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TOPIC:

"CONSTRUCTION OF A SEMI-AUTOMATIC MACHINE FOR LINEAR  
FILLING CAPPING FOR PET BOTTLES 500 CC "

AUTHOR:

JOSÉ JULIÁN MUÑOZ SÁNCHEZ

DIRECTOR:

Ing. José Huaca

Ibarra-Ecuador

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# CONSTRUCTION OF A SEMI-AUTOMATIC MACHINE FOR LINEAR FILLING CAPPING FOR PET BOTTLES 500 CC

*José Julián Muñoz Sánchez*  
*Mechatronics engineering major*  
*Universidad Técnica del Norte, Ibarra, Imbabura*  
*josejuliank@gmail.com*

**Summary.-** This paper is a description of the construction of a machine designed to fill, seal and place the top 500cc water bottles aimed at increasing production focused on small and medium-sized water purification for human consumption companies.

## INTRODUCTION

Drinking water, through the pass of time has had variants like the rest of the products we consume today, so the business of selling not returnable bottled drinks as juices, water, tea, lemonade and energy drinks, has achieved a great boom, due to the economical and practical of carrying a bottle of these products, and it has resulted in a profitable business. (Biology, 2013)

The goal is to design and build a semiautomatic machine to facilitate and increase the production of this product.

## **Bottle capper**

The bottling packages which we fill primary liquid bottles can be divided into very general terms, but it's always known that there are special cases in various categories according to their structure, or way of working, according to the production we desire, by products we package, among others. (Cortes, s.f)

Perhaps the most crucial branchpoint when we start talking about a packaging production whatever the production we want to get is. Rotary Fillers are used for companies with large production instead of that, linears use medium and small companies. The reason is very simple, although it is possible to get any production depending on the number of taps, the rotary filler has an advantage in terms of production, compared to linear and that is an equal number of taps there is no downtime of waiting while filled containers leave and enter the empty ones; but in small and medium enterprises it is preferable to use the linear packaging for its lower cost, while

satisfying the needs of production for such companies. (Cortes, nd)

### ***Control system***

A control system is composed of subsystems and processes (or plants) connected in order to control processes. With a control system you can move large equipment with a precision that otherwise would be impossible. (Nice, 2004)

The purpose of a control system is to achieve, through the manipulation of the control variables, a domination of the output variables, so that these reach predetermined values. (Polytechnic University of Catalonia, 2001)

### ***Microcontroller***

Ingenio-upp (2008) mentions that a microcontroller is an integrated circuit that contains the entire structure (architecture) of a microcomputer, ie CPU, RAM, ROM and input and output circuits.

### ***Sensors***

The proximity sensor is a transducer that detects objects or signals that are close to the sensor element. There are several types of proximity sensors according to the physical principle used. (DACS, 2014)

## **I. PROCESS DESCRIPTION**

The filling machine and lineal capping, is designed to package and seal bottles of 500 cc, with an approximate capacity of 840 bottles per hour, which will be filled and capped into groups of 4 by 4. By means of a conveyor belt, the bottles

will advance to get placed each in its place, then controlled by a motor, it will low the filler block, being in the preset position, a preset valve opens the flow of liquid, filling is controlled by the elapsed time for which it will be stable maintaining the fixed pressure level used in the high tank filled bottles once the water flow is closed, the block filling will risen and the conveyor belt will act . Filled bottles will go through a mechanism that will place the lids, when this type of trap mechanism will be assisted by synchronized sidebands that will prevent the bottle from falling while trying to capture the cap. Upon reaching the sealing section, the sensor will detect the bottles. One by one they come to sealing sector where an actuator will take them from the neck as a piston driven by a DC motor will be responsible for exerting pressure to seal the lid, then 4 empty bottles will be placed to the point of filling so as to repeat the cycle . At the end of the process conveyor band will take out the filled and sealed containers.

While you are in the process of packaging an operator must place the bottles and caps into place.

## **II. SYSTEM DESIGN**

The machine will control subsystem, filling, forward, snap on lids and capping.

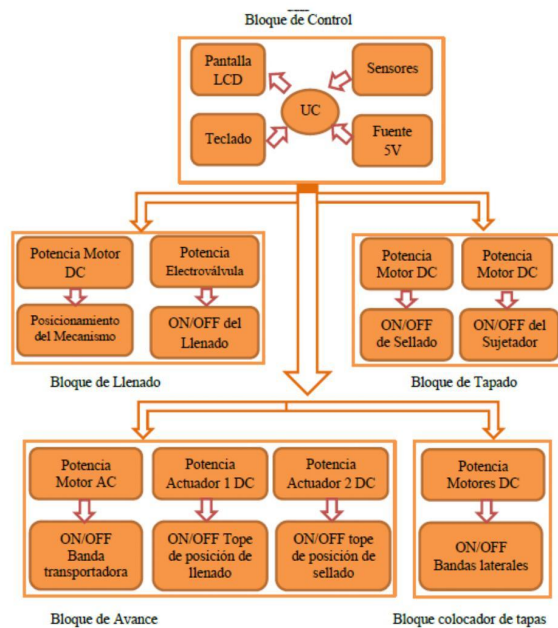


Figure 1.- general block diagram

### 1.- Bottle advance mechanism ( feeding mechanism)

This mechanism will be responsible for advancing the bottles to their next position, which is achieved through a conveyor belt.

The speed of movement of this mechanism must be slow, about four centimeters per second to prevent inappropriate movement of the bottles.

Presence sensors will be responsible for detecting the bottles when they reach the desired position, and actuator bottles will be responsible for the bottles to keep in the preset position for each cycle of the process.

The engine of the conveyor must have a torque superior than 10 Nm to move the bottles without suffering losses in each time when shift is activated.

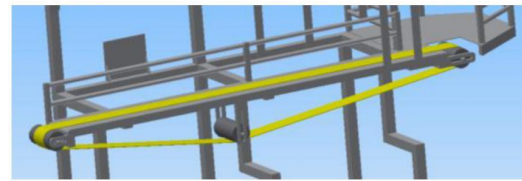


Figure 2.- Design of conveyor

### 2.- Filling Mechanism

Will be responsible for filling water bottles.

Being activated The conveyor belt an optical sensor that detects the bottles reach the filling position. By detecting the first bottle a small actuator stops the bottles just in the right place they will be released. The band will not stop until they reached the four bottles into position, once this happens the conveyor will stop. Immediately the feeler arm is activated, which will have an engine that raise and lower peaks liquid outlet at the time, that is, to enter the empty bottles will drop mechanism to proceed to start filling, after completion this, it will rise back down the actuator to allow the bottles advance, in turn entering new bottles. To perform this task the engine torque should be high, relatively slow and need to stop and start speed.

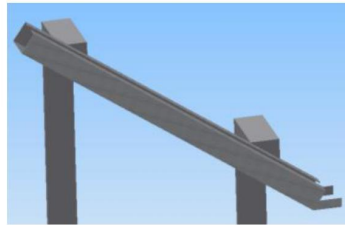
Through the inversion of rotation of the motor it will be ensured that the mechanism goes up or down, in which a presence sensor is installed to detect the exact position of the mechanism and thus accurately control of the mentioned engine.

### 3.- Snap cap mechanism

This mechanism is responsible for placing caps on bottles, its system is considered as a trap, since

that passing the bottle by this section a lid is pulled by the mouth of the bottle and another cap takes place to repeat the process, the cap will be pulled by a structure that will press down so that it is located correctly in place and it will be ready for the next phase of the process, sealing.

The system is supported by two sidebands that are synchronized with the feeding mechanism, these do not allow the bottle to fall when it captures the lid giving greater force to the movement of the bottle.



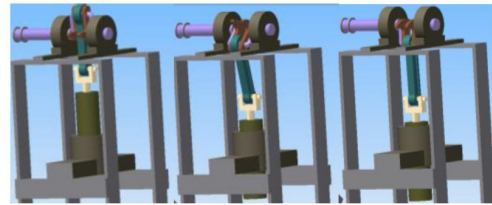
*Figure 3.- Placement of caps*

#### *4.- Sealing Mechanism*

This mechanism is responsible for sealing caps, being in the process of sealing the presence sensor detects the first bottle to be sealed, a DC motor is activated for a little while, this engine is connected to a change in the mechanism pumpjack to make a small hammer hit previously regulated, and press down on the lid. To avoid deforming the bottle before this force before the hit is activated to the bottle holder, a metal plate with the exact shape of the neck of the bottle, this holds and absorbs impact to protect the bottle.

These two movements, the clamping and sealing are synchronized, this process is repeated for each bottle achieving that the bottle gets sealed. Ready to be manipulated by the operator.

The entry of the bottles to a sealing block is synchronized between the presence sensor, the conveyor belt and the sidebands of snap on lids. Such that when the sensor detects a bottle, the sidebands stop instantaneously, but the conveyor belt remains active for a moment, this variation of times allows detected bottles reach their preset position while the other bottles are retained at the sidebands, with this the flow of each individual bottle is controlled



*Figure 4.- piston sealing mechanism*

#### *5.- Control Subsystem*

It Will be responsible for controlling and synchronizing the entire process in order to accomplish the objective.

This will need to have enough memory to store the code necessary for operation, output devices to display data on an LCD, to be able to receive statements of position of sensors, and send actions to the power block, so it must have enough entries for the human-machine interface.

It Will be responsible for both receive the signal of presence located in advance sensor module, and thereby be able to position the bottles in the correct order to activate the solenoid valve, allowing the water flow and beginning the process instead. It will keep the track of the time needed to count the bottles which are filled, after completion of this process it will be sent the order to turn off the solenoid valve, lift the filling



module, actuator and turn back the feed system. It turns on and off the sidebands as bottles enter into the sealing module. Then it will receive the signal from the presence sensor of the sealing module, and it will act the fastener, the sealing piston and ending with activating the stop actuator to allow the exit of the bottles.

### III. CONSTRUCTION AND IMPLEMENTATION OF THE SYSTEM

1. For the construction of the bottles advanced mechanism it was used a flexible corrugated conveyor belt with a 1/8 HP gear motor to a forward speed of 4.2 cm / sec.

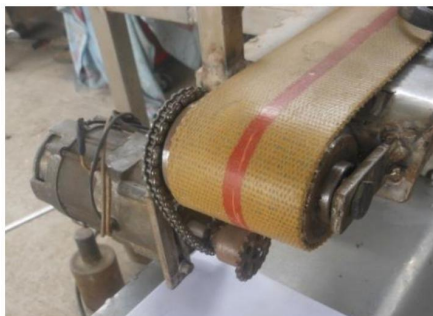


Figure 5.- Conveyor Belt

2.- In the filling mechanism is used a DC Motor TRICO 50 rpm and 8Nm, which raises or lowers the entire filling system.

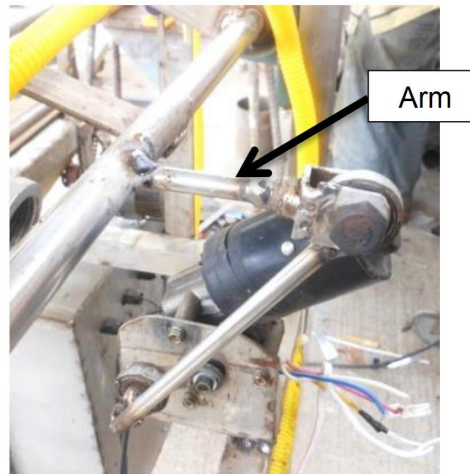


Figure 6.- feeler arm

A capacitive sensor which indicates the position in which the arm should be to start the filling process. It is used for positioning.



Figure 7.- Capacitive sensor

At a time a photo-reflective sensor positioned at the neck of bottles place gives an alert when all the bottles are already in the preset position.



Figure 8.- Retroreflective Sensor

The hydraulic filling part of the subsystem consists of an MANIFOR, a solenoid and 4 ball valves 1/8 "

The MANIFOR and all pipes are made with MONEL 304, a type of stainless steel that meets health standards required by the regulatory body.

The minimum height of the elevated tank that feeds the system is 3.5 m, once controlled its level of liquid with a wrench with a buoy always keeping it in a permissible range and avoiding the most of disturbances.



Figure 9.- Manifor

3.- The type trap method was implemented in the caps setter mechanism, along with two side bands which press and push the bottle preventing falls or turns while holding the lid.

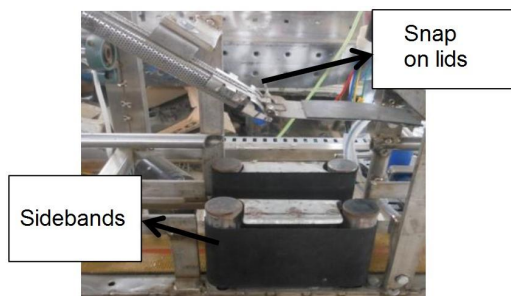


Figura 10.- snap on lids and side bands

4.- Sealing-Mechanism.- This mechanism consists of a DC Trico motor which transmits its

movement in circles to a crank-connecting rod system that transforms a fine line to move the piston which seals the bottle movement.



Figure 11.- Piston seal

So that the bottle will not be deformed while an actuator is sealed with bottle, a clamping mechanism is used, this is activated just before the piston exerts pressure on the bottle and then turns off after being sealed off.

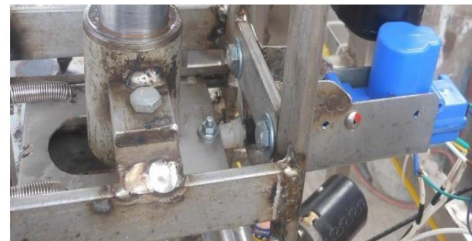
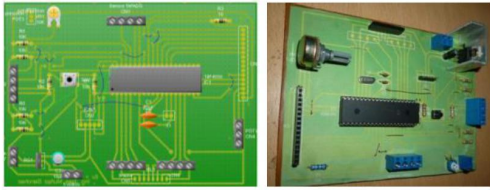


Figure 12.- Fastener

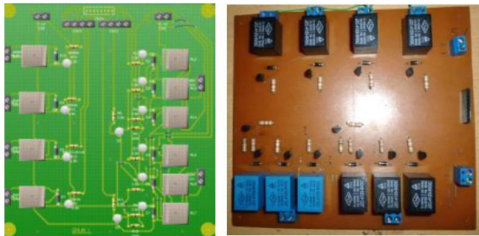
For positioning the bottles within this block it is also used also a photo-reflective optical sensor which in turn it counts bottles which have completed the process.

5.- The control system is performed with the PIC 18F4550 microcontroller which accomplishes the necessary inputs and outputs for the project.



*Figure 13.- Control Board*

In addition to the control board it has a power interface which is responsible for activating the solenoid, the DC motor, spinner Don feeler arm motor, DC motors TRICO sideband and piston.



*Figure 14.- Power Plate*

The assembled system was tested and implemented

### ***TESTS***

Testing of each machine section were done checking and calibrating each part, achieving the expected performance.

100 bottles were filled testing the machine, testing software and hardware constantly checking without presenting problems in its operation.



*Figure 15.- Machine assembly*

### **CONCLUSIONS**

- It was possible to successfully build a semi-automatic linear filling and capping machine PET 500 cc, which is able to produce up to 840 bottles per hour, while 380 bottles a day are manually worked.

- It was chosen to seal the bottles one by one, as they do this four at a time greatly increased its economic cost, and profit would not be appreciated for small and medium enterprises which will focus on its production.

- The filling capping machine contribute to the growth of the company "Water Gar" and the ability to cover the product demand.



## RECOMMENDATIONS

- You can use any method to maintain a stable level in the tank and therefore the filling flow, but always bearing in mind the hygiene standards in the case of liquids for human consumption and it must be avoided to the maximum shocks generated by the filling the tank.

- The most detailed section is calibrated when the snap on lids, since a small variation can greatly reduce the efficiency of the machine

- All personnel using the machine must first be trained to prevent physical and material damage, it is necessary that the recommendations in the manual and maintenance schedule to ensure proper operation of the equipment are followed.

- You can use the machine for packaging liquids other as long as non-gaseous and its viscosity is similar to water. (Coconut water, juices, etc.).

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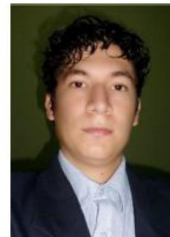
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## ABOUT THE AUTHOR



Joseph J. Muñoz Sánchez was born in Portoviejo, Manabi, December 20, 1989.

He studied his secondary education at the Colegio de Informatica Portoviejo.

Culminated his studies at the Universidad Tecnica del Norte, in the major of Engineering in Mechatronics.

Areas of Interest: Automation, Industrial Processes, microcontrollers.

Contact: [josejuliank@gmail.com](mailto:josejuliank@gmail.com)