WEIGHT BASED LIQUID FILLING USING PLC & HMI

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ABSTRACT
Few manual operations can be automated through PLC (Programming Logic Controller). Liquid filling in the bottles can be automated by HMI (human machine interface). As per the user requirement, not more than five litres of liquids, can be filled by the proposed system. Measurement of the weight can be done depending upon the weight on the load cell in proportion with the calibrated values. As the load cell input is very low unacceptable by the PLC (programming logic controller) signal conditioning is used to amplify the output. Opening and closing of valve is used by the solenoid valve.

KEYWORDS: PLC (Delta Make PLC-DVP20SX2), HMI(DOP-B03S210), Load cell, Signal Conditioning (AD620), Solenoid valve

INTRODUCTION

The liquid filled in the bottles in many small scale industries are filled manually taking the weight with the help of the digital weighing machine. The problem faced by this small scale industries is that the bottles are filled manually according to the weight, but the accuracy is hampered. As manually filling bottles is not that accurate as that the machine or the controller is. There is either overfilling or under filling of liquid in the bottles. In order to overcome this problem, we need to use the PLC and program it accordingly so that it can control the solenoid valve of three tanks containing different liquid filling different bottles in proportion to the weight entered by the operator through HMI.
Instead of filling the bottles manually, one can use micro-controllers for performing the filling operation. But the disadvantage of using micro-controller is that user cannot enter the variable weights simultaneously for different bottles. The proposed system fills the bottle as per the weight entered, by using load cell sensors for measuring the weight. PLCs are very easy to program simple and cost efficient.
Kulkarni et al uses the proximity sensors and position sensors for detecting the presence and position of the bottle. They use timers for filling the bottles. When the bottle comes below the tank, the valve is turned on. The valve remains ON as per the timer set for that particular capacity of liquid bottles[5].

SYSTEM BLOCK DIAGRAM

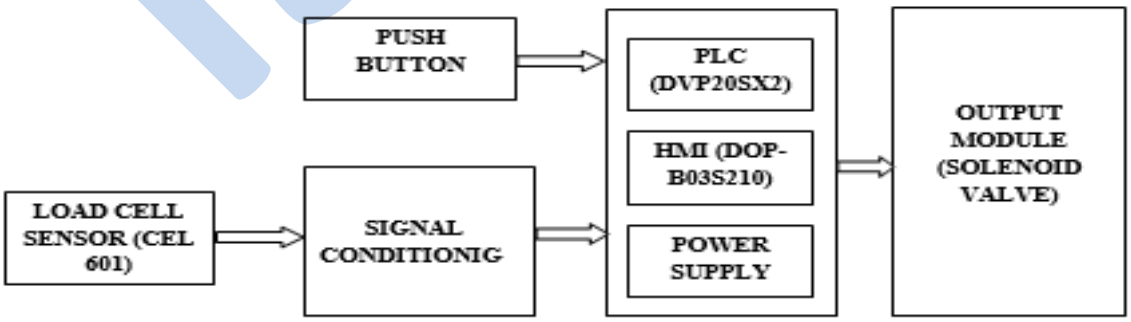

Fig.1: Block diagram of system

In order to start the process, we need to turn on the entire system, so we need the push button.

PUSH BUTTON

- A push-button or simply button is a simple mechanism for starting the system and also for stopping the system at emergency time.
- It is simple push to ON the cycle.

LOAD CELL SENSOR (CEL601)

Weighing module consists of four load cells which will measure the weight of four bottles. Load cell sensors are used to measure the weight of bottles. The output of load cell sensors is in the range of mv/v. Since the proposed system is weight based there should be the provision to measure the weight of the bottles. Here we are using cantilever table top load cell to measure the weight of the bottles.

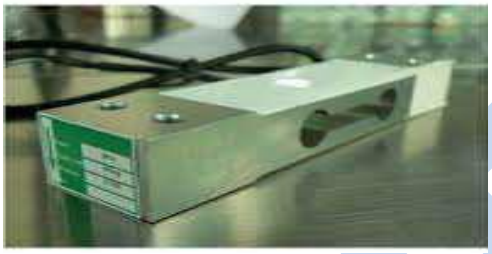

Fig.2: Cantilever type load cell(CEL 601)

SIGNAL CONDITIONING (AD620)

Signal conditioning is an amplifier. As the output of the load cell sensors is very small in the range of milli volts which is not accepted by the PLC. This module is the amplifier which amplifies the output signal of the weighing module compatible to the plc.

PROGRAMMABLE LOGIC CONTROLLER (PLC): (DELTA MAKE PLC-DVP20SX2)

- It is a digital computer used for automation of typically industrial electromechanical processes.
- PLCs are designed for digital and analog inputs and outputs.
- PLC is heart of the system.
- Task of plc is to take the signals from signal conditioning and send corresponding signal to the valve**.** Accordingly, the PLC will turn ON or OFF the valve.

Fig.3: PLC (DVP20SX2)

Fig.4: HMI(DOP-B03S210)

HUMAN MACHINE INTERFACE: HMI(DOP-B03S210)

- An HMI is the interface method between the human and the equipment machine.
- The main task of HMI is to take set point from the operator.
- It also displays the amount of bottle filled.

SOLENOID VALVE

- The valve is turned on when the bottle is empty.
- The valve is turned off when the weight of bottle is same as the set point entered by the operator on HMI.

Fig.5: Tanks with solenoid valve

METHODOLOGY

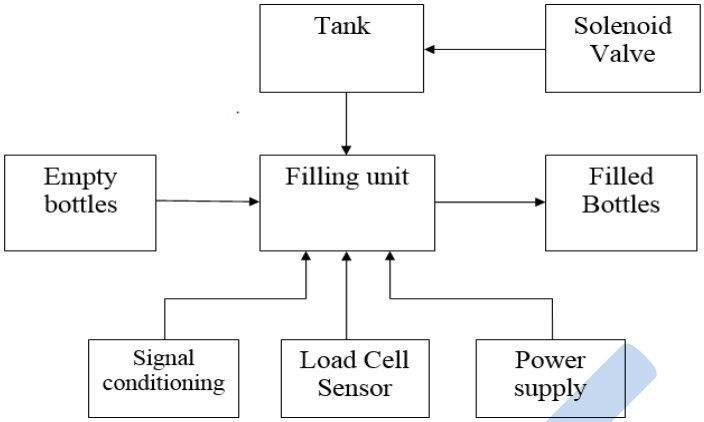

Fig. 6: Methodology diagram

The user enters the weight of liquid to be filled in the bottle through HMI. The empty bottle is kept on the load cell. Load cell is the transducer which converts the physical weight of the bottle to the electrical quantity which is used to compare with the weight entered by the user. Then the user press the push button which tears the weight of the bottle to zero. As soon as the user presses this push button the valve is turned on and the bottle starts to fill. The PLC continuously compares the weight of the bottle being filled with the weight entered by the user. PLC is the brain of the system. PLC controls the ON and OFF timing of the valve. Weight is measured by the load cell sensors. The output of the load cell sensor is in millivolts, which is very low and unacceptable by the PLC. Hence it is important to use some signal conditioning circuit to amplify the output of the load cell using AD620(instrumentation amplifier) IC which is compatible to the PLC.The valve remains ON till the weight of bottle and entered weight are not equal.

The flow chart below shows the flow of the process:

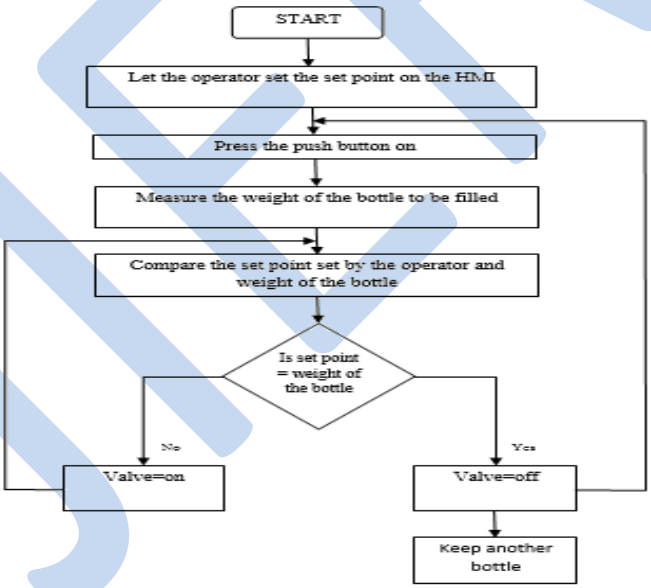

Fig.7: Flow chart of the process

SYSTEM SPECIFICATIONS:
HARDWARE SECTION:

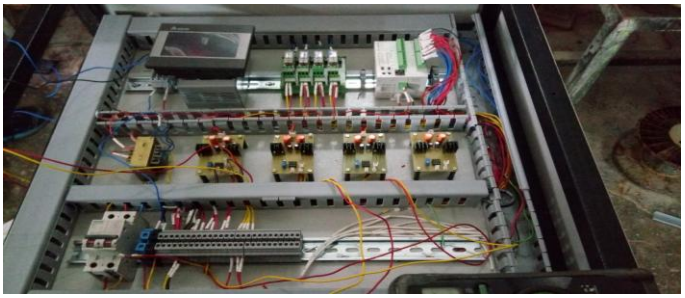

Fig.8: Hardware section

1. PLC(Delta Make PLC-DVP20SX2):
- MPU points: 12 (8DI + 4DO)
- COM port: Built-in RS-232 & 2 RS-485 ports, compatible with Modbus ASCII/RTU protocol.

2. HMI DELTA (DOPB03S211):
- Display type: 4.3" TFT lcd
- Resolution: 480x272 pixels
- operating system: delta real time OS
- Serial COM port: RS232/RS485
- Operating Voltage: 24V DC

3. LOAD CELL SENSOR: (RSL 601)
- Single point Off-Centre load measuring capability
- Economical and low profile cell
- Aluminum alloy, colorless anodized
- Glue sealed.

4. SIGNAL CONDITIONING:
Load cell amplifier: AD620
The AD620 is a low cost, high accuracy instrumentation amplifier that requires only one external resistor to set gains of 1 to 10,000.

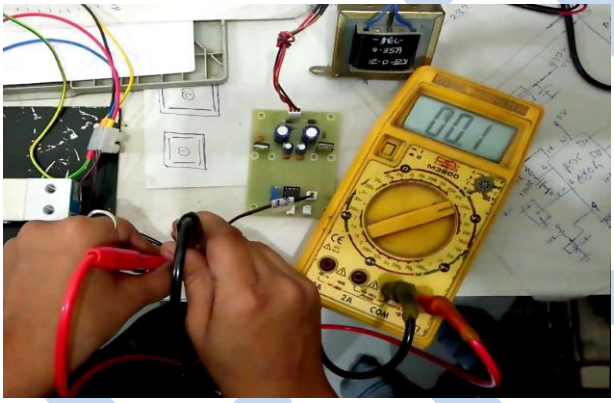

Fig. 9: Signal conditioning(AD620)

SOFTWARE SECTION

1. **WPLSOFT2.3:**
WPLSOFT2.3 is used to program the DELTA PLC(DVP20XS2)[2].

Ladder logic:

Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware.

Below shown fig. 10(a) and fig. 10(b) is the ladder programming for working on a single tank. Similar ladder loagic can be given to other two tanks.

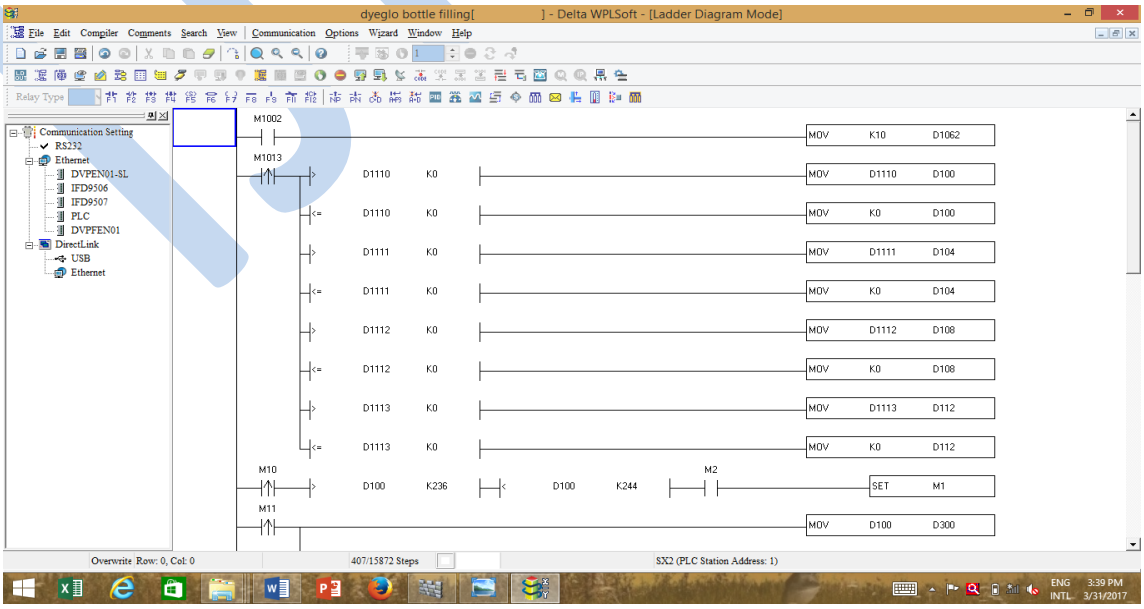

Fig.10(a): Ladder diagram

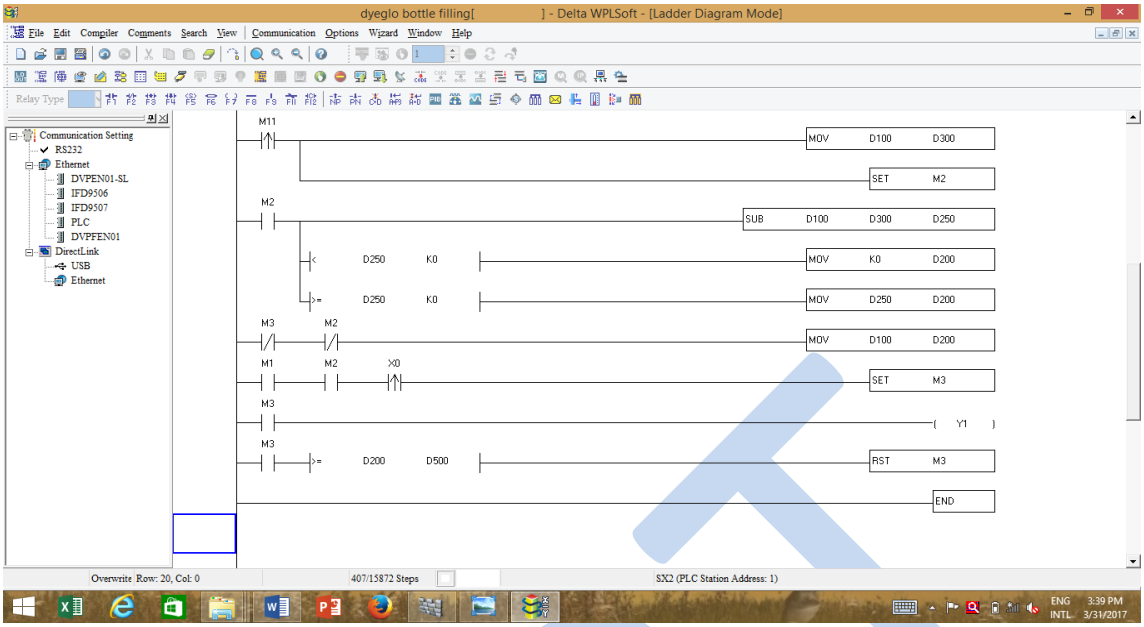

Fig.10(b): Ladder diagram

2. DOPSOFT

DOPSoft is the program that integrates the components and functions of conventional screen editors, the program also delivers greater convenience to use, quicker response and more flexible component planning for users to plan multifunctionalHMIs in fast manner[1].

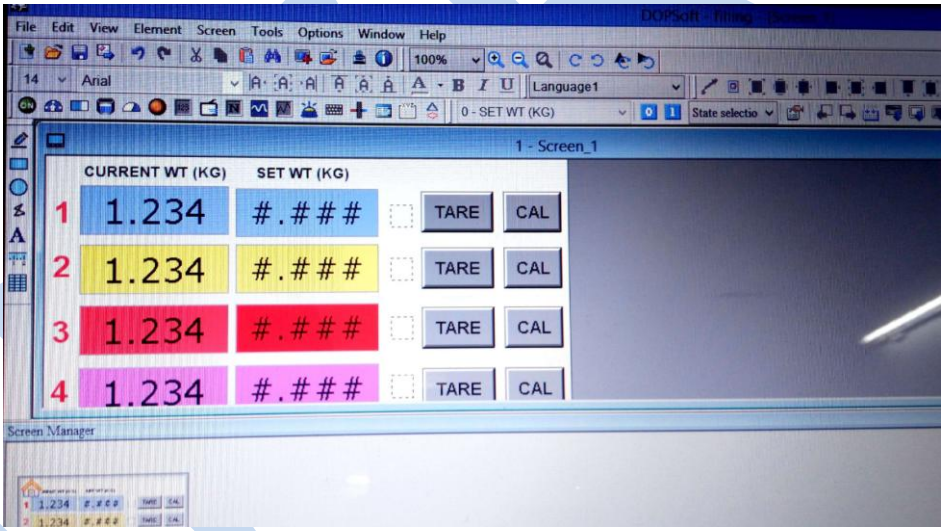

Fig.11: HMI software

RESULTS OF SIGNAL CONDITIONING

Table.1: Result of signal conditioning

SR. NO.	WEIGHT (g)	THEOROTICAL OUTPUT (mV)	PRACTICAL OUTPUT (mV)	AMPLIFIED OUTPUT (V)
1	1000	4	3.8	8.92
2	100	0.4	0.4	1.15
3	50	0.2	0.2	0.72
4	10	0.1	0.1	0.37

CONCLUSION

In industry the production speed should be high because the demand of the product is more. But when we check weight of the object manually then it will take more time for checking the weight and overall speed the production will decrease. So by using this auto weighing control system we totally overcome this problem.

ACKNOWLEDGEMENT

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