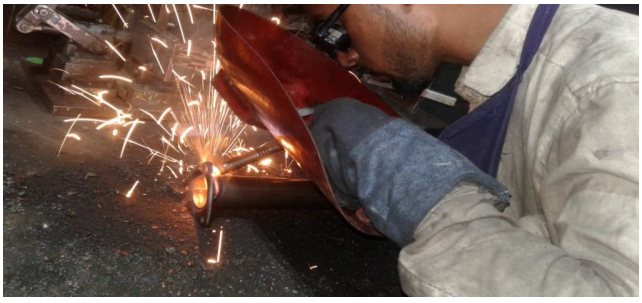

Fig.-1 Existing method

Manual SPM

In manual SPM welding the object is rotating and torch is steady . In this the object is rotating and the welder constantly hold the torch at a constant position.

Fig.-2 Manual SPM

III. PROPOSED METHODOLOGY

Rotary torch SPM welding machine is a special purpose welding machine shown in fig.-3 in which the object is steady and welding torch is rotated. It is used for welding the exhaust tubes or pipes which may large in size or having typical profile.

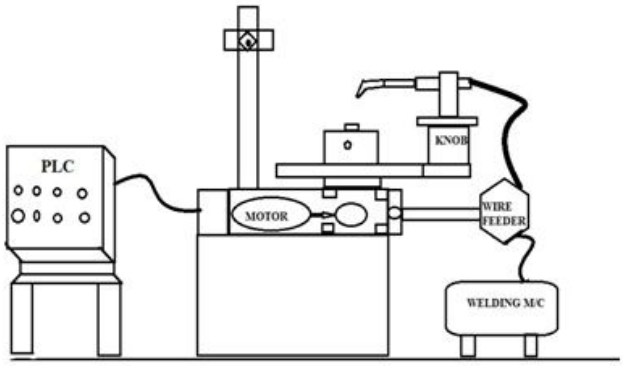

Fig.-3 Visual design of Rotary torch SPM welding machine

The flow of working of the system is in the following manner:

[1] The System is turned on by the operator.
[2] Initially as soon as the machine is started, the SPM block is open. The operator loads the job inside the SPM block.
[3] The operator selects the Auto/Manual mode of working of the system. The manual mode enables the operator to customize the operating parameters of the system; the system can be tested for different operating conditions in the manual mode. The Automatic mode starts the operation automatically as soon as it is selected. The SPM block closes as soon as the operator is done with selecting the mode of operation followed by pressing the start button of the machine.
[4] The Automatic mode operation includes the following sequence of operation:
   (A) The job detection sensor senses the job and sends the corresponding output signal to PLC. The PLC reads this input signal and implements it in the ladder diagram, generating a new output signal.
   (B) PLC sends this output signal to the servo motor and welding gun controllers simultaneously.
   (C) The welding guns move from their home position to the forward position. Also, at this stage, the absolute encoder is initialized.
   (D) The Welding gun controller sends the signal to start welding and simultaneously, welding torch moves to its designated angle during the Welding process.

(E) Absolute encoder measures the angle by which the welding torch has been rotated and it informs the PLC regarding the same.
(F) The PLC waits for the welding torch to rotate to its required angle and it immediately sends a signal to the welding gun controllers to stop the welding process.
(G) The Welding torch move to their home position.
(H) The door to SPM block opens and the job is unloaded by the operator.
(I) This is the end of the first cycle; the cycles can be continued if the set of operating parameters required for the next cycle are the same as the previous cycle.

Rotary Torch SPM Welding Machine Specification

S. No.	Descriptions.	Dimensions.
1	Pipe Size	OD 50.8 to 101.6mm & Thik-1.6 to 2.5 mm
2	Speed of Electrode	Depends on job
3	Current and voltage	110 to 220 A and 18-24 V
4	Motor used	PMDC 36 V
5	Welding Technique	MIG
6	GAS	CO2
7	Wire Dia.	0.8 mm
8	Contact work distance	5 mm
9	Work piece position	Vertical
10	Torch Position	Vertical top down perpendicular to work piece

IV. EXPERIMENTAL ANALYSIS

As per suggested methodology in this thesis, I worked on Gatiman Auto Pvt. Ltd. Manufacturing of exhaust pipes, fuel tank, and tipper. Following details-data could be observed for the analysis purpose.

The raw material used for exhaust pipes is ERW – 1 as per IS3074
Description of tubes
Tube dia. Used for manufacturing the exhaust pipe = 15.88 mm to 101.6 mm
Length of tube = 4000mm to 6000mm
End use = Exhaust pipe

Data Collection and Calculation before Implementation of Rotary torch SPM

The following tables includes the time taken in various operation performed to weld the exhaust pipes.

Tube diameter: - 50.8 mm
Operation: - TACK WELDING AND FULL WELDING MANUALLY
Machine: - CO_2 MIG
Gang Strength: - 1

Table 5.1 Tube dia. 50.8 Tack weld & Full weld manually

S. NO.	ELEMENTS	STD TIME	TIME IN SEC.
1	LIFT THE FLANGE	1.80	1.80
2	LOCATE ON FIXTURE	2.14	2.14
3	LIFT THE PIPE	2.04	2.04
4	LOCATE ON FIXTURE	4.44	4.44
5	CLAMP 01	3.00	3.00
6	TACK WELD 5mm × 03 NOS	5×3×0.52	7.80
7	DECLAMP 01	3.00	3.00
8	REMOVE THE JOB FROM FIXTURE & PUT ON TABLE	5.00	5.00
9	LIFT THE TACK WELDED JOB & PUT ON WELDING TABLE	2.04	2.04
10	FULL WELDING 40 mm	11.60	11.60
11	TURN YHE JOB	2.20	2.20
12	FULL WELDING40 mm	11.60	11.60
13	TURN THE JOB	2.20	2.20
14	FULL WELDING 40 mm	11.60	11.60
15	TURN THE JOB	2.20	2.20
16	FULL WELDING40 mm	11.60	11.60
17	PUT THE JOB ON PALLET	1.30	1.30
	CYCLE TIME IN SEC.		85.56
	13% ALLOWANCES		11.12
	TOTAL TIME IN SEC/JOB		96.68
	PRODUCTION PER HOUR AS PER 100%		37.23
	PRODUCTION PER SHIFT AS PER 100%		297.84

Observed Cycle Time = 85.56 Sec.
Total number of process element = 17 nos.

Calculation based on observed data before implementation of Rotary torch SPM on Tube Dia. 50.8 mm

Average observed time = 8.0 Hours=480 minutes
Workers performance rating = 100 % (Total working time= 8 hours 30 minutes =510 minutes)
Actual working time = 510-30 (30 min lunch) = 480 minutes
13 % Allowance = Cycle time × Allowance factor
85.56 × 0.13 = 11.12 Sec.
Total time in Sec. / Job = Cycle time + 13 % Allowance
85.56 + 11.12 = 96.68 Sec.
PRODUCTION PER HOUR AS PER 100% = 1 Hour ÷ Total time in Sec. / Job
We know that, 1 Hour = 3600 Sec.
3600 ÷ 96.68 = 37.23 per hour
PRODUCTION PER SHIFT AS PER 100% = PRODUCTION PER HOUR × No. of working hours
37.23 × 8 = 297.84 per shift

Data Collection And Analysis After Implementation of Rotary torch SPM

The following tables includes the time taken in various operation performed to weld the exhaust pipes.

Tube diameter:- 50.8 mm

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Operation :- TACK WELDING AND FULL WELDING ON ROTART TORCH SPM
Machine:- CO_2
Gang Strength:- 1

Table 5.5 Tube dia. 50.8 Tack weld & Full weld on rotary torch SPM

S. NO.	ELEMENTS	STD TIME	TIME IN SEC.
1	LIFT THE FLANGE	1.80	1.80
2	LOCATE ON FIXTURE	2.14	2.14
3	LIFT THE PIPE	2.04	2.04
4	LOCATE ON FIXTURE	4.44	4.44
5	CLAMP 01	3.00	3.00
6	TACK WELD 5mm × 03 NOS	5×3×0.52	7.80
7	DECLAMP 01	3.00	3.00
8	REMOVE THE JOB FROM FIXTURE & PUT ON TABLE	5.00	5.00
9	LIFT THE TACK WELDED JOB & PUT ON GRIPPER	6.50	6.50
10	CLOSE THE WELDING TORCH	9.00	9.00
11	START THE CYCLE	1.20	1.20
12	FULL WELDING ON JOB	18.00	18.00
13	OPEN THE WELDING TORCH	9.00	9.00
14	UNLOAD THE JOB	10.00	10.00

CYCLE TIME IN SEC.	82.92
13% ALLOWANCES	10.77
TOTAL TIME FOR /JOB	93.69
PRODUCTION PER HOUR AS PER 100%	38.42
PRODUCTION PER SHIFT AS PER 100%	307.36

Observed Cycle Time = 82.92 Sec.
Total number of process element = 14 nos.

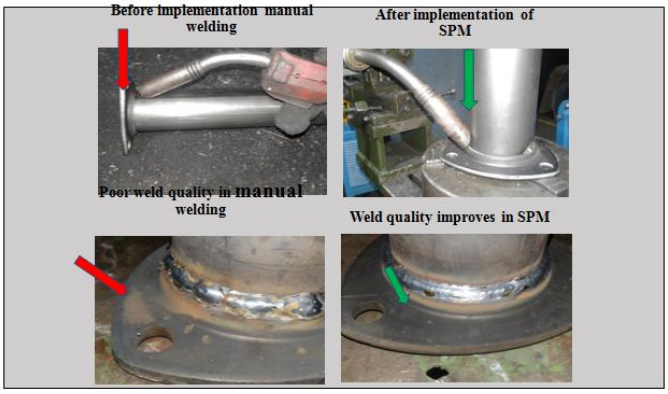
Calculation based on observed data after implementation of Rotary torch SPM on Tube Dia. 50.8 mm

Average observed time = 8.0 Hours=480 minutes
Workers performance rating = 100 %(Total working time= 8 hours 30 minutes =510 minutes)
Actual working time = 510-30 (30 min lunch)= 480 minutes
13 % Allowance = Cycle time × Allowance factor
82.92 × 0.13 = 10.77 Sec.
Total time in Sec. / Job = Cycle time + 13 % Allowance
82.92 + 10.77 = 93.69 Sec.
PRODUCTION PER HOUR AS PER 100% = 1 Hour ÷ Total time in Sec. / Job
We know that, 1 Hour = 3600 Sec.
3600 ÷ 93.69 = 38.42 per hour
PRODUCTION PER SHIFT AS PER 100% = PRODUCTION PER HOUR × No. of working hours
38.42 × 8 = 307.06 per shift

Same Calculation repeated for others tubes.

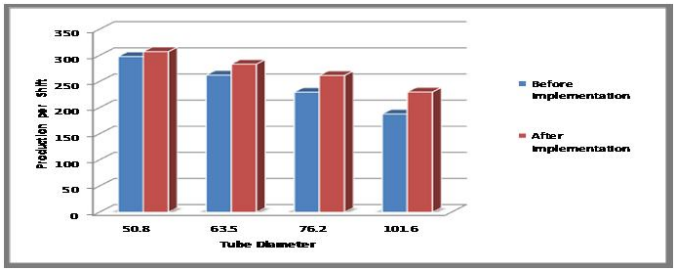
Cost Of weld automation			
S. no.	**Item used**	**Item Status**	**Cost in Rs.**
1	Steel , bar , tube , sheet	Scrap	1000
2	Gear box	Rejected , refurbished	700
3	DC motor	Rejected , repaired	1100
4	Pneumatic cylinder	New	1500
5	Machined item	New	1200
6	Control panel	Old , refurbished	1500
7	Welding machine	Existing	0
8	Other electrical item	New	2150
Total			9150

Comparative Analysis Before and After Implementation Of SPM



S. No.	Tube Dia. In mm	Before implementation Production per shift of 8 hours	After implementation Production per shift of 8 hours
1	50.8	297.84	307.36
2	63.5	262.24	283.44
3	76.2	229.68	261.6
4	101.6	187.92	230.00

Comparative Analysis



V. RESULT AND DISCUSSION

As the proposed methodology is an implementation rotary torch welding SPM. Following are the points which can be improved by implementation of this methodology. Increase in productivity, with a rotary torch SPM ability to process welded components three times faster than humans by operating continuously. Consistent and Repeatability, Manual welding requires a high level of skill as well as concentration

to achieve consistency and repeatability. With a rotary torch SPM welder can continue to perform precisely the same weld cycle continuously.

Flexibility, manual welding requires multiple jigs which are swapped out with each production run. In auto SPM Gripper can grab any part regardless of size and shape and hold it tight during the welding process. Quality, in this we can achieve superior quality by ensuring the correct welding angle, speed, and distance with repeatability of accuracy. Ensuring that every single welding joint is consistently produced to the highest quality significantly reduces the need for costly rework.

Labor, with a shortage of skilled workers auto SPM has helped to overcome this issue. Reduce consumables, with manual welding the size of the weld is determined from the operator and could result in a larger weld than required. In auto SPM object weld to the correct length and size of the joint requirement, providing significant over time. Reduced production cost, through improvements in quality, consistency and productivity a auto SPM system can deliver parts at a reduced cost. Increased competitive advantage, Implementation a rotary torch can set companies apart from the competition by allowing for faster completion and delivery of products whist ensuring consistent quality. Less Scrap Because of the high-level of accuracy and efficiency possible with robot-controlled welding, scrap is reduced. Lower Labor Costs, Even in semi-automatic welding setups, you need to pay fewer human workers.

VI. CONCLUSION

Project aims at automation of circular welding which is successfully achieved in the form of "ROTARY TORCH MACHINE" with all desirable features a SPM carries. The manual welding process has lot many limitations and disadvantages like less productivity, inconsistence quality of welding and dimensional inaccuracy, and dependency on operators to large extent. All these disadvantages are overcome by automatic welding SPM. Quality improvement and decrease in time consumption followed the objective. Productivity increases to a great extent through this project. Company enjoys benefits of improved lead time, quality, customer satisfaction and increase in the number of orders.
Further this SPM allots the benefits to the industry like economic benefits (cost saving), quality benefits and status improvement among the competitors. We gained unique experience of integrating and evaluating theory and practical aspects of design and manufacturing. This helped us to extract valuable knowledge and data. We came to know the reality of ground level working on the workshop floor. We sure that, this valuable experience will be useful in our future in all aspects of life.

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