

Automation for the Process of Powder Coating through Reciprocator using PLC

Kundan Gedam

Assistant Professor

Department of Mechanical Engineering

Vishwatmak Om Gurudev College of Engineering, Aghai,

Tal: Shahapur, Dist: Thane, Maharashtra.

Kundan_gedam@yahoo.com

Sanath Kumar

Dy. Director (Training.)

Central Institute of Tool Design, society of India

Ministry of MSME, Balanagar

Hyderabad-500037, Telangana.(India)

Abstract - In the present day period of late car industry, mechanization assumed a fundamental part in expanding the creation too diminishing the assembling time by coordinating administrator's security and accuracy. In this postulation of our report we are robotizing the powder covering process which is carried on metal employment. To accomplish better nature of covering a computerized material taking care of hardware is executed termed as reciprocator framework.

The motivation behind this anticipate is to keep away from human obstruction with chemicals for the security of the administrator and also accuracy in covering for that we are utilizing diverse components of robotization like closeness sensors, solenoid valves, brake engines, switchgears and wellbeing interlock instrument to get required yield. To control and screen whole framework a focal controller called PLC (Programmable Logic Controller) the heart of our configuration, here Mitsubishi Nexgenie 2k PLC is utilized which is customized and created in IDE CODESYS v2.9.

I. Introduction

Computerization is the utilization of control frameworks and data innovations to lessen the requirement for human work in the generation of products and administrations. While system furnished human administrators with apparatus to help them with solid necessity of work, mechanization enormously diminishes the requirement for human tactile and mental prerequisites also. Robotization assumes an essential part on the planet economy and in day by day experience. Computerization implies utilization of machines and techniques to do work that was already done by human.

It for the most part includes the utilization of innovation worried with the mechanical, gadgets, and PC based frameworks. Computerization decides a decision of components which are utilized to estimations and control hardware operation, framework diagnostics information stockpiling recovery stand by excess. There are different focal points of computerizing an industry as expanded creation rate. The procedures that are continuous can be effectively checked and can be effortlessly controlled.

The establishment and appointing can be effortlessly done. The vitality and assets utilized for the creation can be extraordinarily enhanced. The individuals who are working in the risky premises can work bother free as we are presenting the programmed security measures, for example, alerts, and smoke identifiers.

Powder covering is a sort of covering that is connected as a free-streaming, dry powder. The primary distinction between a traditional fluid paint and a powder covering is that the powder covering does not require a dissolvable to keep the fastener and filler parts in a fluid suspension structure. The covering is

regularly connected electro statically and is then cured under warmth to permit it to stream and shape a "skin". The powder might be a thermoplastic or a thermo sets polymer. It is generally used to make a hard complete that is harder than traditional paint.

Powder covering is fundamentally utilized for covering of metals, for example, "white product," aluminium expulsions, and car and bike parts. Fresher innovations permit different materials, for example, MDF (medium-density fibreboard); to be powder covered utilizing diverse techniques.

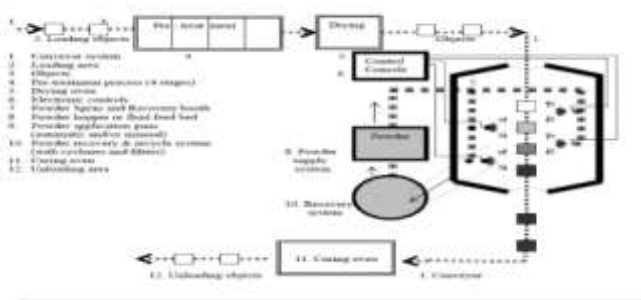
In this anticipate metal employment are stacked on overhead transport, once the metal occupation is comes before reciprocator through transport, the transport stop and the reciprocator begin responding with the end goal of powder covering for certain time with the assistance of weapon which connected to it, after certain time the reciprocator stop and transport advanced for next operation and cycle is ceaseless. The entire procedure is robotized by executing PLC, which is customized by operation and utilizing computerization gear like, hand-off, clock, engine, closeness sensor and so on.

PLC: A programmable logic controller (PLC), likewise alluded to as a programmable controller, is the name given to a kind of PC usually utilized as a part of business and modern control applications. PLC,s vary from office PCs in the sorts of assignments that they perform and the equipment and programming they require performing these undertakings. While the particular applications differ generally.

All PLCs screen inputs and other variable qualities, settle on choices taking into account a put away program, and control yields to computerize a procedure or machine. The essential components of a PLC incorporate data modules or focuses, a

central processing unit (CPU), yield modules or focuses, and a programming gadget.

The essential capacity of a PLC's data hardware is to change over the signs gave by these different switches and sensors into rationale flags that can be utilized by the CPU. The CPU assesses the status of inputs, yields, and different variables as it executes a put away program. The CPU then sends signs to overhaul the status of yields. Yield modules change over control signals from the CPU into computerized or simple values that can be utilized to control different yield gadgets. The programming gadget is utilized to enter or change the PLC's program or to screen or change put away values. Once entered, the project and related variables are put away in the CPU. Notwithstanding these fundamental components, a PLC framework may likewise join an administrator interface gadget to streamline checking of the machine or process.



FIGURE; LAYOUT OF AUTOMATIC POWDER COATING LINE.

II. EXPERIMENTAL DETAILS

A. Powder Coating Reciprocator

The Reciprocator (moving axis) was designed for automatic coating with powder guns. The reciprocator carriage oscillates vertically on the column. The movement sequences (stroke and stroke speed) are controlled by the reciprocator control unit. The gun holders are fitted on the shield of the Z carriage. The Z carriage is moved up and down by a toothed belt on rollers on the central column, inside the reciprocator. This vertical column serves also as a runway for the rollers. The drive unit and the electrical connection are installed in the reciprocator base. An incremental pulse generator, which is installed in the motor case, enables the exact positioning of the carriage.

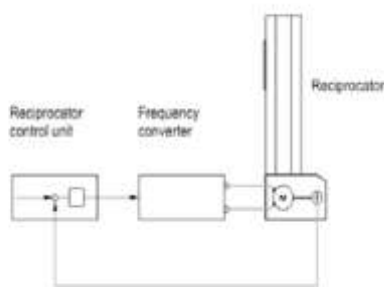


Figure: block diagram of complete unit of reciprocator

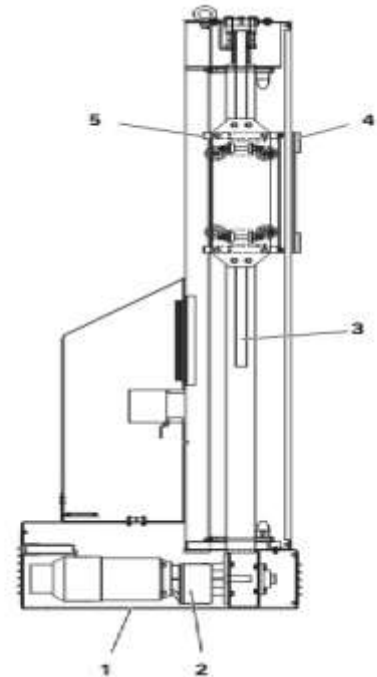


Fig. Reciprocator

Further characteristics are:

- 50 kg load capacity for automatic gun and gun holders
- Integrated holding brake
- Quiet running
- Large speed, maximum acceleration and braking action
- Safe operation and simple maintenance
- High efficiency due to low energy consumption
- Designed for continuous operation
- Mobile version available
- 4 standard stroke heights available: 1.3 m, 1.8 m, 2.3 m, 2.8 m

At every start-up after the mains have been interrupted, the reference point of the reciprocator must be referred again. After the reference point is reached, the reciprocator begins to carry out the movements set on the control unit.

Before starting operation, the upper stroke limit of the reciprocator must be set on the reciprocator control unit!

Attention:

Incorrect setting of the upper stroke limit can cause damages to the booth and/or reciprocator and to the powder guns! Electrical connections / cable connections.

Reciprocator connections: control unit - connections:

- 1 Axis adapter - complete
- 2 Power supply
- 3 Drive I/O connections
- 4 24VDC relay for motor brake



Figure: Electrical connections.

- Power supply line is connected to the 2.2 Drive supply (Drive I/O) port on the reciprocator control unit by the power supply cable

- Drive I/O port is connected to the 2.3 Drive I/O port on the reciprocator control unit by the signal cable Reference point and mechanical stops:

The reference point serves for the reciprocator control unit as starting point for calculating the upper and lower reversing point and the maximum stroke. Each time the reciprocator is switched on, the control unit requires that the Z carriage travels to the reference point (zero point). The Z carriage travels to the mechanical stop that means onto the rubber buffer and afterwards 50 mm upward. This position is saved now as point of reference and remains stored up to the next tension interruption.

Attention:

In order to avoid damages to the booth or the powder gun holders, the reference point must be checked before the first start-up and if necessary, reset! It must be noted that the axis, in reference travel, moves up to 25 mm below the control's zero point, therefore the mechanical stop must be adapted to the gun shots! Service engineer sets the position of the upper and the lower stop plate when the reciprocator is assembled.

Setting the lower mechanical stop:

Attention: The adjustment of the lower mechanical stop must take place without load and by moving axis out of service!

Procedure:

1. Release the brake switch manually
2. Let the Z carriage sink down until the powder gun holder is approximately 50 mm above the edge of the gun slot
3. Remove the boarding (side panels)
4. Loosen the nuts of the lower stop plate and push it up to the Z carriage
5. Tighten the nuts
6. Replace the side panel

Setting the upper mechanical stop

Attention:

The adjustment of the upper mechanical stop must take place without load and by moving axis out of service!

To set the upper mechanical stop, the stop position must be measured therefore, the max. Height of the powder gun slots on the cab must be considered.

Attention:

A wrong (too high) adjusted stroke length can cause damage to the booth and/or the reciprocator!

Procedure:

1. Remove the boarding (side panels)
2. Loosen the nuts of the upper stop plate and push it up to the measured position
3. Tighten the nuts
4. Replace the side panel

Maintenance and General information:

Attention:

Before doing maintenance works to the reciprocator, always be sure that nobody can switch on the reciprocator!

The reciprocator must be free of load and out of service!

The Reciprocator was designed to operate with a minimum of maintenance.

The gearbox of the three-phase AC motor is self-lubricating and maintenance-free.

Regular maintenance and inspection of the reciprocator increases the working reliability and avoids damages, repair downtimes etc.!

Blow off the outside of the reciprocator with compressed air or wipe down with a soft cloth from top to bottom at least once a week. If necessary, blow out the slots.

Drive unit

Attention:

Before doing maintenance works to the drive unit, always be sure that the reciprocator is free of load and out of service!

The gearbox of the three-phase AC motor is self-lubricating and maintenance-free.

Observe the outside contamination of the housing - strong contamination on the outside can increase the operating temperature of the drive unit! Therefore, clean the drive unit from time to time (with a vacuum cleaner etc.). Check the drive unit gearbox once a month for oil loss. If the drive unit gearbox has to be changed for any reason, the complete unit must be replaced!

Finishing Systems of reciprocating machines are designed automatically apply spray coating to either one or both sides of products conveyed on an overhead or flat conveyor systems.

The reciprocator is designed to operate with a continuously running chain around two fixed hardened sprockets. The unit is furnished with an explosion-proof electric motor coupled to a heavy duty gear reducer. The output sprocket of the reducer drives a heavy duty chain to which a carriage is attached. Two brackets attached to the carriage extend outside the cabinet to accommodate the

mounting of a 1" diameter mounting bar for supporting the spray gun assembly.

Each reciprocator is supplied with a hose track carrier, which is a flexible device attached to the gun carriage and machine enclosure to hold air and fluid hoses and protect their movement during operation.

Carriage Assembly:

The carriage assembly runs along the tubular structure on urethane guide wheels. The main chain is couple to the carriage assembly by a heavy duty pin that engages the slider block. The slider block runs back and forth as the main chain goes around the sprockets, which creates a smooth reverse motion of the carriage. Mounted to the face of the carriage are two v-blocks which hold the 1" diameter mounting bar.

Gear Reducer:

To obtain the design speed range, a gear reducer is used; however, the ratio of reduction is specific to the model of machine.

Hose Carrier:

A device attached to carriage and machine enclosure to hold air and fluids hoses and guide their path.

Machine Enclosure

Provides physical protection to the operator from drive mechanism and acts as a support structure. Removable covers on the front and the back of the machine permit access to serviceable parts...

Main Chain and Drive Sprockets:

The chain between the two main sprockets has a specific number of links, which relate to the machine stroke length and spray controls. Attached to the chain is a heavy duty pin, which engages the carriage assembly.

An adjustable motor base is provided to allow for quick chain tension maintenance. Note: The number of links cannot be changed on this chain.

A VFD Drive Controller:

The VFD drive is a variable speed controller that includes start/stop and speed adjustment with a display of the hertz being applied.

The function of PLC operating system:

Loads the user program from programming devices to program memory.

1. To read status of input devices.
2. To execute user program.
3. To form and update input image table.
4. As per the status of input image table controls the output devices.
5. To provide user-friendly function.

PLC Control Panel:

PLC control panel is designed to allow an operator the adjustment of the following functions:

- Stroke Speed
- Gun-trigger signals
- Skip spray control

Control panel consists of:

1. Enclosure (wall mounted)
2. Power requirements (230 VAC, 1-Phase 60HZ)
3. Panel view 300 Operator Interface
4. VFD Speed Controller
5. Booth Fan Interlock
6. Terminal strip for interlock termination with customer signals
7. Photo-eye for part detection
8. Proximity sensor for conveyor travel
9. NEXGENI 2k PLC
10. Gun Auto/Off/Test button

Booth Fan Interlock

The booth fan interlock is a 3-way solenoid valve, which connects the spray gun trigger to the spray booth exhaust fan. It will not allow the spray guns to spray when the exhaust fan is not on.

PLC Skip Spray Control (Stand Alone)

- Controls when the spray gun sprays parts
- Skip spray control prevents the gun from spraying any missing parts

Optional PLC Controls

- Synchronization of conveyor speed with the PLC shift register allows the gun to spray only when a part is present
- Proximity sensor for conveyor travel
- Photo-eye for part detection
- Pre-set gun spray time, adjustable by the Operator Interface Terminal (OIT)

All programming and documentation included.

Control consists of:

1. Enclosure
2. Power requirements (115 VAC)
3. Power on indicator light
4. Operator interface for gun triggering adjustments and part tracking adjustments
5. Exhaust fan interlock contact (no exhaust, no spray)
6. Terminal strip for internal/external wiring
7. Controls up to four guns
8. Photo-eye included for part detection
9. Proximity sensor for conveyor travel

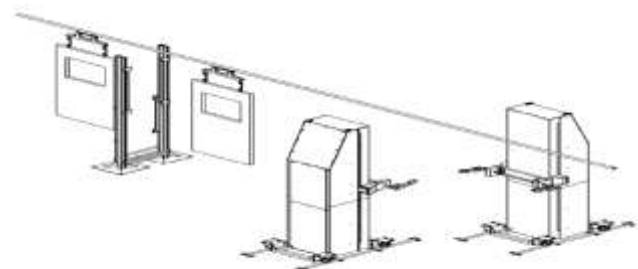
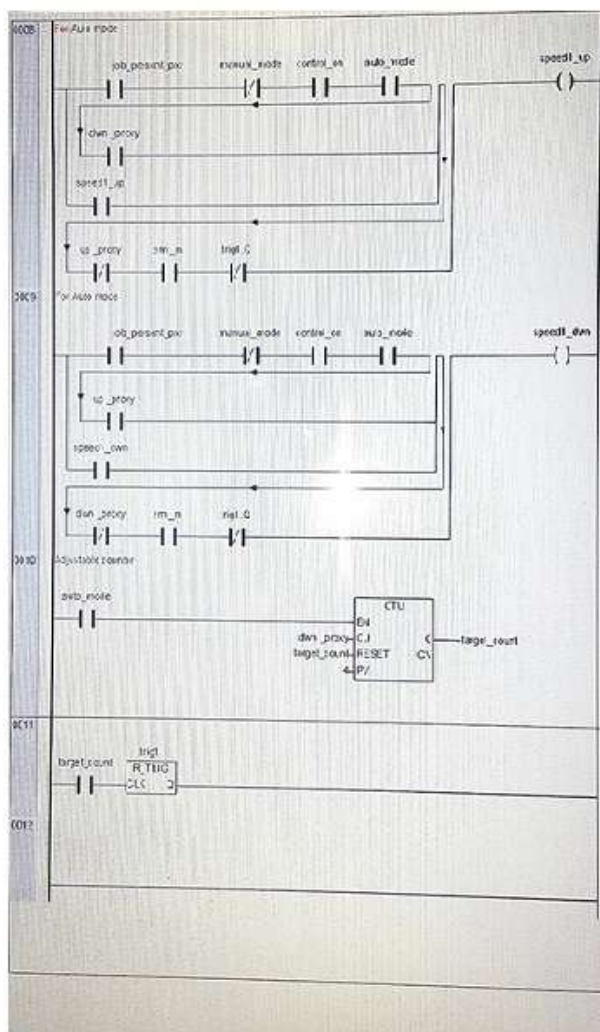
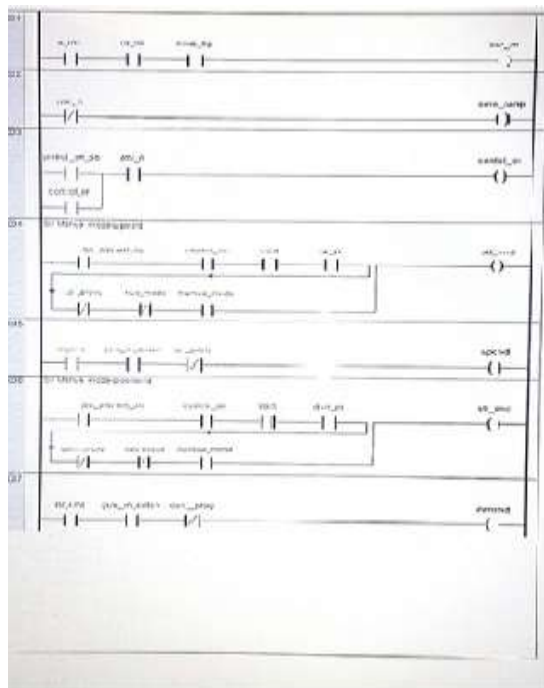


FIGURE: COMPLETE DRAWING OF RECIPROCATOR

PLC PROGRAM FOR AUTOMATED POWDER COATING :

I/O LIST OF PLC



SR. NO.	PARAMETER	Addressin g	data type
1	e_trip	IX0.0	BOOL
2	ud_trip	IX0.1	BOOL
3	drive_trip	IX0.2	BOOL
4	emr_m	IX0.3	BOOL
5	emer_lamp	IX0.4	BOOL
6	_on_pb	IX0.5	BOOL
7	control_on	IX0.6	BOOL
8	_proxy	IX0.7	BOOL
9	up_pb	IX1.0	BOOL
10	stf_cmd	OX0.0	BOOL
11	gun_on_switch	IX1.1	BOOL
12	dwn_pb	IX1.2	BOOL
13	str_cmd	OX0.1	BOOL
14	Dwncmd	IX1.3	BOOL
15	auto_manual_select	IX1.4	BOOL
16	auto_mode	IX1.5	BOOL
17	manual_mode	IX1.6	BOOL
18	speed1_up	OX0.2	BOOL
19	speed1_dwn	OX0.3	BOOL
20	target_count	IX1.7	BOOL
21	trig1: R_TRIG	IX2.0	BOOL
22	job_present_px	IX2.1	BOOL

III. RESULTS AND DISCUSSION

Amid this anticipate, Parameters, for example,

1. Powder covering rate
2. All out process duration
3. Powder utilization rate

Are enhanced by. Expanded powder covering rate will enhance the rate of employment handled. It will diminish the process duration of procedure. Super fine quality coat can be accomplished as simple versatile controls are executed because of PLC. Along these lines we can accomplish more generation rate, even quality coats with precision.

In this anticipate we diminished the wastage of powder likewise this powder covering process has doesn't impact on environment which lessens the VOC.

Powder covering is quickly turning into the new standard for paint applications rather than fluid paint. A percentage of the reasons that powder covering is more proficient are a higher quality complete, no drying time and over-shower recuperation. It demonstrates huge solidness and imperviousness to scraped area, erosion, scratching, and chemicals when contrasted with fluid coatings. It stays splendid with less blurring and shading determination is for all intents and purposes boundless with high and low gleam, metallic and clear wraps up. Composition determinations range from smooth surfaces to wrinkled and harsh surfaces are

accessible for concealing surface flaws. Thick coatings can be accomplished rapidly and effectively

IV. CONCLUSIONS

This anticipates gives brief thought regarding the powder covering process. The PLC has assumed an imperative part in robotization industry. The significance of instrumentation in the field of computerization can be comprehended from this anticipate. By utilizing PLC framework we can make the powder covering handle consequently through reciprocator.

REFERENCES

- [1] <http://www.automation.com>
- [2] <http://www.plcdev.com>
- [3] <http://www.powdercoating.com>
- [4] Introduction to Mechatronics and Measurement system- David G. Alciatore and Michael B. Histan, Tata McGraw Hill Publication.