PLC BASED AUTOMATIC HYGIENIC DISH WASHING MACHINE

Dinesh P\textsuperscript{1}, Gopinathan K\textsuperscript{2}, Dhamodharan M\textsuperscript{2}, Devarajan J\textsuperscript{2}, Imayavaramban N\textsuperscript{2}, Dr. Pradeep Kumar A.R\textsuperscript{3}

\textsuperscript{1} Department of Mechanical Engineering, Dhanalakshmi College of Engineering, Chennai 601 301
\textsuperscript{2} Department of Mechanical Engineering, Dhanalakshmi College of Engineering, Chennai-601 301
\textsuperscript{3} Department of Mechanical Engineering, Dhanalakshmi College of Engineering, Chennai-601301

ABSTRACT
Plate washing is a daily process across the world that involves a lot of human effort to accomplish it completely. In our project, dish washer has made easier and efficient to work. It removes oil and other stuffs accurately compared to manual cleaning process. It cleans by spraying hot water (40°C to 50°C) using the heater. The process is carried in four stages. Initially, normal water is sprayed on the plates using spray arms located on both sides of the cleaning area. Then chemical action of soap oil is applied. Next the thermal action of water is used to clean it completely. Finally normal water is again sprayed to cool the hot plates. The water is again recirculated using the motor pump even when the external water supply is stopped. The used water in the sump is drained using the drain pipe. All the operations are controlled using PLC program. The panel board is fixed in front consisting of ON and OFF push buttons with alarm indication. The time of washing plates can be adjusted as per customer requirements. The main feature of the machine is to clean 16-20 plates in 2 minutes using single rack design. Maximum of 500 plates can be washed in one hour. Additionally, alarm setup is installed to indicate the completion of washing cycle. Large amount of plates is washed in lesser time. This machine can be utilized in Schools and Colleges as well as Industrial purposes.

Keywords—Motor, Heater, Spray arms, Rack design, PLC Control, Relays, Transformer and Alarm system.

I. INTRODUCTION
Dishwasher is a mechanical device for cleaning plates and utensils. Unlike manual dishwashing, which relies largely on physical scrubbing, the mechanical dishwasher cleans by spraying hot water at the plates to remove the dirt and at lower temperatures for delicate items. A mix of water and soap oil is pumped to both rotating spray arms, which blast the water on the plates with the cleaning mixture. Then the hot water flows on the plates to complete the cleaning process. Once the wash cycle is finished, the water is drained by the drain tube. After the cycle finishes and the water is drained, the plates are dried using one of many drying methods. Industrial dishwashers are available for use in commercial purpose such as hotels, schools, colleges and restaurants, where a large number of plates are cleaned. Customers operate dishwashers by placing plates the dishwasher racks, adding soap oil, turning on the device, then removing the clean plates once the washing cycle is over. Many users fix their dishwashers in one place i.e. countertop. However, portable machines are available that may be rolled near the sink, with a
hose tube attached to the kitchen sink faucet. Dishwashers with food waste disposer need not have pre-rinsing or scraping. Machines lacking a built-in food waste disposal, the user scrape the plates before loading for cleaning. From the early 1960s, manufacturers have designed consumer dishwashers for use without pre-rinsing or pre-washing. In the early eighties dishwasher machines used to have "hard food waste disposers" that splits harder food waste such as seeds and dirt into small pieces. Dishwashers are designed to hold different vessels in the washing place available. Usually two-rack design is provided. The user loads cups, bowls, and small dishes onto the top rack and eating utensils at the bottom rack provided in the dishwasher. Few dishwashers have a third rack for utensils as a backup. Many dishwashers use sensors to determine water supply and temperature developed in the heater. Dishwashers and soap oil used in dishwashers are not designed for use in certain materials. The washing cycle's heat developed and chemicals in the soap oil is harmful for kitchen maid and non-stick surface pans. Soap oil have their own usage restrictions, including various materials like wood or certain metals not being safe for cleaning. Automation has been achieved in various fields including mechanical, hydraulic, pneumatic, electrical and electronic and computers. Thus, it is achieved in dish washer using the PLC control which controls the washing cycle automatically and accurately. The design of the dishwasher depends on the following:

- Features
- Washing elements
- Purpose

**TYPES OF DISHWASHER**

- Compact Dish Drawer Dishwashers
- Versatile Freestanding Dishwasher
- Fully Integrated Dishwasher
- Perfect Fit Semi Integrated Dishwasher
- Slimline, Small & Compact Dishwashers
- Countertop or Portable Dishwasher

**II. PROGRAMMABLE LOGIC CONTROLLER**

A programmable logic controller (PLC) is a microprocessor controller that uses a programmable memory for storing the instructions and to implement its functions such as logic, sequencing, timing, counting and arithmetic in order to control machines and its functions. The main components of a PLC are as follows.

- Central Processing Unit (CPU)
- The input/output unit
- The Programming unit and
- Memory unit.

**PLC CONTROL PANEL**

This controller panel consists of a PLC, MCB, Relays, Transformer, Connector, Panel mounting plate, Druff and Druff plate. In this, PLC controls four operations in all its four output such as Q1, Q2, Q3 and Q4. Relays are used for ON and OFF operations which is to be done in motor and heater. Both motor and heater are operated using it automatically. MCB determines the light indication.
TABLE 2.1 SYMBOLS USED IN THE PLC PROGRAM

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Motor</td>
</tr>
<tr>
<td>Q2</td>
<td>Heater</td>
</tr>
<tr>
<td>Q3</td>
<td>Soap oil</td>
</tr>
<tr>
<td>Q4</td>
<td>Buzzer alarm</td>
</tr>
<tr>
<td>T</td>
<td>Normally Open</td>
</tr>
<tr>
<td>t</td>
<td>Normally Close</td>
</tr>
</tbody>
</table>

III. PLC BASED DISHWASHER

PROJECT CONSTRUCTION

This dishwasher consists of major components which are responsible for the cleaning process. Each component serves their function for better cleaning. Motor is placed below the sump. Heater is located near the motor. Spray arms are placed inside the cleaning area both facing the rack in the washing area. Steel rack is mounted on the sump with its legs placed on four edges where the plates are loaded. All are connected using the connecting tubes with the help of clamp and tie. The springs are available at the back of the dishwasher which is fixed to the...
handle. It is used for lifting the dishwasher upwards for placing the rack. The capacitor is connected to the motor. The overall dimension of a dish washer is 190cm. The dimension of a wash basin is 57 cm.sq. The rack capacity is 20 plates. PLC panel is kept at the bottom of dishwasher where there is no possibility of water flowing or leakage.

**COMPONENTS**

- Motor
- Steel Rack
- Spray Arms
- PLC
- Heater
- Relay
- Transformer
- MCB
- Sump
- Soap Oil

**MOTOR**

In our project, motor plays a major role. It pumps the water and circulates it to both the spray arms for efficient cleaning. High pressurized water is developed by it. It is connected to the external power supply and a capacitor.

Figure 3.1. Motor

**STEEL RACK**

Dishwasher racks are designed to occupy a specific type of vessels, whether it can be plates, glasses or utensils. Plate racks are designed by the diameter of plates that they can accommodate. They are open-ended to hold many different size plates.

Figure 3.2. Steel Rack

**SPRAY ARMS**

A mix of water and soap oil is sprayed to both the rotating spray arms, which flows with high pressure to clean the plates. This spray arms can withstand the temperature of the hot water and rotates constantly with normal speed.

Figure 3.3. Spray arm

**PLC**

Programmable Logic Controller is the digital computer which has been adapted for the control of manufacturing processes such as assembly lines or
any activity that requires high reliability control and ease of programming and process fault diagnosis.

Figure 3.4. Genie PLC WORKING PRINCIPLE

A dishwasher is an automatic machine that cleans and removes dirt on the utensils using a microcontroller or a PLC system. Users have to load the plates, add soap oil and to set the proper washing mode and turn ON the machine. The workings of our dish washer are as follows.

- Initially the external water supply is allowed to flow through the dishwasher for few seconds.
- The sump is filled with the external water which is flowing through the dishwasher.
- Then, motor supply is turned ON to pump the water and circulates it to the spray arms located on top and bottom of the cleaning area.

Uncleaned plates are loaded on the steel rack and it is placed inside the washing area by pulling the handle upwards.

- The process is carried in four stages. They are as follows.
- Mechanical action of water is sprayed on the plates with the help of the spray arms for 30 seconds.
- High pressurized water is developed inside the washing area due to motor power.
- Chemical action of soap oil is mixed with the water through the solenoid valve to clean the unwanted stuffs in 20 seconds.
- Thermal action of hot water is sprayed through both the arms with full force of action for 1 minute to clean the plates entirely with no dirt.
- Finally normal water is sprayed on the plates to reduce temperature of the plates and rack.
- All the operations are controlled using PLC system located in front of the dishwasher.
- The beep sound indicates the completion of washing cycle.

- The plates are safely removed from the rack and used for dining purpose.
- The dirty water on the sump is drained outside through the drain tube.

ADVANTAGES

- Multi plates can be washed at a time
- Less floor space required
- Less skilled persons can operate the machine comfortably
- 20 plates are washed accurately in 2 minutes
- 500 plates are washed in 1 hour approximately
- In this, automation is done through the PLC system for effective performance
- Less consumption of water than manual use
- Low maintenance cost

DISADVANTAGES

- Full automation can’t be achieved
- The dirt in the drain sump by the left over foods and other stuffs will result in slow drain of the water.

Failure of the dishwasher performance is caused due to the stuff in the holes of the spray arms. Thus water is sprayed unevenly which results in poor washing of plates.

APPLICATIONS

It is used in large scale cuisine such as colleges, hotels, restaurants, marriage ceremonies where there is requirement of more number of plates.

TABLE 3.1. COST ESTIMATION

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>QUANTITY</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genie PLC</td>
<td>1</td>
<td>5500</td>
</tr>
<tr>
<td>MCB</td>
<td>1</td>
<td>250</td>
</tr>
<tr>
<td>Relay</td>
<td>2</td>
<td>400</td>
</tr>
</tbody>
</table>
### TABLE 3.2. COMPARISON BETWEEN HUMAN AND MACHINE FOR WASHING PLATES

<table>
<thead>
<tr>
<th>Serial</th>
<th>Factors</th>
<th>Human</th>
<th>Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plates washed</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Time consumed</td>
<td>10 min</td>
<td>2 min</td>
</tr>
<tr>
<td>3</td>
<td>Water</td>
<td>15 litres</td>
<td>10 litres</td>
</tr>
<tr>
<td>4</td>
<td>Performance</td>
<td>120 plates per hour</td>
<td>500 plates per hour</td>
</tr>
</tbody>
</table>

### CONCLUSION

Nowadays in Schools and Colleges there is system of mid-day meals. Many health issues occur due to improper cleaning of plates. It is completely eliminated by using dish washer. 500 plates are washed in one hour. This saves lot of time and man power and the 60% of time saving is achieved as compared to human. Our system is eco-friendly. The life of the machine is 5 – 6 years by proper maintenance of the machine.

### FUTURE SCOPE

In future, by modifying this system, we can add conveyor to the dish washer machine and improve the speed of the cleaning process by using alternative motor. Also, stands can be welded at the sides to load the uncleaned plates on one side and cleaned plates on other sides. Variety of racks can be designed based on the customer needs.

### REFERENCES


