

Analysis of Filling Machines in an Alcoholic Beverage Company at PT. Karunia Jaya Abadi Inds

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Abstract

Purpose: PT. Karunia Jaya Abadi Inds. is an industry that operates in the alcoholic beverage sector. To meet the increasing market demands for alcoholic beverages, the company switched to using robotic-based filling machines.

Method: The methodology used in collecting data includes field reviews, consultations with field supervisors, consultations with lecture supervisors, and literature studies.

Practical Applications: The aim of this research is to find out the specifications of the filling machine and to know the working principle of the filling machine at PT. Karunia Jaya Abadi Inds.

Conclusion: The robotic-based filling machine is an innovation carried out by PT. Karunia Jaya Abadi Inds. This machine is Robo Filler type. The specifications of the filling machine include robot and controller, filling system, product delivery system, and utilities. In general, the working principle of the Robo Filler bottle is carried by a conveyor to a nozzle which will spray the product liquid according to the volume indicated on the control panel. The volume is controlled by a Coriolis flowmeter.

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Introduction

Filling machines have a very important role to support the performance of the beverage industry. The machine can be said to be the heart of the beverage industry. The

development of science and technology in filling liquid into bottles automatically requires a mechanical system to be able to make the system efficient. In the industrial world, liquid filling applies an automation system that causes the production process to be shorter and more accurate in order to get more profit for a company. Bottle filling systems in small industries are less efficient because they still use manual systems. A filling machine is a machine that functions to move liquids that have gone through a certain process (sterilization, mixing, heating, etc.) in a container such as bottles, cans, with a limited number of volumes. The main production of this filling machine is mineral water, beer, juice, carbonated water (soda), tea, etc. (Rahmatullah, et al, 2021).

Filling machines have a high level of accuracy that allows the process of filling products into bottles to be more efficient. Generally, the filling machine is connected to a PLC (Programmable Logic Controller). The material commonly used for filling machines is stainless steel because the nature of this material is not easy to rust so that the product is not easily contaminated. In general, the components that make up the filling machine are product tanks, sensors, filling valves (nozzles), valves (valves), flowmeters, stepper motors, control panels, conveyors and others. The function of the product tank is to hold the product before it is flowed into other packaging. Sensors function to detect bottles and read orders to fill liquid into bottles. The filling valve serves to control the volume of fluid flow (product). Conveyor functions to carry goods (bottles) (Tobing, et al, 2022).

PT Karunia Jaya Abadi Inds is an industry engaged in alcoholic beverages. Based on data from (WHO, 2016), the consumption of alcoholic beverages in Southeast Asia has increased by 34%. Indonesia is one of the countries that contribute to the increase in consumption of alcoholic beverages in Southeast Asia. To meet the increasing market demand for alcoholic beverages, the filling machine used at PT Karunia Jaya Abadi Inds has an important role in the process of filling alcoholic beverages in bottles with a certain volume to increase production effectiveness and efficiency. The product that is filled into the bottle has passed the QC checking process. In general, the alcoholic beverage processing process consists of fermentation, mixing, and aging. The density of alcohol is different from other fluids, so the filling machine used must also adjust.

Method

This Field Work Practice activity is carried out for 58 days (464 working hours), starting from Monday, 3 October to Friday, 29 December 2023. The PKL implementation is carried out at PT. Karunia Jaya Abadi Inds located in Malang Regency, East Java, Indonesia from 07.30-16.30.

This implementation method is carried out to support the preparation of street vendor reports, increase insight and knowledge. The form of activities and methods of data collection carried out during the implementation of field work practices by participating in activities carried out at PT. Karunia Jaya Abadi, including collecting data and information related to the topic of discussion of field work practices, observing processes in the field directly, conducting interviews with field supervisors and workers involved in the field, carry out analyzes of problems in the field according to the topic of field work practices.

Result

1. Liquid Filling Machine

A fluid filling machine is a machine that functions to move fluid that has gone through a certain process (sterilization, mixing, heating, etc.) in a container such as bottles, cans, with a limited volume. With the development of the beverage industry, the development of fluid filling machines is also growing. The main production of this fluid filling machine is mineral water, beer, alcoholic drinks, syrup, juice, carbonated water (soda), tea, etc. (Pangestu Ajie, et al., 2020).

The fastest fluid filling machine capacity in Indonesia is currently 128,000

bottles/hour for carbonated water products, while for mineral water it is 56,000 bottles per hour. The larger the engine capacity, the more filling valves are needed. The material commonly used for a fluid filling machine is stainless steel because the nature of the material does not rust easily so the product is not easily contaminated (Rumalutur & Allo, 2019).

According to (Hermawan et al., 2020) Liquid filling machines have several forms of filling machines, including standing pouches, bottles, or jerry cans. The filling machine process usually uses a manual system to fill liquid into standing pouches, bottles or jerry cans. To get high accuracy, faster and easier, an automated system is needed.

Figure 1. Machine Operation Documentation & Troubleshooting Documentation



2. Robo filler

a. Working principle of filling machine

PT Karunia Jaya Abadi Inds uses a robotic-based machine called robo filler. The process of placing bottles on the conveyor line occurs outside the production room. The bottles are transported by conveyor to the first part of the filling machine, namely the pitchmaker. In the pitchmaker the bottles are spaced according to the distance of the nozzle head to the mouth of the bottle. After going through the pitchmaker stage, the bottles go to the second part of the filling machine where the robot arm will move towards the mouth of the bottle and the nozzle will spray the liquid in the supply tank according to the volume set on the panel. The flowmeter will detect the amount of liquid sprayed by the nozzle. After reaching the target volume set on the machine, the robot arm will lift the nozzle (Solanki et al., 2015). The Robo Filler visuals are as follows.

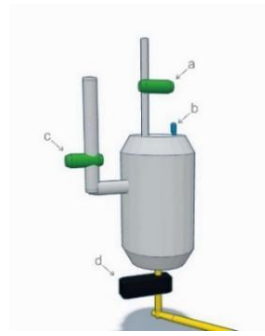
Figure 2. Robo Filler



b. Filling Machine Specifications

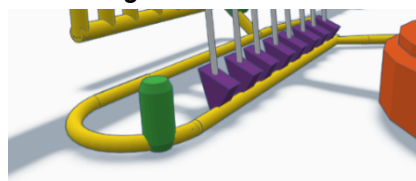
The filler machine used at PT. Karunia Jaya Abadi has constituent components, namely:

Figure 3. PDS Tank



- 1) PDS Tank is a container or reservoir used to store or provide a supply of product fluid to the machine filling channel. There are several components that help the machine to supply product fluid properly, including (Sitompul, 2021):
 - Inlet Drain Valve
The inlet drain valve is a flow valve that functions to distribute fluid into the tank. The inlet drain valve is used to regulate the flow of fluid which functions to rinse the inner tank. The inlet drain valve on the filling machine is controlled pneumatically (using compressed air). The material used in the inlet drain valve is made of stainless steel because it has properties that do not rust easily. This material is very safe for keeping fluids from being contaminated with dangerous substances.
 - Level Sensor
Level sensors are devices or sensors used to measure, detect and monitor levels in supply tanks. The sensor level also influences machine performance, for example when the fluid level is at 25% or variable 1 on the panel, a warning will appear on the HMI (Human Machine Interface) that the fluid will run out.
 - Product Inlet Valve
A product inlet valve is a valve used to regulate the flow of a product or liquid into the tank. The product inlet valve on the filling machine is controlled pneumatically (using compressed air).
 - Product Pump
The Product Pump is used to pump liquid from the product tank to the filling line. The Product Pump on this Robo Filler machine is specifically designed for sanitation pumps which are commonly used in the food, beverage, medicine and cosmetics industries. This pump is very efficient and resistant to corrosion. This pump is usually called a lobe pump.
- 2) Manifold
In the Robo Filler machine, the manifold is used to regulate the flow of product fluid from the supply tank to the flowmeter, where the flowmeter functions to calculate/measure the product fluid sprayed from the machine nozzle. (Fillomatic Global Industries, 2020).

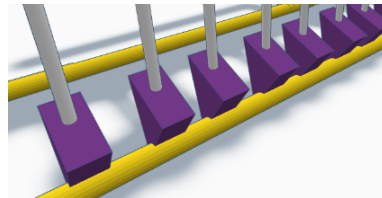
Figure 4. Manifold



3) Coriolis Flow Meter (Coriolis Meter)

Coriolis flow meter (Coriolis Meter) is a flow meter that utilizes Coriolis to measure liters of passing product based on density. The Coriolis effect is a phenomenon of bending the direction of a moving object which looks like it is "curved" when the object is moving (Fillomatic Global Industries, 2020).

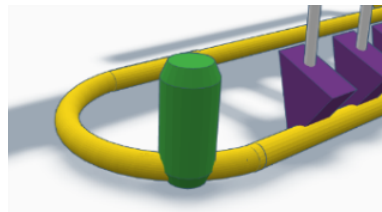
Figure 5. Coriolis Flow Meter



4) Manifold Valve

The manifold valve is a valve that is connected between the flowmeter channel and the CIP cleaning channel. The remaining product liquid remaining in the flowmeter and nozzle can be cleaned through a pipeline controlled by a manifold valve, then the liquid moves to the cleaning channel/CIP (Fillomatic Global Industries, 2020).

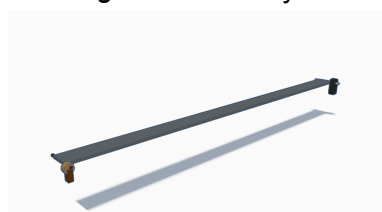
Figure 6. Manifold Valve



5) Conveyor

A conveyor is a mechanical device used to transport goods or materials automatically from one location to another in a production process or logistics system. The type of conveyor used in the robo filler filling machine is a chain conveyor type. Chain conveyors use moving chains to move or move goods (Surakusumah, 2009).

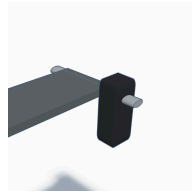
Figure 7. Conveyor



6) Servo Conveyor

Servo conveyors are electric motors designed to provide very accurate and precise control of conveyor chain speed (Fillomatic Global Industries, 2020).

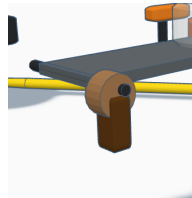
Figure 8. Servo Motor



7) Motor Gearbox

Motor Gearbox is a combination of an electric motor and a gearbox (reducer or reducer box) which work together to change the mechanical characteristics of the motor and produce the desired output. This combination is used to change the torque, speed or direction of rotation of the motor according to the machine's needs. The function of the gearbox motor on the filling machine is to regulate the conveyor speed (Ahmed et al., 2019).

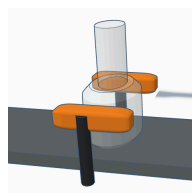
Figure 9. Motor Gearbox



8) Bottle Stopper

Bottle stopper is a mechanical device used to lock or hold bottles in a stable position during the production process. The module in this bottle stopper is designed to allow strong and precise holding or holding. The function of the bottle stopper is to reduce the buildup of pressure on the bottle against the pitchmaker. When the pressure on the pitchmaker is too great it will disrupt performance and impact the size of the distance between the bottles created by the pitchmaker (Rahmatullah, 2021).

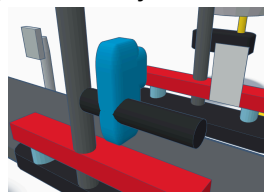
Figure 10. Bottle Stopper



9) Adjuster Sensor

The sensor adjuster functions to adjust the location of the sensor and reflector. In the robo filler filling machine, the sensor and reflector are adjusted to the height of the bottle, the laser shot at the sensor is positioned right at the mouth of the bottle (Fillomatic Global Industries, 2020).

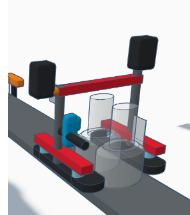
Figure 11. Adjuster Sensor



10) Pitchmaker

A pitchmaker is a device that functions to create distance between bottles that will go to the filling line. The distance between the bottles is made so that the product liquid filling nozzle is right at the mouth of the bottle (Fillomatic Global Industries, 2020).

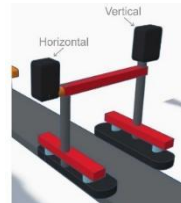
Figure 12. Pitchmaker



11) Vertical And Horizontal Adjuster

The vertical adjuster functions as a height regulator for the pitchmaker relative to the bottle. Meanwhile, the horizontal adjuster functions as a regulator of the width and narrowness of the pitchmaker relative to the bottle (Fillomatic Global Industries, 2020).

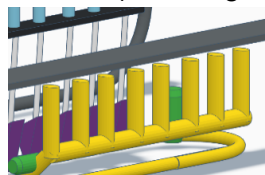
Figure 13. Vertical and Horizontal Adjuster



12) CIP (Cleaning in Place)

CIP or commonly called Cleaning in Place or washing is a method used to clean or rinse the remaining liquid from the previous product left on the filling nozzle. On the robo filler filling machine, every time the product fluid is changed, the CIP process is carried out. The aim of CIP is so that the current product fluid is not contaminated with the taste, color and content of the previous product fluid (Fillomatic Global Industries, 2020).

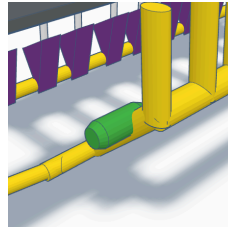
Figure 14. CIP (Cleaning in Place)



13) CIP Inlet Valve

CIP Inlet valve is a valve for cleaning the remaining product fluid originating from the CIP (Cleaning in Place) process. CIP Inlet valve also functions as a separation line between contaminated fluid and fluid that is still suitable for use (Fillomatic Global Industries, 2020).

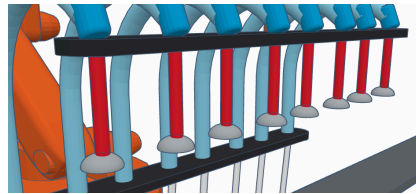
Figure 15. CIP Inlet Valve



14) Nozzle

The nozzle is a component used in the process of filling liquid into bottles. The nozzle on the Robo Filler machine is specifically designed to facilitate the flow of liquid into the bottle precisely, efficiently, and reduce the risk of spills or splashes. (Rahmatullah, 2021).

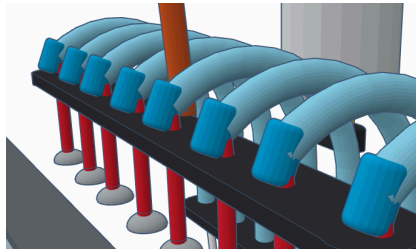
Figure 16. Nozzle



15) Bottle Sensor Nozzle

Bottle nozzle sensor is a component or device used to detect or identify bottles that touch the nozzle mouth area (Rahmatullah, 2021).

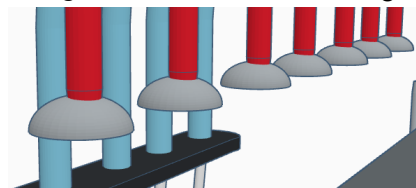
Figure 17. Bottle Sensor Nozzle



16) Nozzle Centering

Nozzle centering is a device that ensures that the nozzle is in the correct position or right in the middle of the mouth of the bottle which will then be filled with product liquid.

Figure 18. Nozzle centering



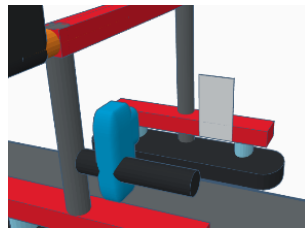
17) Sensor

Sensors are devices or tools used to detect or measure changes in the physical or chemical environment and convert this information into signals or data that can be interpreted by humans or computer systems. Sensors work by

changing physical or chemical quantities into electrical signals or other signals that can be processed. In the robo filler filling machine there are several sensor devices including (Sitompul, 2021):

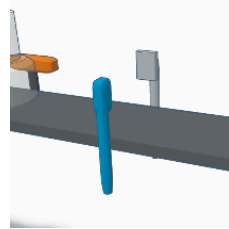
- a) A bottle sensor is a type of sensor or device used to detect the presence of a bottle at the desired location in the filling process. In the Robo Filler machine, the bottle sensor also functions to count how many bottles are processed in the filling machine.

Figure 19. Bottle Sensor



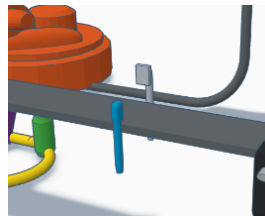
- b) Infeed Sensor Line Empty, this sensor functions to detect the presence of bottles in the early stages of the product liquid filling cycle.

Figure 20. Infeed Sensor Line Empty



- c) Outfeed Sensor Line Full, this sensor functions as a detector for the presence of bottles at the final stage of the filling process cycle. This sensor also functions as a safety sensor on the filling machine, when the outfeed line is full of bottles, the sensor will signal the machine to stop the filling process.

Figure 21. Outfeed Sensor Line Full



18) Robot Arm

A Robot Arm is a mechanical component or device designed to imitate the movements of a human hand or other body part. The robotic arms on robo filler machines can move in a variety of different axes or axes, allowing them to achieve various positions and angles with precision. This can include rotational movements, linear movements, and various other types of movements, so that the filling nozzle is directly at the mouth of the bottle (Nugraha, 2010).

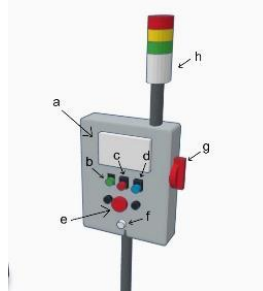
Figure 22. Robot Arm



19) Control Panel

A control panel (or in English "control panel") is a device or structure used to control, monitor or operate the system on a robo filler machine. The control panel on this machine consists of buttons, switches, indicators, screens and other components (Ahmed et al., 2019).

Figure 23. Control Panel



a) HMI (Human Machine Interface)

This human machine interface is technology or software that allows humans to interact with machines or computer systems intuitively. The HMI on the robo filler machine is designed to make communication between humans and machines easier, more efficient and user friendly. The HMI on the filling machine is a touch screen that allows users to interact with the system by touching icons, buttons, or other interface elements on the screen, such as opening valves, changing machine mode from auto to manual, turning off sensor functions, adjusting conveyor speed, setting machine speed, regulate the height and low of the nozzle, regulate the filling speed, and regulate the pump speed.

b) The Start button is the button used to start the filling process on the machine.

c) The Stop button is the button used to stop the filling process on the machine.

d) The Reset button is a button used to return a system or process to its initial condition or default state. The reset button is often used when there is a problem or failure in the product's fluid filling process, and this action can help restore normal function.

e) Emergency Stop is a safety device designed to provide an instant and quick way to stop operating machinery in an emergency situation. The function of an emergency stop is to protect operators, workers, or the surrounding environment from potential dangers or accidents that could arise during the filling process.

f) RFID is the abbreviation of "Radio-Frequency Identification" in English. This is a technology used to identify and track certain objects or intensities by sending data via radio waves. This technology involves the use of an RFID tag attached to the object to be identified, as well as an RFID reader that can read information from the tag.

g) Main Rotary Switch is a rotary switch on a robo filler machine used to control the flow

of electricity or the main rotary switch by turning it to the on position.

- h) Tower Lamp Buzzer is a device used to provide visual and sound signals. On the robo filler machine, there are 3 signal colors displayed by the tower lamp buzzer, namely:
- Red is a signal that an error or problem is occurring on the machine, and the machine stops automatically.
 - Yellow is a signal that the machine is carrying out the preparation process for several devices and modules.
 - Green is a signal that the machine is ready to be used or started.

Discussion

Filling machines play a crucial role in the beverage industry, serving as the backbone of efficient production processes by ensuring accurate and hygienic liquid transfer into containers. For companies like PT Karunia Jaya Abadi Inds, which specialize in alcoholic beverages, these machines are vital for meeting high production demands while maintaining strict quality standards. The integration of modern technology, such as Programmable Logic Controllers (PLCs) and stainless-steel components, enhances functionality, reliability, and hygiene, especially when dealing with the unique properties of alcohol.

As beverage consumption increases, particularly in Southeast Asia, the adoption of high-capacity filling machines enables industries to scale operations and remain competitive. These machines also contribute to sustainability by reducing waste and ensuring precise material use, providing economic benefits by minimizing losses from overfilling and lowering dependence on manual labor. However, challenges such as high initial costs, maintenance, and the need for skilled operators persist. To address these, companies must invest in regular maintenance, employee training, and innovations like AI-driven predictive maintenance.

Conclusion

Analysis of filling machines in beverage companies can involve several aspects, including efficiency, reliability, operational costs, and ability to meet production demands. Below are some points that can be considered in such an analysis.

1. **Production Efficiency:** Filling machines must be able to fill bottles or packaging quickly and accurately. Production efficiency is crucial to ensure that companies can meet market demands without significantly increasing production costs.
2. **Machine Reliability:** Reliable filling machines are essential to maintaining smooth production operations. Machines that frequently break down or require intensive maintenance can disrupt production schedules and cause delays in product delivery.
3. **Product Quality:** The filling machine must be able to fill the product with high consistency and avoid contamination or damage to the product. This is important to ensure that the products produced meet the quality standards set by the company and regulators.
4. **Operating Costs:** Operational costs include electricity costs, raw materials and machine maintenance costs. The analysis must take these costs into account to determine the overall efficiency of the filling machine.
5. **Flexibility:** Filling machines that can be easily adapted to a variety of packaging sizes and types can help companies respond to changing market demands and expand their product range.
6. **Latest Technology:** Choosing a filling machine that uses the latest technology can increase production efficiency and quality. For example, machines equipped with advanced sensors can reduce the risk of filling errors and increase accuracy.
7. **Conformity To Regulatory Standards:** Filling machines must comply with all applicable safety standards and regulations in the beverage industry. Compliance

with these regulations is important to avoid sanctions and maintain the company's reputation.

8. Production Capacity: Filling machines must be able to handle production capacities that match current and potential future market demand. Theosing a machine with the right capacity can help companies avoid unnecessary investment or lack of production capacity.

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