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# PLC Based Automatic Nozzle Welding Control System

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***Abstract- In industries, to produce different products we need various types of raw materials. Those can be in solid, liquid or gaseous state. To store such large quantity of material, we need big containers. Hence large containers such as 'shells' are used along with nozzles to fix to it. Nozzles are use as inlet or outlet to store fluids.***

***The problem associated with the constructions of such big containers is welding of nozzles with shells. SAW is type of welding use for fixing. During welding, boom is used to control vertical motion of the shaft on which whole assembly of the welding is situated. Even during the welding according to curve path of the job we have to vertically move the welding torch which is done manually. This is very inconvenient, inappropriate and time consuming. Objective of this project is to reduce time consumption and human efforts and to increase the accuracy. Along with this use, objective of this project is to control the different parameters of welding. So there are following objectives of this project:***

***To control vertical motion of the welding torch.***

***To control different parameters which handle the functions of welding torch.***

***To Avoid time consuming task of manual handling.***

***Keywords- PLC, Automatic nozzle welding, Control system, sagita, nozzle.***

## I. INTRODUCTION

Automation is the use of various control systems for operating equipment. The biggest benefit of automation is that it saves labour, energy and materials and improves quality, accuracy and precision.

### *A. Introduction to nozzle welding*

The nozzle welder is required to weld in the profile formed due to the curvature of the shell. In short the welding head should move, both upstream and downstream, a maximum distance equal to the sagita during its circular travel about the nozzle. This device is mounted on the boom and using the adjustments on the boom does the rough positioning. For the fine adjustments on the nozzle, the various movements provided in the nozzle welder are used.

In case of Sagita welding, it consists of pipes having nozzles connected to it. If we see the profile of the nozzle part, it gives sinusoidal profile. Manual welding on such curved profile is not possible. As during welding, it is necessary to maintain specific distance between job and welding torch. We do welding by using nozzle welder. In whole setup of nozzle welder consist of welding torch, electrode, flux feeder and sensor.

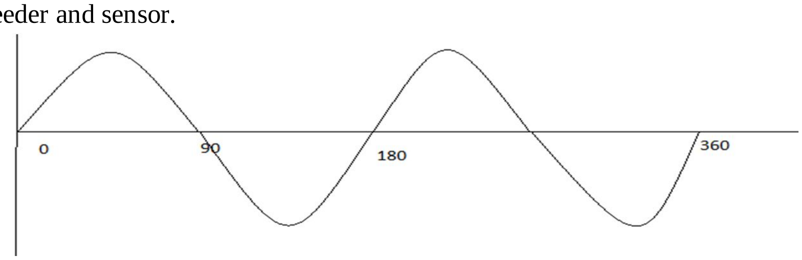


Fig.1 The sinusoidal wave represents the way in which we have to do nozzle welding.

First, we set the position of the boom according to the height of cylinder manually. On sinusoidal welding profile, we adjust the welding torch up and down accordingly. This is very difficult to do manually,hence automation is needed. This can be done by using motors, PLC. After completion of one cycle, we need to do 'Bead Welding'. In bead welding, the welding torch is shifted by some distance (in cm) and again welding is done. We get smooth and high quality welding profile by this method.

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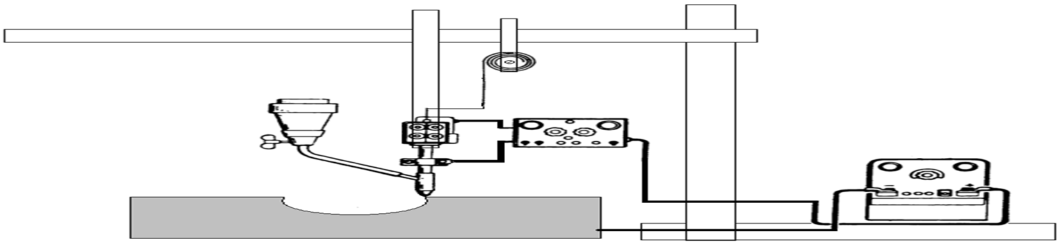

Fig.2. Overall proposed system.

## II. PROBLEMS RELATED WITH NOZZLE WELDING

*A.* The welder has to adjust the up and down movement of the gun with the help of y slide.

*B.* The welder has to maintain the same distance throughout the circumference of the nozzle between electrode tip and base of the weld.

*C.* Quality of the weld has to check regularly, which increases the cycle time

*D.* Weld obtained can be irregular as the distance between electrode tip and job has to maintain.

## III.AIM OF PROJECT

The aim of this project is to automate the welding of nozzles on the jobs. The basic idea was to reduce the cycle time by elimination of manual arc welding for this purpose. The previous practice was to weld the nozzles by manual arc welding (MAW). This needed to be replaced by submerged arc welding (SAW).

Objectives of the project are:

*A.* To reduce cycle time of the product

*B.* Controlling vertical movement of the welding torch in order to follow the sagita.

*C.* The sagita should be controlled for the complete rotation of the central shaft.

*D.* The sagita control should be such that it should be variable for different values of shell I/D nozzle I/D

*E.* Height of set up should be controllable.

Submerged arc welding (SAW) is a common arc welding process. This is the main welding process, which we used in our project for welding purpose.

SAGITA is there on the job due to curved shape of shell. Sagita movement is such that when the profile on the circumference of the nozzle is unwrapped it will give a sinusoidal curve, such that for first 90 degrees the level rises, for next 90-degree interval it falls. The maximum Sagita is as shown in figure.

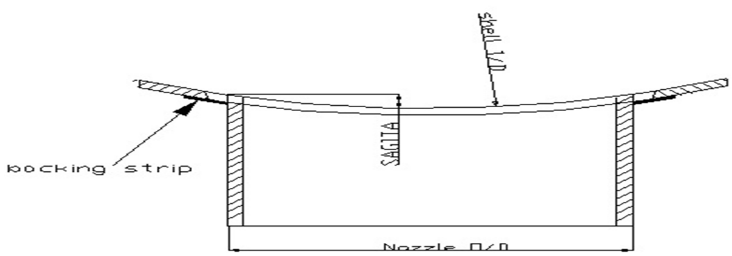


Fig.3.Sagita

The nozzle welder consists of the following main parts:

*1)* *Drive motor and housing*: This is the main drive for the entire unit. The motor is connected to the main shaft with a worm gear box along with a taper roller bearing that constitutes the housing. The welding head gets its rotary motion due to this drive motor.

*2)* *Drive Motor Control Panel*: This control panel controls the functioning of the main drive panel. The voltages required for a particular speed of motor can be manually set for this. It contains an ON-OFF switch, a knob to set voltage and another knob for forward and reverse movements of the motor. It gets its input supply voltage of 110V form an isolation transformer.

*3)* *Isolation Transformer:*Isolation transformers are separate units that step down the voltages to the required functional voltage. This transformer takes 230 V input supply and steps down the voltage to required 110V. This is kept along the motor assembly

Volume 4 Issue X, October 2016
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on the nozzle welder boom with its output supply going to the control panel.

4) *DPM panel for voltage indication*: It is digital potentiometer panel board to indicate voltage. It is connected in parallel with the control panel and directly indicates the voltage.
5) *Slip Rings With Brushes and Brush Holders:* This system is used to supply power to the rotating welding head from the power source. If the welding head (rotating during welding) is directly connected to the power source (stationary) the connecting cables will get twisted. The number of slip rings is equal to the number of the cables to be connected. The slip rings are insulated from each other. In total 9 rings is required for the Lincoln NA5 welding head.
6) *X-Y Slide For Welding Head Mounting:* The X-Y slide on which the welding head is mounted serves as the motion in two perpendicular directions. The Y-slide has a track on which the wheels can move up or down. On the Y-slide is attached an X-slide having lead screw mechanism to carry the welding head in the horizontal direction. The X-slide is manually adjusted according to the radius of the nozzle. The minimum diameter of the nozzle is 500mm and the maximum is 1600mm.
7) *Vertical Slide:* This is the slide on which the welding head is actually mounted. It is used for fine adjustment vertically when required. The adjustment on this slide is manual.
8) *Centering X-Y Slide:* This slide is mounted on the extreme top of the nozzle welder unit. Its two-axis movement enables the whole unit to have fine adjustments during centering.
9) *Horizontal Bracket:* This bracket serves the purpose for connecting the rotating shaft with the slides on which the welding head is mounted. It contains two horizontal plates with overall dimensions of 140X207.5X12 thick. These two horizontal plates are again connected with a 3” pipe having 88.9 mm O.D and length of 124mm.
10) *Vertical Plate:* The plate supports the slide on which the welding head is mounted and also the worm reduction gearbox. The horizontal bracket is connected to this vertical plate and this plate also supports the coil springs that are used for balancing the load.
11) *Center Pin For Truing:* This pin is made to rotate in a hole drilled at the bottom of the main shaft for centering. It contains a rod with a drilled pin, in which another rod can be fitted and grubbed. The entire center pin has a grove into which a ball is fitted and can roll inside the groove. For truing the nozzle, the rod can be rotated with the help of ball in the groove. A grub screw is tightened to the ball to prevent it from falling

## IV. METHODOLOGY

### A. *Block Diagram*

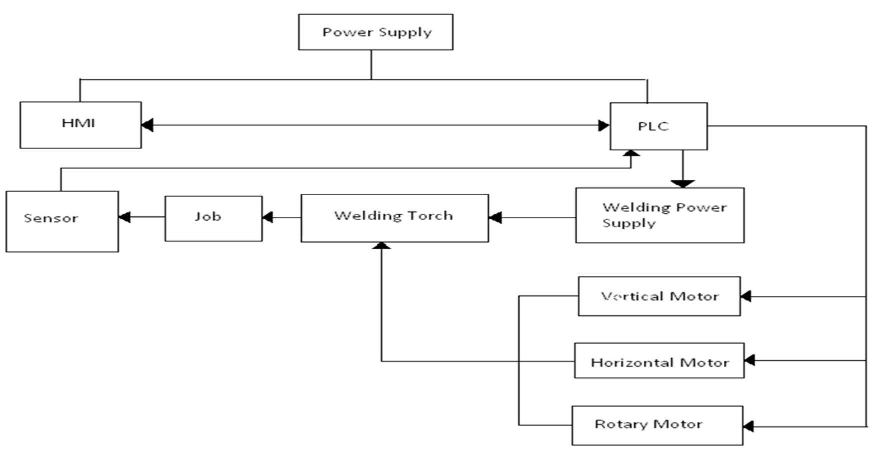


Fig.4.Block diagram of the system.

### B. *Components Used In System*

1. *PLC*: A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery .The unit consists of separate elements, from left to right; power supply, controller, relay units for input and output.
2. *AC Servo Motors and Drive*: A servo is a small device with circuitry built right in. It has a positionable shaft that can be

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arranged in a number of angled positions via a coded signal. The position of the shaft changes as it receives different signals.

3. *HMI*: Human-Machine Interface, is a device that lets users communicate with a machine or automation system.
4. *Operating pendant*: Operator pendant is a controller that is used as an operator to move cranes and other heavy moving objects. The operator pendant incorporating the following input buttons was suggested: Emergency Stop, Motor Forward, Motor Reverse,Vertical motor control, Horizontal motor control.
5. *Ultrasonic Sensor*: Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.Systems typically use a transducer that generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

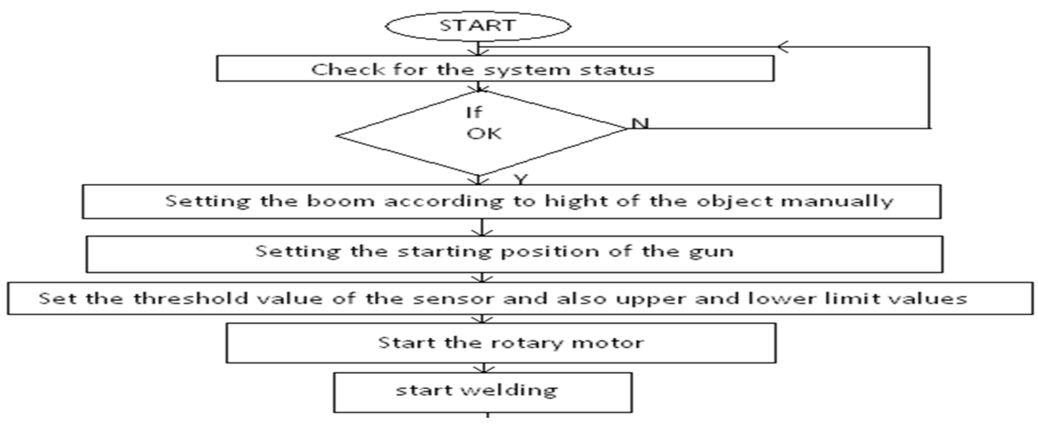
## V. WORKING OF THE SYSTEM

*A.* Nozzle welding is used to weld the nozzles to the cylinder in which the path to be welded is curved path.
*B.* The first part of this involves the apparatus mounting for the welding work.
*C.* The flux is poured into the container which is mounted just ahead the welding gun so that it can be dropped over the path as soon as welding starts and continues.
*D.* After mounting to keep the constant distance between the welding gun and the circular metallic surface the distance sensor is used. The different distance sensing techniques are Ultrasonic, Laser, Infrared and Inductive. Out of this the most common technique used is Laser and infrared. Then by using the sensor setup the distance is measured. 'Seam tracking' is the process used to detect the distance parameter.
*E.* This distance is given as feedback to the PLC (Programmable Logic Controller) which senses the distance and gives the input mechanically to the boom which controls the motion of welding gun.
*F.* At the same time, current status of the various physical parameters can be viewed on HMI (Human Machine Interface).
*G.* The parameters shown by HMI include the distance between job and welding gun, temperature and different I/O parameters.
*H.* At the start, the welding gun is placed at some threshold distance above the job then as the welding starts the distance is continuously measured and given as input to PLC at the same time the circular motion is controlled. In this way the first circle of the welding is completed.
*I.* For the next round, the position of welding gun is slightly shifted manually and then again the welding starts.
*J.* In this way the welding work is done without much human interface

## VI. PROGRAMMING

For proposed system, we had to draw electrical drawings for understanding purpose and software programming for working of the system, so we drew our electrical drawings with the help of AutoCAD 2010.We drew electrical drawings such as power supply, digital inputs, digital outputs, analog inputs, analog outputs, PLC layout and operating pendent.

For programming, we used LADDER logic programming with help of Siemens SIMATIC step 7 software which is widely use to program Programmable Logic Controllers.



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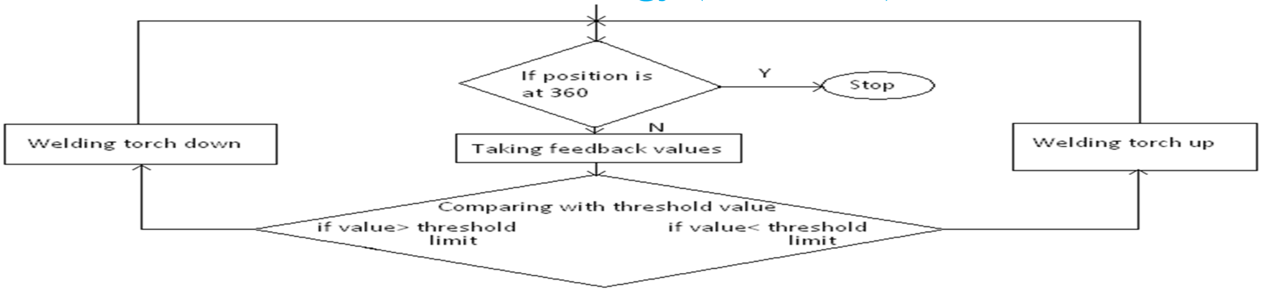


Fig.5. Flowchart of the program.

## VII. RESULT AND DISCUSSION

### A. Advantages of System

1) This Method reduces time consumption and human efforts and increases the accuracy.
2) PLC-controlled automatic welding machine can improve welding quality and efficiency, reduce labor intensity and bring huge economic benefits.
3) The nozzle welder provides high deposition rates due to the use of submerged arc welding process. This is much higher than the second alternative, which is manual arc welding.
4) Subsequent analysis has proved the superiority of the quality obtained by nozzle welder in comparison of manual arc welding.
5) The cost of manual arc welding is higher than the nozzle welder when used in jobs having large number of nozzles on a shell.
6) The manual arc welding requires high skill on the part of welder where as once the nozzle welder is properly positioned the only task left for the welder is to remove the slag.

### B. Disadvantages of System

1) This can use at Industrial level only.
2) Production cost is high.
3) Inflexible.
4) Difficult to transport.

### C. Applications

1) Chemical Plants.
2) Paint Industries.
3) Packaging Industries

## VIII. CONCLUSION

A. It was found that the quality of weld has distinctively increased without any porosity and with regular profile throughout the joint
B. With MMAW the weld deposit per shift per kg was found to be 3.5
C. With nozzle welder, it was increased to 15 kg per shift per weld. Now, with sagita nozzle welder it is further increased to 20 kg per shift per welder. Hence a definite saving in terms of time.
D. The consistent weld throughout the joint prevents any re welding. The welder skill does not come into the picture, which can vary leading to variable weld profile.
E. Welding cycle is considerably reduced.

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Volume 4 Issue X, October 2016
ISSN: 2321-9653


our project work would not have been a success.

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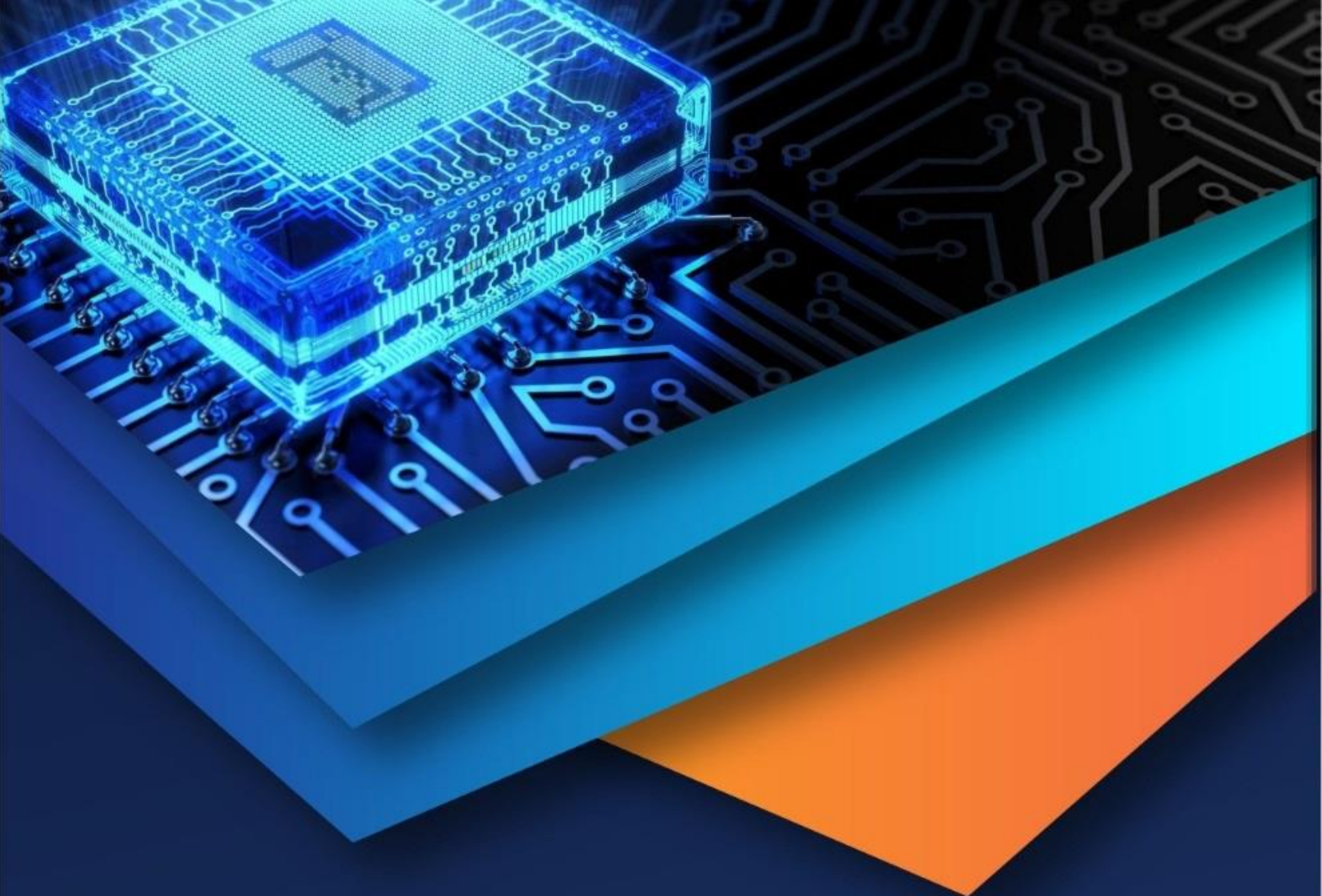


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