Design & development of a automatic bottle filling machine

MD MASUD RANA
Executive Engineer, Tool & technology institute
Bangladesh Industrial Technical assistance center (BITAC)

Abstract:

In this paper a bottle filling machine for alcohol is introduced using Programmable Logic Controller (PLC) based controller in automation industry. The main objective of the paper is to design and fabricate a small, manual feeding with a simple filling mechanism using PLC. The belt conveyor is used for moving the bottle. An Electric pump is used for pumping the alcohol from the tank for flowing the alcohol to the filling nozzle. The position of bottle is detected by sensor so that pump can be functioned at right time. When bottle is under the filling nozzle, the pump is started and the nozzle enter the bottle neck and a specially designed nozzle which contain two line of flow one for entering the fluid and other is for removing trapped air and excess alcohol as the nozzle seal the bottle neck completely. This gives accurate filling height. This filling machine is cost effective and it can be used in small scale bottle filling systems such as coffee shops, juice shops and other beverage industries.

Background:

Carew & Co (Bangladesh) Ltd. is the only licensed distillery producing alcohol made from sugar molasses in Bangladesh at Darsana, Chuadanga ,Khulna Division, Bangladesh. It is the only distillery in Bangladesh owned by the Government of Bangladesh producing the alcohol but packaging and filling mostly in manual process. This operation was earlier carried out by humans and involved placing one bottle under a tap at a time on a table and filled it manually. The process was slow, involved spilling of liquid and resulted in unequal quantities of liquid in bottles.

To solve the problem, BITAC had taken an initiative to fill the bottle automatically without human hand contact at a hygienic condition. In 2012 BITAC developed an automatic filling machine for **Carew & Co (Bangladesh) Ltd** to fill automatically.

R & D and design step: Engineers from BITAC visited the filing line practically at Carew & Co for understand the process clearly. After visiting BITAC had developed a filling machine suitable for filling alcohol. As alcohol creates more bubble than water during filling and it became a challenging task for BITAC. Finally BITAC developed a special type nozzle for filing which had two part one was for filling and other was for removing the trapped air from the bottle as the bottle was fully sealed during filling process. Container had to place manually bellow the filling nozzle at a platform of the machine, where pneumatic operated cylinder controlled by PLC was used fill the bottle at desired preset volume.

Mechanical Design: In this domain the mechanical components were designed with the aid of SolidWorks computer aided-design (CAD) software with appropriate material selection carried out. The design of the subsystems had to be modular for ease of maintenance. Finite element analysis was used for dynamic tests putting the stability, overall weight and strength of the structure in consideration. SolidWorks was also used in carrying out simulations for evaluation of the possible configurations for the conveyor and filling systems. A conveyor system driven by DC geared motor was selected with a filling unit which delivers the liquid to six bottles through a distributor being settled for. The working drawings for the mechanical structure are shown in figure

Fig1:Automatic bottle feeding machine

Methodology: The alcohol creates more bubble than water during filling an overflow common phenomenon during filling. To overcome this problem a specially design filling valve was introduced which developed at BITAC. The valve had two port one for incoming fluid into the bottle and other for removing air from the bottle and extra liquid after full height of the bottle. The stainless-steel valve moving tolerance is so small even water does not leak form the valve. When top of the nozzle is pushed it allow the fluid enter into the bottle. When the filling is completed, Pneumatic cylinder is released and nozzle is pushed back by the force of a return spring. Filling

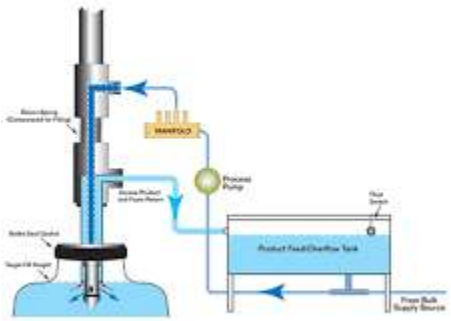


Fig2: Filling process diagram

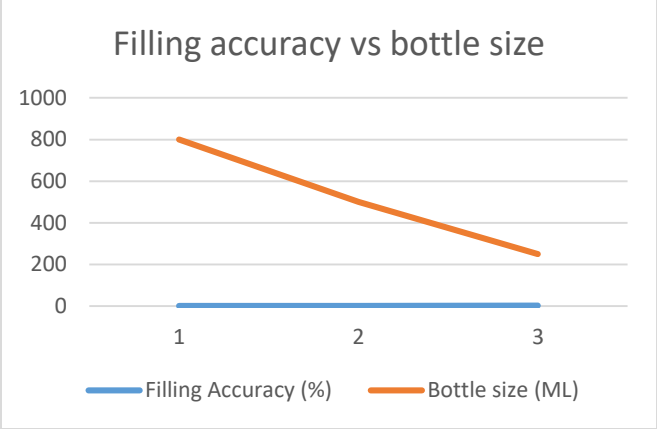
height can be adjusted as required by the bottle height. A SIEMENS LOGO PLC is used for control whole automation task programmed by the user.

Working Principle: A pump is installed at the reservoir for pumping the fluid to the connected nozzle. When the tray of the bottle fed into the machine a sensor detected the position of the tray. After detecting the tray PLC command the pneumatic valve to push down into the bottle. Alcohol start to entre into the bottle after certain period of time the filling process goes stopped. The PLC ladder logic is used to control whole process.

Fig 3: Specially designed filling nozzle

Purpose and uses: Bottle filling machine is used to reduce filling time with a hygienic condition.

Performance Test: As the machine can be fed by six bottles simultaneously filling accuracy is measured and curve is plotted bellow. It's found that accuracy is increased when the bottle size is increased. But all three size of the bottle the filling height is within ± 2% deviation.



Conclusion: In this project, an automatic bottle filling machine is designed and constructed. All the components are performing well. It can fill 200 ml bottle in 3 second. It is a time-based control system and it can fill 67 ml per second. It has some advantages over traditional filling process. This filling machine is cost effective. It saves human effort and time. It can be used in small scale bottle filling systems such as coffee shops, juice shops and other beverage industries. Bottle filling machine which developed at BITAC for Carew & Co. was only a foot-step for automation began at 2012 but by introducing more automation the manufacturing cost can be reduced tremendously.

Acknowledgement:

Authors like to acknowledge the staff and student of BITAC, Dhaka for their support during this work.

Further information:

Please contact at BITAC Dhaka if any further information is required.

References:

[1] G. Eason, B. Noble, and I.N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955.

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892,pp.68-73.

[3] I.S. Jacobs and C.P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[4] K. Elissa, “Title of paper if known,” unpublished