Food Industry Container Cleaning Mechanism using PLC Automation

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Abstract— A concept of automating cleaning system for product container in food industry is proposed. Though, this system is already available on the market cleaning in small scale and budding industries still is done by manually with cleaning equipment. The existing and traditional systems have limitations like Manual cleanliness is not same every day. The workers entry inside the container is prohibited byword Health Organization (WHO) [1].

Key words: PLC Automation, Food Industry Container Cleaning Mechanism

I. INTRODUCTION

The meaning of the word Automation is the Self-dedicated derived from Greek literature. Automation helps to improve productivity by modernizing and increasing the work efficiency. It is the process of having machines follows a predetermined sequence of operation with or without human interaction in a manufacturing process [8]. The main objectives of automation are integration of manufacturing processes, increased safety level of operator as well as work piece to increase productivity, improve quality, efficiency and reduce labour cost as well as the human errors. Automation and system monitoring are the logical choice to improve system performance and to achieve customers and shareholder's satisfactions [8].

This project introduces a concept of a completely automatic food industry containers cleaning system design. The food container cleaning system already exists in the market but it is not economical to the small scale industries. Due to economical problem, these industries have continued their traditional cleaning system. Until now, the traditional method is implemented by human workers with manual cleaning equipment. However, such a system still has a disadvantage: worker's interaction with the container inside [1]. Nowadays, the hygiene factor is seeking much value in the food industries from the society. This factor is highly important to all, being as a production member as well as society member.

Ultimately, the containers used in such industries are more accurate as well as complex to work too. And more the complex is to clean such containers. We are forming the mechanism that will simplify this complex job.

The Industrial Container Cleaning Mechanism using PLC Automation system derives the actual function of the cleaning of containers used in the food industries. The cleaning is done by using high pressurized hot water and cold water, detergent liquid and highly pressurized compressed air. These ingredients are sprayed in the container with a help of spray nozzle. The sticky ingredients will wash away. This working is controlled by the PLC. This cleaning machine is completely automated mechanism that uses PLC for automation.

II. LITERATURE SURVEY

Jet nozzles are most suitable to increase the water pressure. With the purpose of applying the jet nozzles are responsible to rise water pressure [1].This paper describes the importance of degree of a taper that increase a pressure of a liquid flowing through it. High weight spouts are essential to splash the liquid to clean hard stains [7]. The water flow has the linear relationship to the speed of the pump. The rotational speed of the pump is depends on the frequency given it. Hence, the motor pumps are selected taking the reference of paper [2]. This paper represents the pressure of the out coming water from the nozzle depend on area of the pipe i.e. the pressure of the water increases with decrease in area of the nozzle [2].

To optimize the adequate capacity of the liquid spray, constant pressure always required by both pump motors. As the pump conveys constant current, the pressure must be adjusted continuously. Speed of the pump motor is directly proportional to the pressure of the water conveyed by it [3]. That simply means the pressure of a conveyed liquid increases with increase and decreases with increase and decrease in speed of a pump motor respectively. Hence, output pressure of a liquid is maintained by maintaining the speed of motor. It is also to be ensured that the pump motor is only operated with sufficient supply of liquid [3]. Selection of a pump motor is most important aspect to maintain the pressure of liquid. It depends on the requirements of the control speed. While selecting an electrical system we have three general choices: a DC motor, an AC induction motor and a solenoid motor. Among all, the AC motor is virtually maintenance free, and is essentially a fixed-speed unit [1].

Transport is utilized for automatic moving through different phases of washing. When conveyor and roller are in ideal position, they will work legitimately [7]. An appropriate grasp of auto wheels on the conveyer is required with a specific end goal to keep away from relocation of container [7]. Belts and chains represent the major types of flexible power transmission elements.

A belt is a flexible power transmission element that seats tightly on a set of pulleys [1]. This kind of driving system is widely used in the industry.

Mechanical transmission, which is used to convert rotational motion into linear and has good performance efficiency and high accuracy. Hence, by rotating the roller with constant speed, to and from movement of a container takes place for each revolution of the wheel by an amount S, the length equal to the pitch circle of the roller (in mm), i.e. $S = \pi.d$ where d is diameter of the pitch circle of the gear in mm [1]. We have found the belts most suitable method to implement in reality. The main aspect to design conveyer and roller such that they can provide reliable and smooth movement [1].

Pneumatics is the study of systems operated by the air pressure. Air from the atmosphere is compressed in the

compressor, and that compressed air acts on a designed piston. Our system uses this compressed air for drying because pneumatic system is most efficient, economical and reliable for drying purpose [1]. The comparison of the electrical, pneumatics and hydraulic system has given in the section of analytical work [1].

Output of sensors and switches are given as an input to PLC. Input signals are processed by PLC and output signals are given to the different peripherals. The output signal activates the motors, conveyer, roller and compressor [6].

PLC is designed to operate in harsh industrial environments that have high temperatures and high humidity and has a high ability to withstand vibrations for communicating with the processing of the input and output actually inside the controller. It can be programmed ease with one of the programming languages allocated to them [6]. The works in ceramic, cement, chemical, a food processing, packaging industry and so on strongly requires the use of PLC systems for the great profit and performance [8].

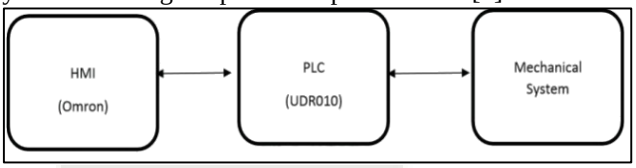

Fig. 1: Connections between the peripherals, PLC and HMI (display). The basic components in a ladder logic program are the contact and the coil. The contact is the name given to a general input device set by an external switch, an internally set logic or timer function. Coil is the name given to an output device and is used to drive relays, contactor, motors, solenoids and other process actuators [8].

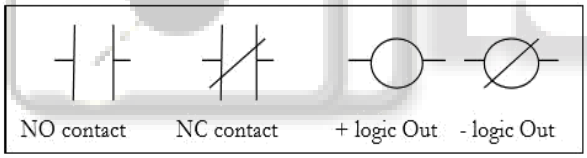

Fig. 2: Basic Ladder Logic Components.

Figure shows the few such contacts used in Ladder programming namely, normally open, normally closed, logic high out and logic low out.

III. PROBLEM STATEMENT

As an introduction given above, the container cleaning mechanism is fully automated using PLC. PLC automated cleaning system is already available in the market but it is not cost efficient. The available system is not economical for small scale industries or the industries which are newly started.

There are many factors that force any industry to continue the traditional method of cleaning. The available system is not affordable to the rising industries. Along with, due to complex design of containers, manual cleaning is not that much accurate that it should be. Many factors like mood, laziness, tiredness, continued efficiency, salary of a worker affects the cleaning of the container. Also, the accuracy of the cleanliness cannot be calculated by the naked eyes.

Hence, we are designing the industrial container cleaning mechanism using PLC Automation especially for small scale food industries. The proposed mechanism will maintain proper hygiene and will reduce the manual work. PLC replaces the human work by maintaining the accuracy and continuing the constant efficiency as before. PLC based automation works will surely turn the production activities into profit. The complex operations and reduction in set up time can be greatly reduced by making use of PLC based automation [8].

IV. BLOCK DIAGRAM AND DESCRIPTION

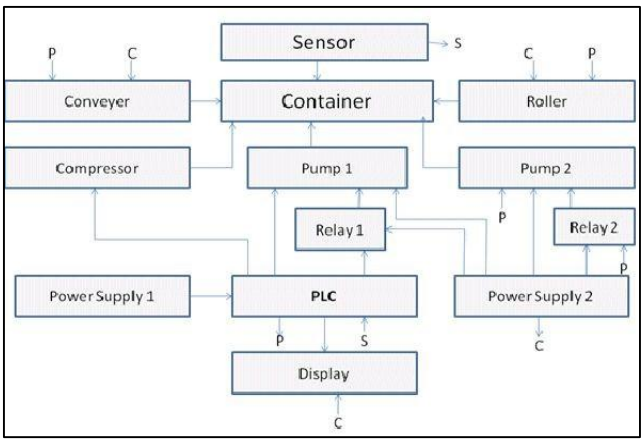

Fig. 3: Methodology of the system

V. DESCRIPTION

The interconnection in the peripherals of the system is according to the methodology given in the figure no 3. This figure represents the various peripherals that help the cleaning mechanism and cleans the container.

1] Conveyer: The conveyer is a mechanical system that used to move the object. Our system uses conveyer for left-right movement. The signal from the PLC is given to the conveyer as an input and attached container in moves left-right motion.

2] Container: The container used in this mechanism is a prototype of an industrial container. This container is attached to the conveyer and roller. The operations will do according to the PLC signals given to a roller and a conveyer.

3] Roller: Roller is external functional part which has input from PLC and operates at 230 V/AC. Basic function of the roller is to up and down motion of the container. This motion is based on the signals given by the PLC. The roller will act for the 3 seconds in which the rope of 1 feet that holds the container will roll. This rolling results in the up and down movement of the container which is required to fit in the bottom plate of the sprayer.

4] Sensor: The cleaning mechanism contains the Proximity sensors which sense a presence of object without any physical contact. In the proposed system, we are using the optical proximity sensor. This sensor emits the IR light. As the object comes in the contact range of the IR light, the light continuity breaks and the sensor passes this physical signal in the form of electrical signal to the PLC as an input.

5] Pump motor: In our system, the pump motor is the AC motor used to pump the liquid. The function of a Pump motor is to pump the liquid from the reservoir. Here we are using two pump motors to lift the water and detergent liquid from the reservoir. The PLC correlates and controls the operational parameters to the speed requested by the system and monitors the system during normal and abnormal conditions.

6] Power Supply: Power system itself is one system that provides the power required to the system. In the proposed system, we are using 2 power supplies Power supply 1: This supply is of 24v which required operating the PLC Power Supply 2: This power supply is of 230V/AC which is used to operate pumps, compressor, conveyer and the roller.
7] Compressor: Compressor is used to compress the air. We are using a compressor to obtain the air of pressure 3 Bar. Compressor operates on the 230 V/AC supply. The functionality of the compressor depends on the signal from the PLC.
8] Display: Display displays anything that we give it as an input. Here we are using it to display the results of the sub functions that are carried out for an execution of the whole system. The display is ultimately connected to the PLC.
9] PLC: Programmable Logic Controller that automates the system using programming languages like ladder diagram, function block diagram, statement list and logic functions

VI. APPLICATION

The automated industrial container cleaning mechanism is applicable in the food, chemical and pharmaceutical industries to clean their product container. The proposed system which is specially designed for small scale industries is very economical and can use these places.

VII. CONCLUSION

Industrial container cleaning mechanism using PLC automation cleans the containers especially used in the food industries. This mechanism is designed considering numerous aspects such as efficiency, accuracy, human error, traditional methods of cleaning etc. This is especially for small/budding industries that are under development and conscious about their products hygiene.

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