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Design and Development of Semi-automatic dish washer and its comparison with Automatic dish washer

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Abstract—Washing dishes is most commonly done activity in the world, in most of families people wash dishes by hand which is straining to muscles and detergent is chemically harmful. As far as manual process is concerned in houses of India, washing is done by hand scrubbing which is straining to the muscles through its energy and postural requirements. It may also lead to clinical, anatomical disorders and back pain which may affect the operator's health. Many of their household chores are performed by the women and some can be very physically challenging and time-consuming.

The dishwasher has made cleaning and drying dishes much easier and more efficient. This Concept discusses the problems faced in Automatic Dishwasher and solutions on those problems. Automatic dishwasher uses large amount of energy, time and is costly. As it is costly, the usage of automatic dishwasher in our country is very less, by using semi-automatic dishwasher, time, cost and human efforts can be reduced significantly. Also by using Galvanized iron material for inner & outer part, the overall weight of the assembly is also reduced. The capacity of machine is to wash 24 pieces of dinner set at a time by using two rotary jet controlled by single pump using parallel connection.

Keywords— Rotary jet, Centrifugal pump, Ball valve, Utensil Grills, Regulator, Drain pipe, PVC pipe

I. INTRODUCTION

Washing dishes is most commonly done activity in the world, in most of the families, people wash dishes by hand which is straining to muscles and detergent is chemically harmful. As far as manual process is concerned in houses of India, washing is done by hand scrubbing which is straining to the muscles through its energy and postural requirements. It may also lead to clinical, anatomical disorders and back pain which may affect the operator's health. Many of their household chores are performed by the women and some can be very physically challenging and time consuming. So in several ways in which we can improve their lifestyle, and one aspect that we can improve on is the way they wash their dishes. Currently the chore of washing dishes is performed by the women, and can be very labor intensive as it is done for up to several hours each week. The same can be experienced in marriage ceremony with caterers. Then it could be the biggest manufacturing industry, Pharmaceutical industry, Hospitality field and even Household or Kitchen automation. Washing dishes is not the most rewarding task. Cooking can be creative, but cleaning up afterward seems like a waste of time and leaves the person washing complaining about dishpan hands. The requirement of water and energy were especially high when persons usually washing up under running tap water changed their behaviour and washed up the dishes in a sink filled with water as shown in fig 1.1 The dishwasher has made cleaning and drying dishes much easier and more efficient.



Fig 1.1 Manual dish washing

II. PROPOSED SEMI-AUTOMATIC DISH WASHING MACHINE

Semi automatic dish washer consist of motor with centrifugal pump in which water is flow through PVC pipes which is connected to rotary jets which is in upper side and downward side. Pump is help to rotate the jet .These jet are sprinkling the water with required pressure on the plates and utensils. Regulator is provided in the machine which controls the operation of machine. Water consumption of this machine is depends on customer .Time, water and energy consumption are very less in the machine. Mostly

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Motor is used to convert electrical energy to Mechanical energy .When electrical energy convert to mechanical energy, water suck by centrifugal pump and it passes through pipe to rotary jet which is parallel connected. Rotary jet throw the water into plates and utensils at some pressure for cleaning purpose. Semi-automatic dishwasher combines water and detergent into very effective cocktail then sprays it against the dishes. The dishwasher then pumps out the water containing food particles that have been removed from the dishes, and rinses the dishes with clean water and a rinse agent. After pumping out the rinse water, leave the dish for drying

Fig 1.2 shows sketch of machine which explain internal part of proposed system

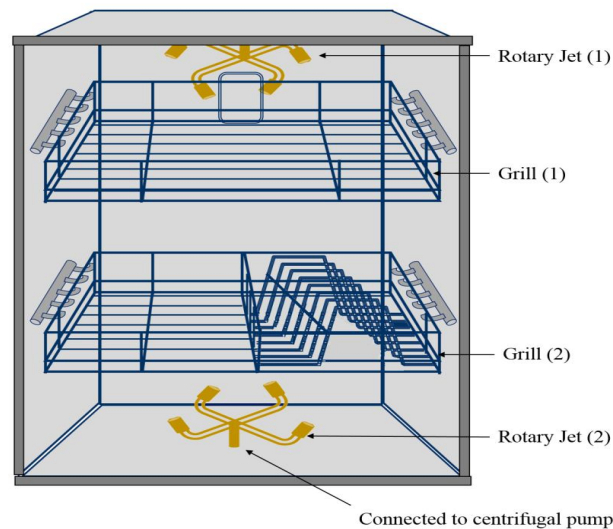


Fig 1.2 Sketch of Proposed system

III. DETAIL OF SEMIAUTOMATIC DISH WASHING MACHINE

The following are the components of Semi-automatic machine.

A. Rotary jet

Rotary high pressure water jet for cleaning surfaces which is equipped with four arms and It is available in either 180 mm or 200 mm) jet path diameters. Application in various types of surface cleaning. For example, cleaning floors, walls, transport tapes, painting grids, airport runways, etc...Multi jet system is used in our semi-automatic dish washer. One is top side and another is at the bottom. When motor and pump suck the water, it will passing through the pipe to both rotary jets. These jets are used to sprinkle the water at pressure, **25 to 30 psi** (Pound/Square inch) that means **1.72 to 2.06 bar** (from reference) to remove oil, dust and rusting from the plates and utensils. There are holes are provided on the arm ,which are too small to put anything in to clean them out. It is easy to maintain.

B. Motor with Centrifugal pump

In semi-automatic dish washer, electric motor coupled with centrifugal pump shown in Fig 1.3., Centrifugal pumps are dynamic pumps which move fluids through a system using one or more impellers. They are the most common type of pump because of the simplicity and effectiveness of their design and operation. Because they are the most familiar, they also tend to cost less than other types of pumps. Compared to positive displacement pumps, they provide higher flow rates and lower pressures. When the impeller is made to rotate, it makes the fluid surrounding it also rotate. This imparts centrifugal force to the water particles, and water moves radially out. Since the rotational mechanical energy is transferred to the fluid, at the discharge side of the impeller, both the pressure and kinetic energy of the water will rise.

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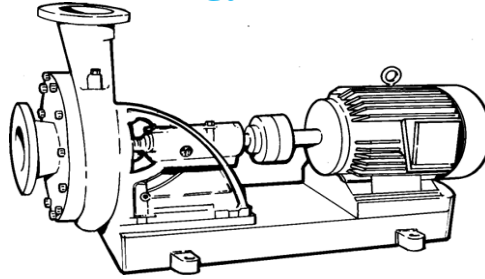
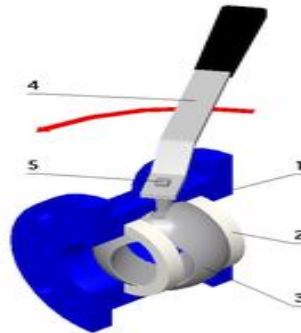


Fig.1.3 Electric motor coupled with centrifugal pump

C. Ball Valve

A ball valve fig 1.4 is a device with a spherical closure unit that provides on/off control of flow. In semi-automatic dish washing machine ball valve is used for convey detergent (liquid form) through the pipe into jet which spread into utensils. In a ball valve, the sphere has a port, also known as a bore, through the center. When the valve is positioned such that the bore is aligned in the same direction as the pipeline, it is in open position and fluid can flow through it. When rotated 90 degrees, the bore becomes perpendicular to the flow path, meaning the valve is closed and the fluid cannot pass through. The ball valve, along with butterfly and plug valves, is part of the quarter-turn valve family.



1.Body 2.Head 3.Ball 4.Lever Handle 5.Stem

Fig.1.4 Detail of Ball Valve

D. Utensil Grills

Utensil Grills used in semi-automatic dish washer is to carry the number of plates, Bowls, cup, spoons and other utensil for washing purpose. It consist of SS (Stainless steel) It is easily available and low cost.. For larger and heavier items such as plates, serving platters, saucepans, bowls, etc, upper grill used. Glasses, cups and small items such as saucers can also be placed in the lower basket. Do not place thin, delicate glassware in the lower basket. Place very large plates in the centre of the lower basket. When tilted, plates up to 35 cm in diameter can be accommodated. Multi Comfort zone The rear section of the lower basket is used for washing cups, glasses, plates and pots. Hinged spikes The spikes at the front are used for washing plates, soup bowls, platters, dessert bowls, and saucers. The spikes can be lowered to make more room for large items, e.g. pots, pans and dishes.

E. Galvanise Iron (GI)

This iron or steel is steel that has been coated with zinc oxide in order to prevent rusting / corrosion. These iron is used for making inner and outer body of dishwasher. Normally stainless steel is used for making body of automatic dish washer, but they have required three coating to prevent corrosion and rusting which is costly .But GI is less costly than metal steel. Sometimes the galvanizing process is referred to as hot dip galvanizing. The zinc forms a barrier against corrosion in that the steel underneath does not come into contact with water / moisture in the air.

IV. DESIGN CALCULATION

In semi-automatic dish washing machine, the centrifugal pump along with motor is used to regulate the water. The jet is used to increased the pressure of water. Then the water is sprinkled on the dishes and utensils. The design calculations of two basic machine

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components; (i) motor power (ii) Rotary jet

A. Design For Motor

0.5 HP Motor [15] is used for this machine because 2 bar pressure required to rotate and flow high speed water and minimum requirement of pump is 2 bar.

$$\text{Motor Power} = \frac{1}{2} \text{ HP} = 0.5 \text{ HP}$$

$$\text{Power} = 0.5 \times 746 \text{ kw}$$

$$= 0.373 \text{ kw}$$

B. Design Calculation Of Jet

There is the condition as the vertical plate is considered for calculating the force exerted by the jet on the dishes and utensils.

1) *Force exerted by the jet on a stationary vertical plate:* The jet after striking the plate, will move along the plate, as the plate is at right angles to the jet, the jet will be deflected through 90°. Hence the component of the velocity of jet, in the direction of jet, after striking will be zero, as shown in the fig 1.5

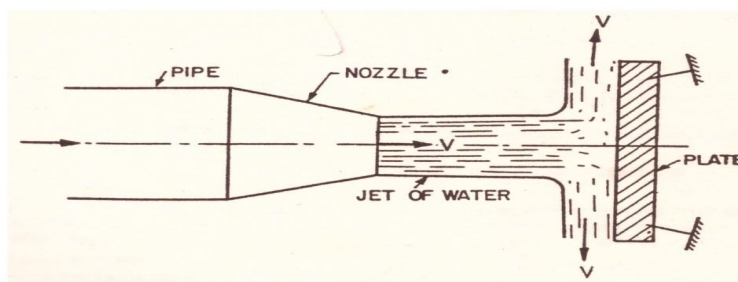


Fig.1.5 Force exerted by the jet on a stationary vertical plate

Consider,

V = Velocity of the jet,

D = diameter of the jet,

A = area of cross-section of the jet

$$= \frac{\pi}{4} d^2$$

We know,

$$\text{mass/sec} = \rho \times A \times V$$

$$= \rho \times A \times V (V-0)$$

$$F_x = \rho A V^2$$

The value of density (ρ) of water = 1000 kg/m³

We have,

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d = diameter of jet = 200 mm

$$= 0.02\text{m}$$

a) Area of jet,

$$A = \pi/4 d^2$$

$$= \pi/4 (0.02)$$

$$\mathbf{A = 3.14 \times 10^{-4} \text{ m}^2}$$

b) Flow rate

$$Q=30 \text{ lit/min}$$

$$= 5 \times 10^{-5} \text{ m}^3/\text{s}$$

Since there are four jets, the flow rate is divided by 4

$$\mathbf{Q1=Q2=Q3=Q4= 1.25 \times 10^{-5} \text{ m}^3/\text{s}}$$

c) Velocity of jet

$$Q=A \times V$$

$$1.25 \times 10^{-5} = 3.14 \times 10^{-4} \times V$$

$$\mathbf{V=0.0398 \text{ m/s}}$$

d) Force exerted by jet

$$F_x = \rho a V^2$$

$$= 1000 \times 3.14 \times 10^{-4} \times 0.0398^2$$

$$\mathbf{F_x = 4.9738 \times 10^{-4} \text{ N}}$$

We know that,

e) Pressure required through jet

$$\text{Pressure (P)} = F/A$$

$$= 4.9738 \times 10^{-4} / 3.14 \times 10^{-4}$$

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P = 1.5840 N/m² or bar

V. EXPERIMENTATION AND RESULT

The test were carried out in order to determine the performance of the machine. This was done by comparing the rate of washing with the designed dish washer to the hand-washing (manually). And also comparing Automatic & Semi-automatic Dish washer These are shown in Table No. 1.1 Table No.1.2 and Table No.1.3 below.

A. Comparision between manual dishwashing and semi-automatic dishwasher

From the analysis and comparison between Manual dish washing, and Semi-automatic dishwasher as shown in Table 1.1 and 1.2.

S/N	No of Plate	Quantity of Detergent used (ml)	Quantity of water used in washing (liters)	Quantity of Water used in Rinsing (liters)	Time used in Washing (sec)	Time used in Rinsing (sec)
1	1	1	0.2	0.5	5	3
2	4	1.5	0.5	1	10	4
3	10	4	1	3	30	15
4	24	7	1.5	4	70	35

Table1.1 Evaluation of Semi- Automatic dishwasher

S/N	No of Plates	Quantity of Detergent used (ml)	Quantity of water used in washing (liters)	Quantity of Water used in Rinsing (liters)	Time used in Washing(sec)	Time used in Rinsing (sec)
1	1	1	0.5	1	15	5
2	4	1.5	1	2	40	10
3	10	4	2	4	60	20
4	24	10	3	6	150	60

Table 1.2 Performance of Hand washing

B. Comparison between automatic dishwashing and semi-automatic dishwasher

From the analysis and comparison between Automatic dishwasher and Semi-automatic dishwasher as shown in Table 1.3

	Automatic Dish Washer	Semi-automatic Dish Washer
Material	Stainless steel is used, having three coating for resisting corrosion. It increased cost	Galvanized iron is used having zinc coated for resisting corrosion. It is less costly than SS and easily available
Electronic Circuit and controller Board	Electronic circuit and controller board are used to control and perform all operation sequently.Its total cost is rs.20,000 approximately	These circuit and board are not used in this machine. All operation are performed manually which saved time, water and money.
Motor and Gear	Mostly two motor and Gear used for rotation of jet which running cost is high ,high energy consumption and make design complicated.	Only one motor with centrifugal pump used for rotation of jet which is less costly, less energy consumption and design become simple.
Time Consuming	Fixed cycle(60min) because of electronic circuit and board, which is time consuming.	No electronic circuit and board used ,so cycle can be fixed as per customer requirement.
Water Consuming	It consume 23 to 25 lit.water	It consume maximum 10 lit water

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Cost	Cost of Automatic Dish washer is Rs.38000 to Rs.40000 (IFB,Electrolux,LG etc)	Cost of Semi-automatic dish washer is Rs. 15000 to 20000
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Table 1.3 Comparison between Automatic dishwasher and Semi-automatic dishwasher

VI. RESULT

From all the experimentation and comparisons, it is clear that Semi-automatic dish and utensil washer is better than Manual dish washing and Automatic dish washer. It is less time, water and energy consumption. It is less costly than existing dish washer. And it is affordable by every class.

VII. CONCLUSIONS

From the study and comparison of automatic and semi-automatic dish washing machine, it is clear that function of both machine are same like washing dishes,utensils,cups,glasses,spoons etc. But their construction and working are different. Following are the conclusion of semi-automatic dish washer.

- A. The performance of the machine is better than Automatic dish washer and manually dish washing.
- B. Capacity of machine to wash 24 plates per minute.
- C. Low maintenance and easy to operate.
- D. Design is simple and very efficient.
- E. Less time and water consuming machine.
- F. Cost is less than automatic dish washer.
- G. Every components of this machine is easily available in market.
- H. Semi-automatic dish and utensil washing machine can be purchased by every type of customer

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