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Automated Universal Utensil Washer

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Abstract

The meal service industry in India is the 3rd largest service industry, following retail and insurance services industry. About 2.5 lacs mid-day meals are delivered in Mumbai alone. As a fact, a renowned tiffin delivery service named "Dabbawala" serves 80 million lunches per year. These meals are being served in either washable utensils or disposable plates. Taking the washable ones into consideration, due to hype in the commercialization of food service, the conventional method of washing utensils , lunch boxes, tiffins, etc results in more consumption of water, labor and time, which leads to decrying of profit and increase in human error making this method untenable. Our country is the largest plastic consumer, meeting a daily usage of 26,000 tons per day. Out of which 120 billion pieces are plastic utensils and cutlery. These numbers are reached due to people preferring disposable utensils over washable ones, unknowingly endangering the environment under the mask of profitization. To overcome these problems, we propose an automated system solution. This system integrates all the various steps involved in washing and can be used for a wide range of equipments and utensils. It emphasizes on commercial sectors dealing with utensils on a large scale.

Keywords—: *meal service industry, washable utensils, disposable utensils, automated, commercial sector*

1. Introduction

The commercial dishwashing currently involves human loading, sorting, inspecting and unloading dishes. Such difficult working conditions lead to high expenditure on low paid employees. Thus, automation is becoming a necessity especially on a large scale in the kitchens of hospitals, hotels, and other dining options. Also, the growth in population due to migration, such dishwashing system is becoming a necessity on a commercial basis. This paper deliberates about reducing human efforts in utensil washing by replacing it with an upgraded and improvised version which yields much better results**.**

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Figure 1. Actual Setup

2. Functional Introduction

A cubical cage is made to pass along with the conveyer made up of Modular Poly Acetyl. This belt is moved with the help of a geared motor of 1.5 HP. The cage is a wire mesh like structure,that allows draining of water after any wash section, and is made up of stainless steel. Before getting completely washed, the equipments kept in the cage are passed on through five sections namely the prewash section, the first rinsing section, the hot detergent rinsing section, hot water post rinsing section and the drying section.

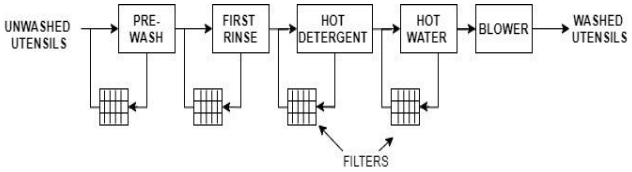

Figure 2. Block Diagram of the System

A. PRE WASH SECTION: The pre wash section, also known as pre rinsing section throws more amount of water with less pressure on the equipments or utensils in order to clean off the thick residue left on it and also helps in reducing the adhesiveness of the oils, leftovers, etc on it.

B. FIRST RINSING SECTION: The cage now passes on to the first rinsing section, where the product begins to get cleaned. The nozzles which are fed by the pumps, spray water with high pressure of around 3-3.5 bar to clean the surface. The nozzles are arranged at such angles that they cover the entire surface including corners and edges of the mould to be washed. Here the water which is being sprayed is at the atmospheric temperature (approx. 30degrees).

C. HOT DETERGENT WASH SECTION: The next section where the cage enters is the hot detergent wash section. This section involves spraying of water with a temperature of around 60 degrees centigrade. This temperature is attained using a heat exchanging system. The heater supply is cut off automatically when RTD temperature sensor (pt 100 type) senses the water temperature at 60 degrees. This section takes care of the sterilization of the utensils/ equipments and thus making them germ free for reuse.

D. HOT WATER WASH SECTION: The cage now moves to the clean hot water washing section wherein, the clean detergent- free water is sprayed through the nozzles on the moulds. The temperature of the water here is around 75 degrees and this is attained using direct heat injector known as Sparger. A Sparger is a device which diverts and sparges steam in the tank and directly

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heats the water. This section takes care about cleaning off the detergent left on the surface in the previous section.

E. DRYING SECTION: The cage now enters the drying section. This is the last section in the system where a centrifugal pump provides the nozzles with dry air from the atmosphere. This air is sprayed with high pressure on the entire surface thus drying the entire mould and the cage can be stacked further.

3. Main components specification

Components	Specification
RTD Sensor	PT 100 T Type
Float Switch	
Temperature controller	
Pump1 (2.2KW3.7KW,3.7KW,1.85KW)	MCB 3P- (10A,16A,16A,6A)
Pump 2(3.7KW)	
Pump 3(3.7KW)	
Pump 4(1.85KW)	
Heater 1	MCB 3P(32A)
Heater 2	MCB 3P(25A)
Conveyer(0.75KW)	MCB 3P-4A
Noise filter	6A
OLR(1,2,3,4,5)	(4-6.3,6.3-10,3.2-5,20-32,16-25)
Transformer	300vA
Power Terminal(1,2,3,4,5,6,7,8)	RYB(2.5,6,4)sq mm, Yellow/green(4,35)sq mm, Red(35)sq mm, Blue(35)sq mm, Black(35)sq mm
Power Cable	2.5 SQ 4C
Emergency button	
Flexible hose pipe	

Table1. components table

4. Requirements of the system

A. Working environment:

Criterion	Degrees
Max. Temperature	+30 deg
Min. Temperature	+10 deg
Relative humidity	5-8.5%

Table 2.1

B. Electrical requirement:

Criterion	Value
Voltage	415VAC

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Frequency	50Hz
Phase	3 phase ,4 wire AC
Control Voltage	24 V DC

Table 2.2

*C. Earthing Requirements***:**

The necessity for earthing is to ensure that the metalwork of electrical equipment, other than current carrying parts, cannot have a potential above earth in the event of a fault which might otherwise cause danger of an electric shock. This machine requires evaluated earthing by making use of a minimum cross section as per the industry standards .The wire must be corrugated and screwed to earthing bus bar located in the control panel.

*D. Mechanical Requirements***:**

The minimum air supply required for pneumatic operation is about 5kg/cm2. The pre-rinsing section has a water storage capacity of about 580 lit. for normal water supply. The cleaning zone has a water storage capacity of 908 lit. The post –rinsing section has a water storage capacity of 1000 lit. Thus, the total storage capacity of water is 2488 lit for one time filling. Water pressure required is 3 kg/cm2.The steam supplied for heating of the water is 5-7kg/cm2 minimum. Hence the total steam consumed is 450kg/hr.

5. Equations

$$\text{Efficiency of the system } (\eta)\ \% = \frac{P\,V}{A\,t} \times 100$$

where :

P= Pressure of water through nozzle
V= Velocity of conveyer belt
A= Area of the mould to be washed
t= Time required for the system to complete one cycle

6. Information about units involved

A. Driving unit:

The driving unit being a motor, is used to obtain required speed of rotation for the conveyer as soon as it is provided with power supply .It has the ability to run the drive shaft, and is mounted at one end .The modular chain which is coupled with the shaft, delivers the utensils/equipments, to the other end of the washer.

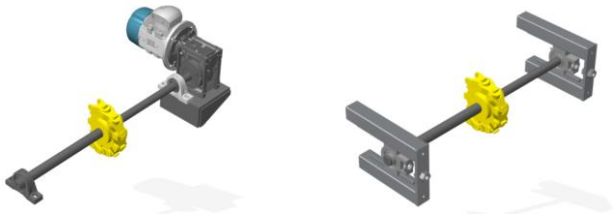

Figure 3.1 Driver and driven unit

B. Piping unit:

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This unit comprises of a coiled structure of sprinkler heads. Pumps are used to supply water to these heads through discharge pipes.

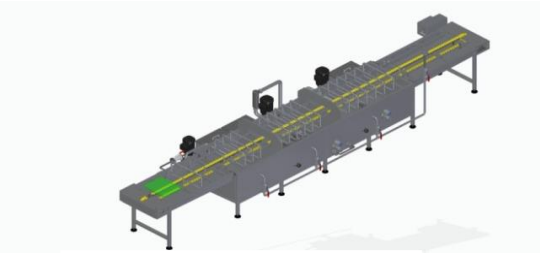

Figure 3.2 Piping Unit

C. Nozzles:

To ensure thorough cleaning of the total mould, nozzles have been used for spraying the water at around 3 to 3.5 bar pressure. V coned nozzle, making an angle of 130 degree are used for the spraying action. Nozzle arrangement is made in such a way that, it covers the entire surface of the mould to be washed.

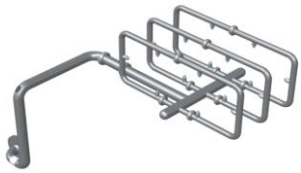

Figure 3.3.Nozzle arrangement

D. Pumps:

Separate cleaning pumps with variant flow and pressure capabilities are provided for respective sections of the washer. The sprinkler heads mentioned above provide enough water to the nozzles .A centrifugal vertical pump is used for the suction of water, which is to be provided to the sprinkler heads.

Figure 3.4 Pump Unit

E .Pipe guiding:

To avoid the horizontal drifting of the cage enclosing the moulds, during its motion on the conveyer belt, pipe guiding is provided. These guiding can be varied horizontally according to the width of the cage.

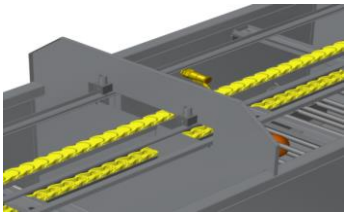

Figure 3.5 Pipe Guiding

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F. Filters:

The water drained from the cage is passed through filter mesh, which obstructs the entrance of garbage, plastic waste, or any other insoluble material into the suction of pump, thus avoiding any possible harm to the blades of the pump .These filters should be cleaned regularly by spraying water with high pressure through a pipe. Using a union coupling, the filter unit is attached to the inlet section of the pump.

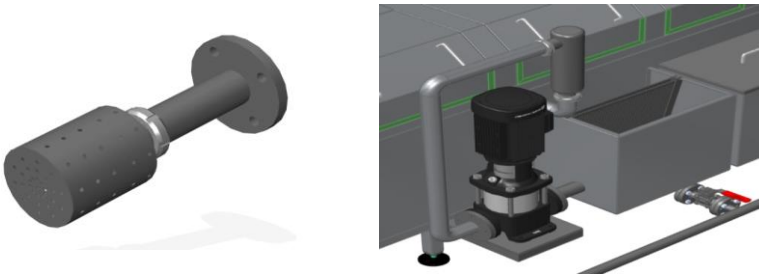

Figure 3.6 Filtering Unit

G. Drain piping:

After filtration is completed, the water is drained out using manually operated drain valves and is passed on to the tank for reuse. This process needs to be done after completion of each cycle .The common drain pipe (this unit) can be taken out for maintenance.

Figure 3.7.Drain piping

H. Heat Exchanging Unit:

The pre detergent hot wash and normal hot wash requires water at around 60 degrees. To meet this requirement the heat exchanging unit is implied. A pneumatic cylinder passes the heated steam into the heat exchanger tubes, which are located in the respective tanks which results in rise in temperature of water.

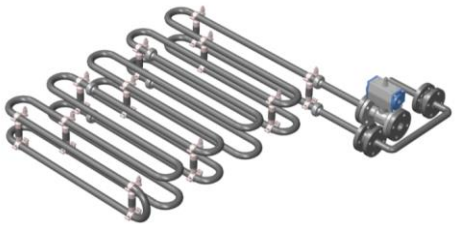

Figure 3.8 Heat Exchanger

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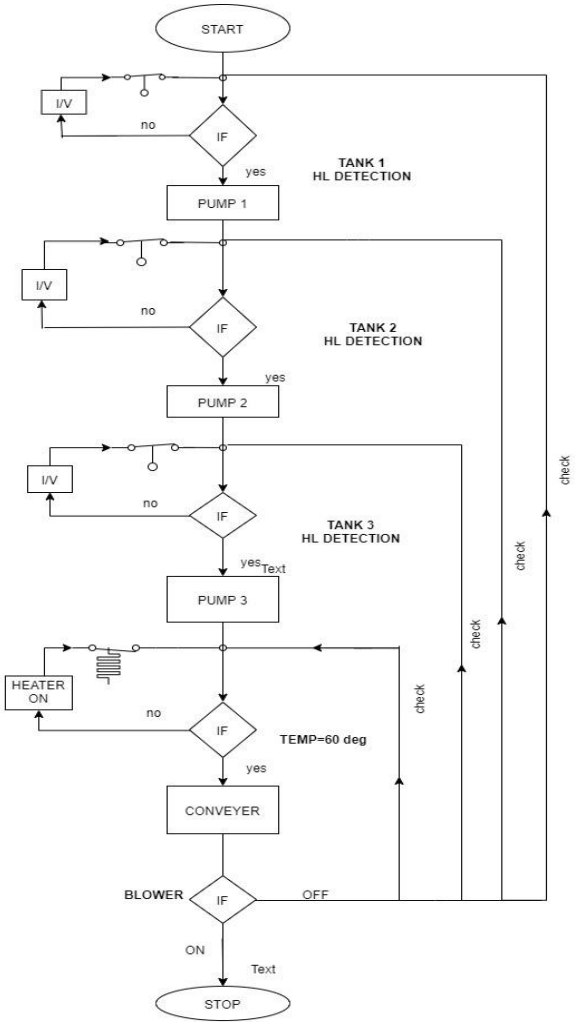
7. Algorithm



8. Conclusion

The current conventional method includes a lot of human intervention which leads to a lot of errors, which lead to customer dissatisfaction resulting in goodwill loss for the organization. The errors also include the skipping of some step resulting in lack of uniform washing, lack of hygiene in washing resulting in customer dissatisfaction, errors due to confusion led by huge number of utensils to be washed resulting in repeatedly washing same moulds over and over again. This huge number shows the need of more manpower adding up to the expenses of the company. Also increase of equipments some day would bring in the need of more manpower working for additional hours and more time would be required. This system also makes the handling of utensils very easy as it automatically stacks the cages after they are passed through the drying end section. This helps in saving lot of space involved in drying of these utensils. This system works on the principle of water recirculation, thus saving a lot of water from being wasted, in such a water scary situation today. Moreover the system is controllable in terms of speed and temperature without addition of any excess budget to it. The essential temperature required for sterilization of equipments used in hospitals could be attained easily and whenever required.

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9. Future Scope

This system finds application wherein a lot of people having meals are involved for a short period of time. In hotel industry, where hygiene maintenance becomes a priority and in hospitals where, making the equipments germ free is necessary. In marriage halls instead of using harmful disposable plastic utensils and cutlery, steel washable utensils could be used .In temples ,which serves food for pilgrims and poor people , washing on such large scale proves to be difficult and hence this system could be applied. The multiplex theatres which also have meal serving options could also make use of this system on commercial level. In trains, that travel over a long distance and serve food to the passengers, such system which re-circulates water can be applied.

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