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Automatic Liquid Mixing and Bottle Filling Plant using PLC

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Abstract : *This paper proposes, automatic liquid mixing and bottle filling plant using PLC instead of relay logic, factory 4.0 or a microcontroller based, with the only objective of getting high efficiency. The bottle filling plant is design such that it includes the mixing of the two liquids, then filling the mixed liquid in the empty bottle & then measuring the weight of the filled bottle for accuracy purpose. This weight measurement is done by Arduino based load cell model which first senses the weight of bottle & convert the mechanical pressure into electrical signal with the help of HX711 microcontroller & the this electrical signal is finally fed to Arduino which displays the weight of the bottle on LCD. Using PLC instead of the relay logic ,factory 4.0 or microcontrollers gives the advantage of less maintenance with very simple programming language which can be debug in further case if required and which is compatible for all kind of industrial environment. Manual handling of such tasks consumes more time in addition with less productivity with increase in loss rate. The cost of PLC component which the heart of whole system is more but which can be payback with a smooth loss free operation within a year with less maintenance than any other choice. The system also includes mechanical as well as electronic component such as solenoid valve , proximity sensor, limit switch ,push buttons, conveyor accessories & stirrer for mixing operation.*

Keywords : *Automation, Mixing of two liquid, Bottle filling, Weight measurement by Arduino, Ladder Logic.*

I. Introduction

In pharmaceutical companies say the company of cough syrup , the problem arises with state of the liquid. The liquids they used are viscous with different boiling and melting temperatures. So the change in weather means increase in the room temperature may cause change in state of the liquid. The liquid may becomes more viscous with increase in temperature or less viscous or vice-versa. So the problem arises with bottle filling that the more viscous liquids takes time to fill the bottle and rest the less viscous will take the less time than the actual time required by the normal state of liquid. But whatever the programming is done is based on the time which is required to the filled the bottle in the normal state of liquid . Hence it leads to an inappropriate operation with the timer programming.

To overcome such difficulty with the existing bottle filing plant we introduces the Arduino based weight measurement with the help of load cell. The change in temperature causes the change in state of liquid irrespective of weight i.e. weight is unaffected by rise in temperature. So, timer programing plus weight measurement scheme is used to overcome such difficulty. In which if the condition of both timer & Arduino is satisfied by PLC programming then & then only the accuracy can be achieved.

Block Diagram Of The Plant

As shown in the below figure1, the liquid from different tanks or different liquids are with the finite proportional are added for the mixing purpose in the tank. Thereafter the mixing I done with the help of the stirrer, a small dc motor. After achieving the desired mixing, the mixed liquid is end to the main tank. The conveyor remains in operation until there is bottle under the solenoid valve is reached, once reached the conveyor is turned off. After that according to programming done in PLC the liquid is filled to the bottle with the help of the solenoid valve. After filling it is tested for the weight condition via load cell. Once the load cell senses the pressure(which converts mechanical pressure into electrical signal), it will further send that electrical signal to the HX711 for amplification purpose. After that the signal is finally fed to the Arduino model. And with the help of the Arduino programming we can display the weight of the bottle through LCD. After that one lever is come which move the filled bottle from load cell to conveyor & simultaneously bought the empty bottle under the solenoid valve. Note here load cell located exactly below the solenoid valve to which empty bottle is place and filled and measured for the weight & after that it is moved by lever.

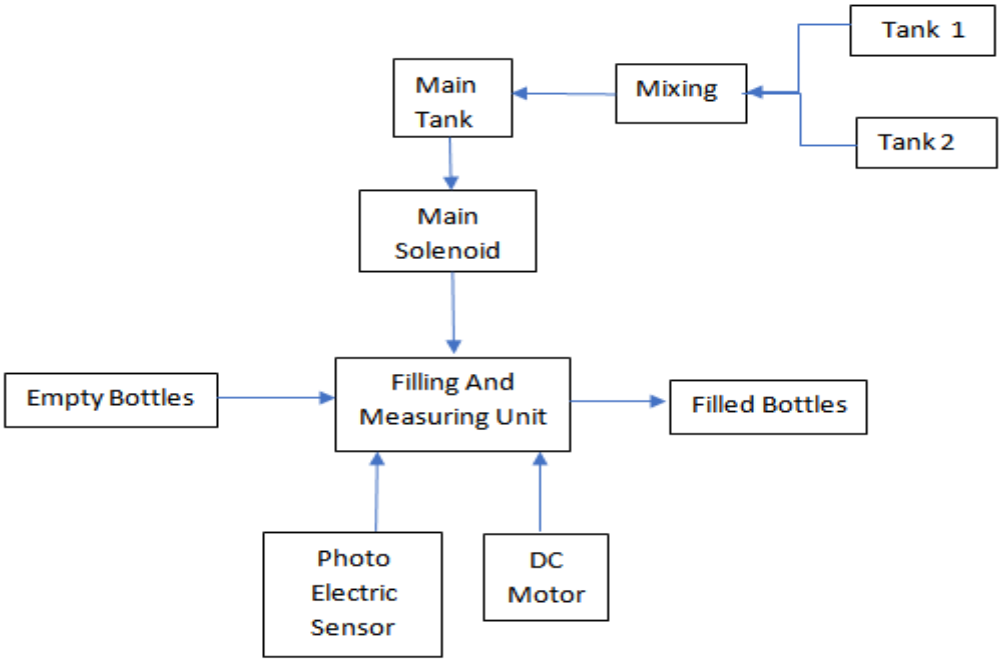


Fig. 1: Block diagram of the plant

II. Components Used

3.1PLC

PLC is mainly stands for the programmable logic controller where the programmable actually stands for ,that it can be reprogram again & again , the logic relates with the mode of the programming we are using i.e., software logic, e.g., ladder logic, FBD(Functional Block Diagram),SFC(Sequential Function Charts),SCL(codding like C++) etc. PLC is nothing but computer based solid device that controls the industrial equipment's and processes. It is capable of storing instructions such as sequencing , timing , counting , arithmetic ,data manipulation & communication. It mainly consists of power supply, CPU , input & output modules, memory, programming unit etc.

There are the various benefits of using PLC over any other device, first of all PLC is designed to operate near the equipment , they are meant to control. This means that they function in hot, humid, dirty, noisy & dusty industrial environment. PLC can operate in 60˚C as well as 0˚C,wuth tolerable relative humidity ranging from 0% to 95% non-condensing. The second advantage of using PLC is that its programming language. The ladder diagram language is easy to learn and understood world-wide by maintenance technicians as well as by engineers. After that its maintenance & troubleshooting is easily conducted as PLC components are modular & simple to isolate , remove-and-place diagnostic techniques are usually implemented. Also PLC in combination with the HMI allows the user to view the process , determining how the system is running , and trend values, receive alarm conditions etc.

3.2. Solenoid Valve

In this project ,the solenoid valve is normally used to automatically control the flow of the liquid that shall fill the empty bottle. When the empty bottle placed over the conveyor belt, which is initially at motion , is sensed by the photoelectric sensor, the conveyor stops running and at the same time the solenoid valve is gets energized and the liquid starts flowing through the valve for a certain time period. As the time period is over then the solenoid valve gets DC energized and the liquid steps flowing through the valve. The conveyor belt starts moving again and valve remains DC energized until and unless the bottle is sensed by the sensor again.

3.3. Proximity Sensor

In this project ,it is used to sense the position of the bottle without any physical contact. A proximity sensor often emits an electromagnetic field & look for the change in the field or return signal. Here we are using the capacitive type proximity sensor for sensing the plastic bottles. Proximity sensor can have a high reliability and a long functional life because of the absence of mechanical parts & lack of physical contact between the sensor and the sensed object.

3.4. Conveyor Motor

The conveyor motor used is simply a dc motor , used to drive the conveyor belt from rollers on the one side. Basically, the operation of the conveyor belt needed is like start-stop , which can be achieved by controlling supply of the DC motor , thus by controlling speed of the motor. This can be achieved by the PLC programing.

3.5. Load Cell

Load cell is basically a transducer which converts the force or mechanical pressure into the electrical signal. Magnitude of this force is directly proportional to the electrical signal generated. The load cell consists of the four strain gauges in Wheatstone's bridge configuration.

3.6. HX711

The electrical signal generated by the load cell is in few millivolts. To amplify this signal HX711 used as a weighing sensor. It has 24 high precision ADC(Analog to Digital Converter) on chip.

3.7. Arduino model

Arduino s nothing but the trending microcontroller whose programming language is quiet simple. After sensing the mechanical pressure into electrical signal & amplify it ,it required to display the weight which is actually measured. So, with the LCD interfacing to the Arduino the weight measured can be display on LCD

4. Arduino Based Weight Measurement System

Working of this Arduino Weight Measurement system is easy. First of all we have to calibrate the system for measurement of accurate weight. When operator will turn it ON then system will automatically start calibrating. And if operator wants to calibrate it manually then it can be done using the push button.

For calibration, observe LCD indication for placing 100 gram on the load cell as shown in the picture. When LCD will display ,*put 100g*, then put the 100g weight on the load cell and waits. After some time delay calibration procedure will be finished. After calibration user may put any weight up to 40kg on the load cell and can get the value displayed on LCD in grams. The figure 2, below shows the wiring of the system.

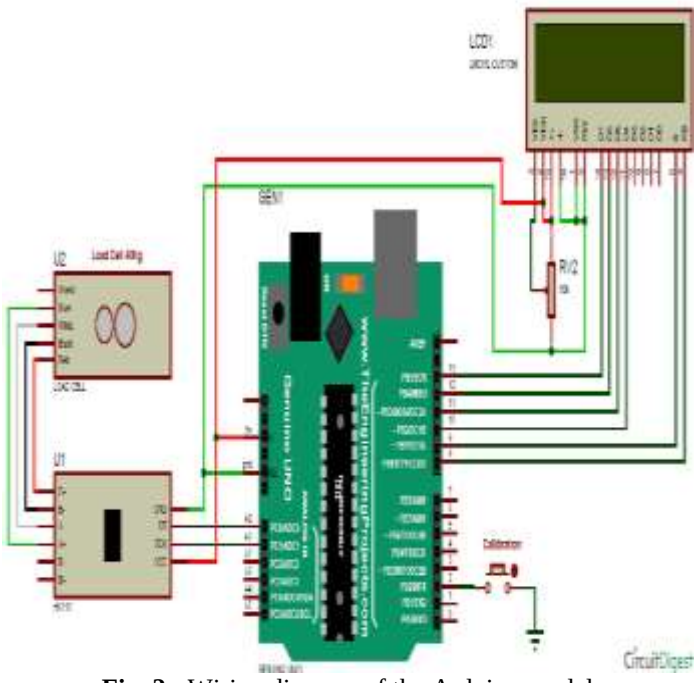
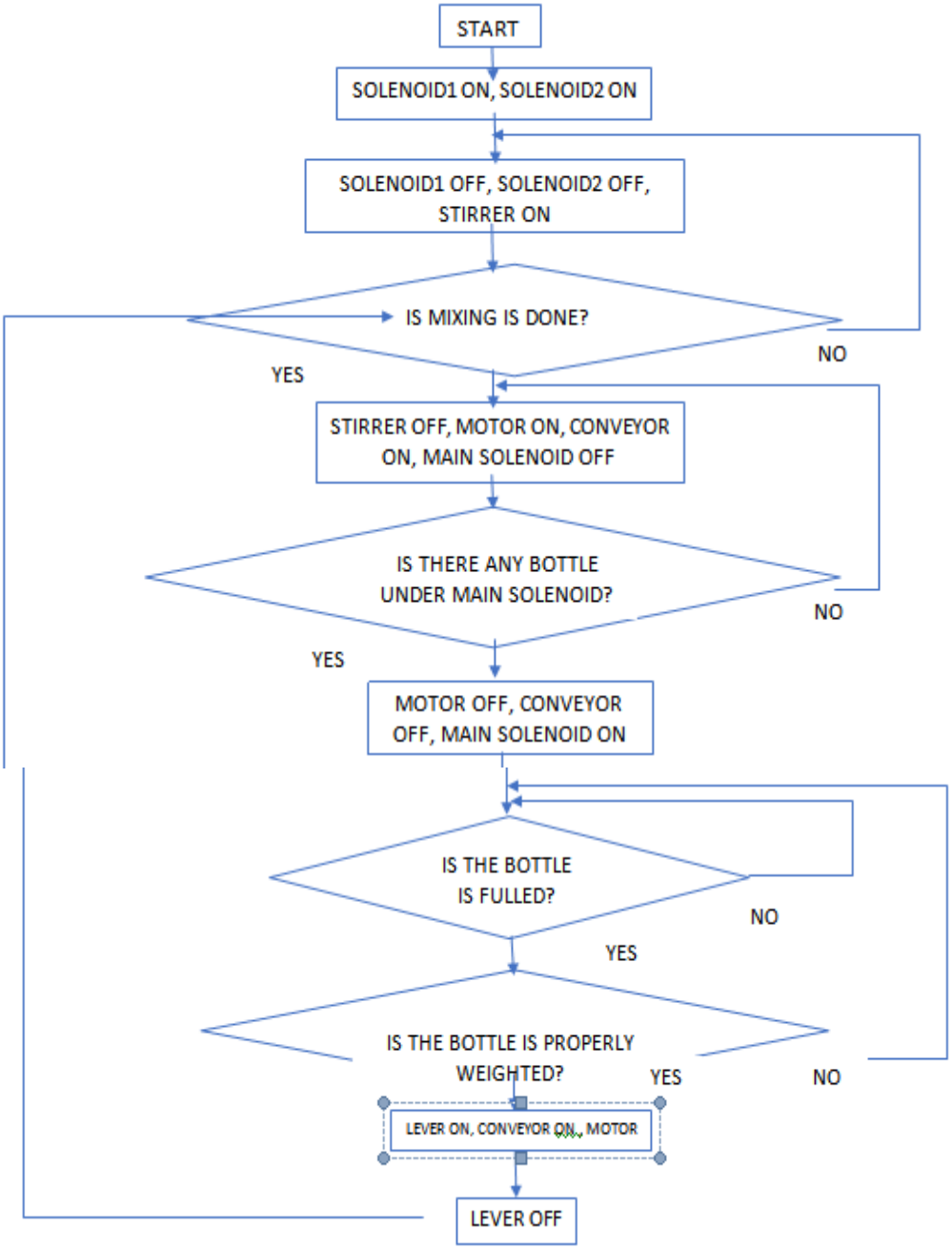


Fig. 2: Wiring diagram of the Arduino model

III. Flowchart Of The System



IV. Conclusion

Demand of accuracy is increasing day by day in model era of automation. Also how to implement the automation in industries is biggest challenge for every industrialist. Our project bottle filling is already in use in industries , but the only difference is that we redesigned it and make it more accurate with the help of arduino weight measurement & mixing system. Adding mixing in the existing plant gives us advantage that further in future as per the requirement we can add more than two liquid mixing conveniently i.e. number of containers can be increased. Our project is compact in size with the one advantage of low cost as compare to the existing plant. All the components used in the system is food-grained i.e., the nature of the components or the material may not affect or react with the liquid, which gives the advantage that we can use the same bottle filling plant to the oil industries, paint industries, beverage industries etc . The operation of the system is reliable with the only limitation that the life of Arduino system is less as compared to the PLC, hence it requires a periodic maintenance.

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