

ALTERNATE DESIGN SOLUTIONS OF DISHWASHING MACHINE FOR DOMESTIC PURPOSE

Kshirsagar P.R¹, Solkar R.I², Nikam M.P³, Hodekar A.M⁴, Shinde B.G⁵

Assistant Professor¹, B.E Mechanical^{2,3,4,5}, Department of Mechanical Engineering, RMCET, Ambav (Devrukh), Ratnagiri Maharashtra, (India)

ABSTRACT

This paper discusses how to reduce human efforts and save water. Also to save energy if user runs a partial load by separating assembly in three parts for washing of dishes, rinsing of dishes and rinsing of glasses. Large amount of work can be done in considerably lesser time. In conventional dish washing process large amount of human power as well as quantity of water is used. So keeping that in mind to reduce this, semi-automatic dish washer is developed. This dishwasher is useful for domestic use, which can save time, cost and human efforts.

Keywords- Motor, Rotary brush, Drain pipe, Spray arm, Rack

I. INTRODUCTION

A dishwasher is a mechanical device for cleaning dishware and cutlery. Unlike manual dishwashing, which relies largely on physical scrubbing to remove soiling, the mechanical dishwasher cleans by spraying hot water, typically between 45 and 75 °C (110 and 170 °F), at the dishes, with lower temperatures used for delicate items. A mix of water and detergent is pumped to one or more rotating spray arms, which blast the dishes with the cleaning mixture. Once the wash is finished, the water is drained, more hot water is pumped in and a rinse cycle begins. After the rinse cycle finishes and the water is drained, the dishes are dried using one of several drying methods. Typically, a rinse aid is used to eliminate water spots for streak-free dishes and glassware resulting from hard water or other reasons. In addition to domestic units, industrial dishwashers are available for use in commercial establishments such as hotels and restaurants, where a large number of dishes must be cleaned. Washing is conducted with temperatures of 65–71 °C (149–160 °F) and sanitation is achieved by either the use of a booster heater that will provide a 82 °C (180 °F) "final rinse" temperature or through the use of a chemical sanitizer.[01]

The first patent for a dish washing machine was taken in 1850 by Joel Houghton. It was a wooden machine with a hand-turned wheel which splashed water on dishes. It was not very good at washing dishes. Ms. Josephine Cochran invented a practical dishwasher in 1886 but it was not a commercial success. In India most of the women wash the dishes with their hand scrubbing on it which is giving strain to the muscles. Therefore purpose of this research is to reduce human efforts in dish washing. Currently the chores of washing the dishes is being performed by the women which results in the labour work as it is carried out for up to several hours each week. So by developing

semiautomatic dish washing machine we can overcome the above mentioned problems significantly. Also by using plastic material for casingpart , the overall weight of the assembly also reduced. [02]

II. NEED

As we all know that plate washing is adaily activity across the globe which involves a lot of energy to accomplish manually or mechanically. Keeping this point in mind we need to design and fabricate a dish washing machine i.e. efficient and easy to operate. Also it is needed to reduce the cost and energy consumptions, so that this dish washing machine can easily affordable to common people.

In India dishwashing was traditionally done by house maids but in modern India, getting housemaids is becoming more and more difficult as the days go by. So to answer the question 'how good is a dishwasher in India?' or 'how effective is dishwasher in India?', we have to say a dishwasher has now become a necessity rather than a luxury for the vast majority of professionals in India. A dishwasher for Indian cooking is very helpful because of the large number of cooking pots and pans used in our Indian type of cooking and also the many dishes used for eating the many varieties of curries and chutneys. Dishwashers have been very successful in India with sales of dishwashers in India growing exponentiallyover the last several years.

III. OBJECTVES

1. To study the quantity of water and detergent required depending upon the dishes loaded.
2. To study Performance of the dishwashing parameters using manual dishwashing, semiautomatic, automatic dishwashing machine data.

IV. LITERATURE REVIEW

In order to carry out this work we have undergone through extensive literature survey and contribution by various authors is as follows,

1. Prof. Mark J. Jackson, et al. 25th November, 2009.in this research paper author mentioned comparison between dishwasher faucets and automatic dishwashing machine made by washing same amount of dishes as standard load for dishwashers. Amount of water spend by dishwasher was measured by flow meter.
2. Odesola, I. F &AfolabiOlusegum Adigun,Vol.1 (1) January-March, 2012,In this research paper author explained that mechanical dishwasher cleans the dirt & removes soiling by spraying hot water, typically between 55 – 75°C at the dishes. A mix of water and detergent is used for cleaning purpose, followed by clean water to remove detergent residue.
3. Prof. Dr. Rainer Stamminger, Natalie Anna Fuss, et al.17th May, 2011. In this research paper author compares manual dish wash&semi-automatic dishwasher. Main parameter is water, energy and soap. Study of three type of dish wash in different country and compare.

4. International Journal of Engineering Research and General science Volume 3, Issue 3, May-June, 2015. This journal explain the design will consist of one rectangle plastic casing and this is divided in three compartment. To rotate all this brushes there will be single motor shaft which will be mounted with 4 pulley for belt drive.
5. Sagar P. Jamonde and Sachin T. Badge, Issue :2182-184 IJRITCC February 2015. In this paper author have done case study on Utensils washer machine has adjustable two racks containing utensils tend to rotate. Racks are rotated by separate motor and placed with stationary single sprinkler. It uses hot water for cleaning.
6. Wokje Abrahamse, et.al. Journal of environmental psychology 25(2005) 273-291. In this paper author referred various journals and data basis and feedback was taken of various house wives and overcome the issues given by the house wives during feedback.

V. DESIGN CALCULATIONS

5.1 Power calculations and selection of motor:

Torque = Force \times Perpendicular distance

Where, Force = (load applied on the rack + mass of shaft) \times gravitational force

Let, The average load applied on the rack will be 10kg, the mass of the rack be 1.5kg and ,the mass of shaft be 1kg

We get, Force = (10+1.5+1) \times 9.81 = 122.65 N

Also, Perpendicular distance = 60 cm = 0.6 m , \therefore Torque = 122.625 \times 0.6 = 73.575 Nm

Now, Power = $2\pi N T / 60000$

Where, N – Speed in rpm – 15 rpm (Assume)

T = Torque in Nm = 73.575 Nm , \therefore Power = (2 \times 3.14 \times 100 \times 73.575) / 60000 = 0.770085 kW

5.2 Dimensions of Dishwashing machine:

The entire body of the dishwasher that is outer surface was made of metal sheet which is of dimension Length=90cm; breath=60cm; width=70cm, dishwasher (metal sheet):

Length=90cm; breath=60cm; width=70cm

The volume of dishwasher = (90 \times 60 \times 70) cm³ = 378000 cm³

5.3 Dimension of Washing Basin

This is the section where plates are washed and has the following dimensions

Length=70cm; breath=60cm; height=90cm, Volume = (70 \times 60 \times 90) cm³ = 378000 cm³ = 378 lit.

VI. CAD SETUP

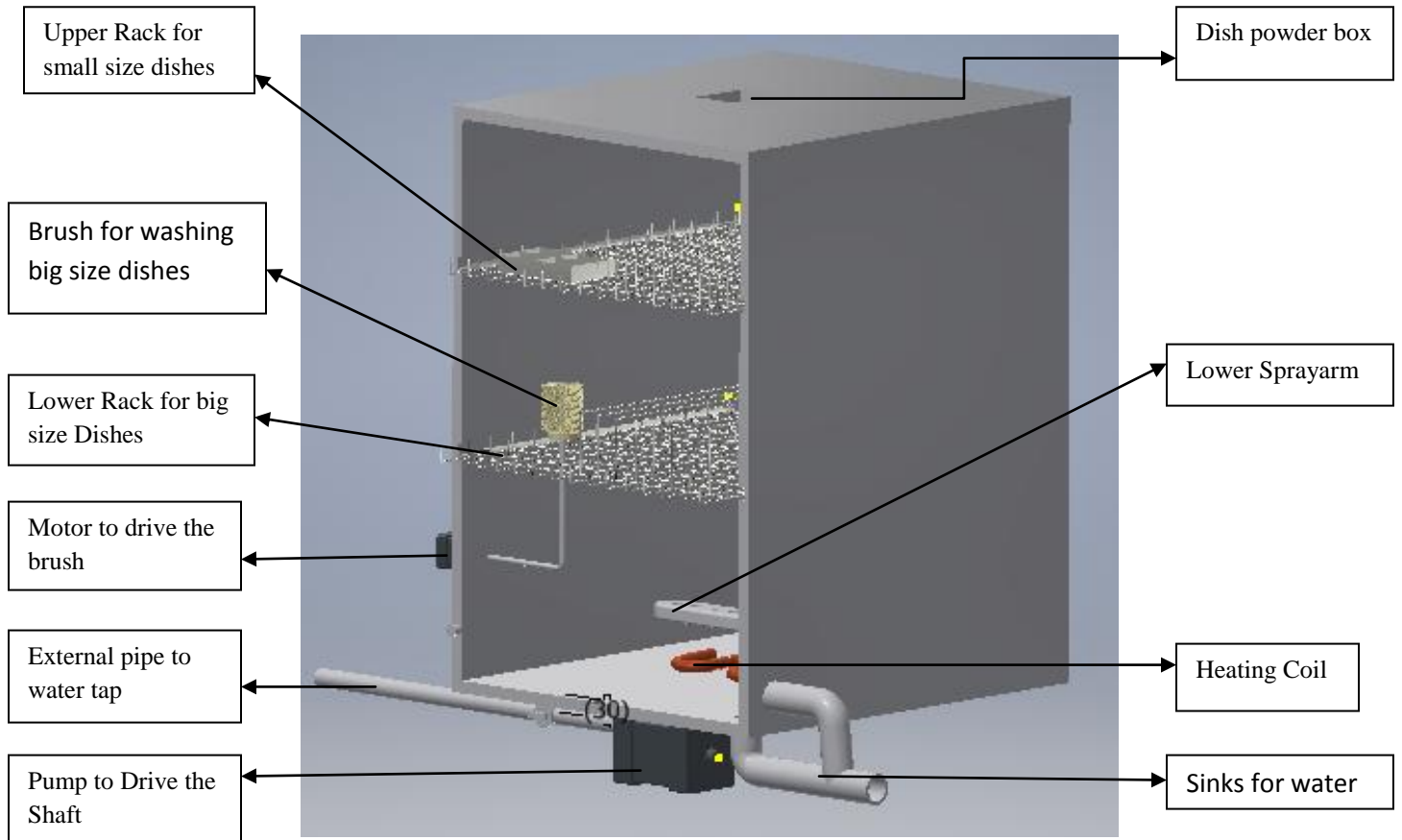


Fig.1 Details of Dishwashing Machine

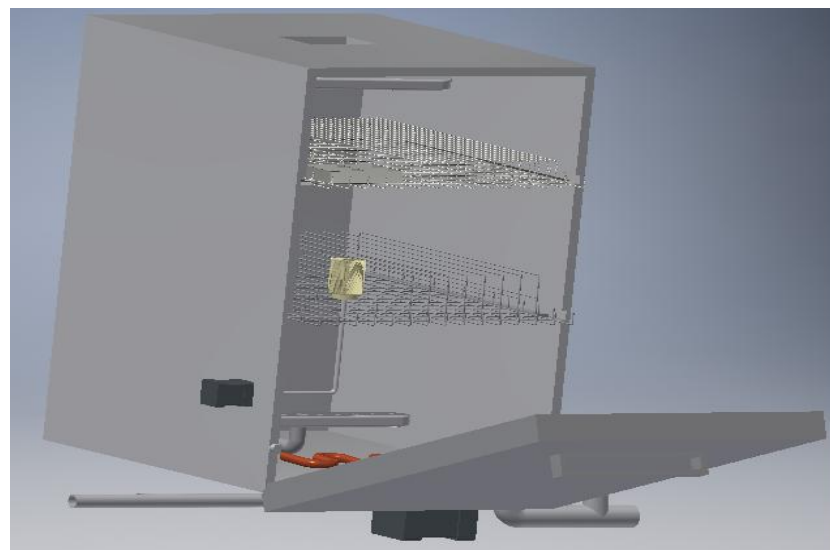


Fig.2 Side view of Dishwashing Machine

In this study we found some problem regarding spray of water, size of plate and power consumption. So as per our further study we have suggested alternate design new model for better efficiency.

Design calculations are as follows-

VII. NEW DESIGN CALCULATIONS

7.1 Selection of Motor

We know,

$$\text{Power} = \frac{2\pi NT}{60000}$$

Where,

P = Power in kw, N = speed in rpm, T = Torque in N.m

We have,

Torque = Force \times perpendicular distance

Where, Force = (Load applied on the rack + mass of shaft) \times gravitational force

Let, The average load applied on the rack will be 10 kg , the mass of the rack will be 4 kg, the mass of shaft be 1 kg.

We get, Force = (10 + 4 + 1) \times 9.81 = 147.15 N , Perpendicular distance = 20 cm = 0.2 m

\therefore Torque = 147.15 \times 0.2 = 29.48 N.m

$$\text{Now, Power} = \frac{2\pi Nt}{60000}$$

$$P = \frac{2 \times 3.14 \times 20 \times 29.48}{60000} = 0.0771 \text{ kw} = 0.10 \text{ HP}$$

Therefore , select standard motor as 0.5 HP.

7.2 Calculations of V-Belt

As we calculated, Power = 0.5 HP = 0.373 kw

Select standard cross section A, we get-Usual Load of drive = 0.75-5 kw. [08]

Recommended min. pulley pitch diameter = 75 mm, top width (w) = 13 mm, Nominal thickness (T) = 8 mm.

Weight per meter = 0.106 kgf.

Let,

Speed ratio $i=2$

$$i = \frac{D}{d}$$

$$D = i \times d = 2 \times 75 = 150 \text{ mm.}$$

$$\text{Also, } C_{\min} = 0.55 (D + d) + T \quad [08]$$

$$= 0.55 (150 + 75) + 8 = 131.75 \approx 135 \text{ mm}$$

$$C_{\max} = 2 (D + d) = 2 (150 + 75) = 450 \text{ mm}$$

Now ,

$$\frac{c}{D} = 1.2$$

$$\frac{c}{150} = 1.2 \therefore c = 180$$

Length of belt is given by-

$$L = 2C + \frac{\pi}{2}(D + d) + \frac{(D-d)^2}{4c}$$

$$= 2 \times 180 + \frac{\pi}{2}(150 + 75) + \frac{(150-75)^2}{4 \times 180} = 721.24$$

From, Select standard length of belt for cross section A , C = 1001 mm.

Selection of motor –

Type = 3Ø induction 0.5 Hp, 0.5 Hp= 0.373 kw, Speed = 1440 rpm .

7.3 Calculation of Gear Box

For standard 0.5 Hp motor , we can take N = 1440 rpm

As we take i= 2,

∴ N = 720 rpm ,Here , Assume i= 3.16

We know ,

$$i = \frac{N_p}{N_g}$$

$$3.16 = \frac{720}{N_g}$$

$$N_g = 227.85 \approx 230 \text{ rpm}$$

Twisting moment (Mt) is given by –

$$Mt = 97420 \times \frac{kw}{N}$$

$$Mt = 97420 \times \frac{0.373}{720}$$

$$Mt = 50.06 \text{ Kgf.cm}$$

$$= 5.006 \text{ N.m}$$

Design twisting moment [Mt] is given by –

$$[Mt] = Mt \times 1.5$$

$$= 5.006 \times 1.5$$

$$= 7.509 \text{ N.m}$$

Select material of steel .

We have ,

$$\text{Module (m)} = 1.26 \sqrt[3]{\frac{[Mt]}{y[\sigma_b] \phi z}}$$

For steel material ,

[] = 140 N/mm

Y= 0.383

No of teeth on pinion (z) =19

$\phi = 8$

$\therefore m = 1.26 \sqrt[3]{\frac{7.509 \times 10^3}{0.383 \times 140 \times 8 \times 19}} = 1.26$

Select standard module , m= 1.5 .

Also ,

$i = \frac{z_g}{z_p}$

$3.16 = \frac{z_g}{19}$

$Z_g = 60.05 \approx 62$

$\therefore D_p = m Z_p = 1.5 \times 19 = 28.5 \approx 30 \text{ mm}$, $D_g = m Z_g = 1.5 \times 62 = 93 \text{ mm}$

$\phi = \frac{b}{m}$, $8 = \frac{b}{1.5} \therefore b = 12$

VIII. MODIFIED CAD SETUP

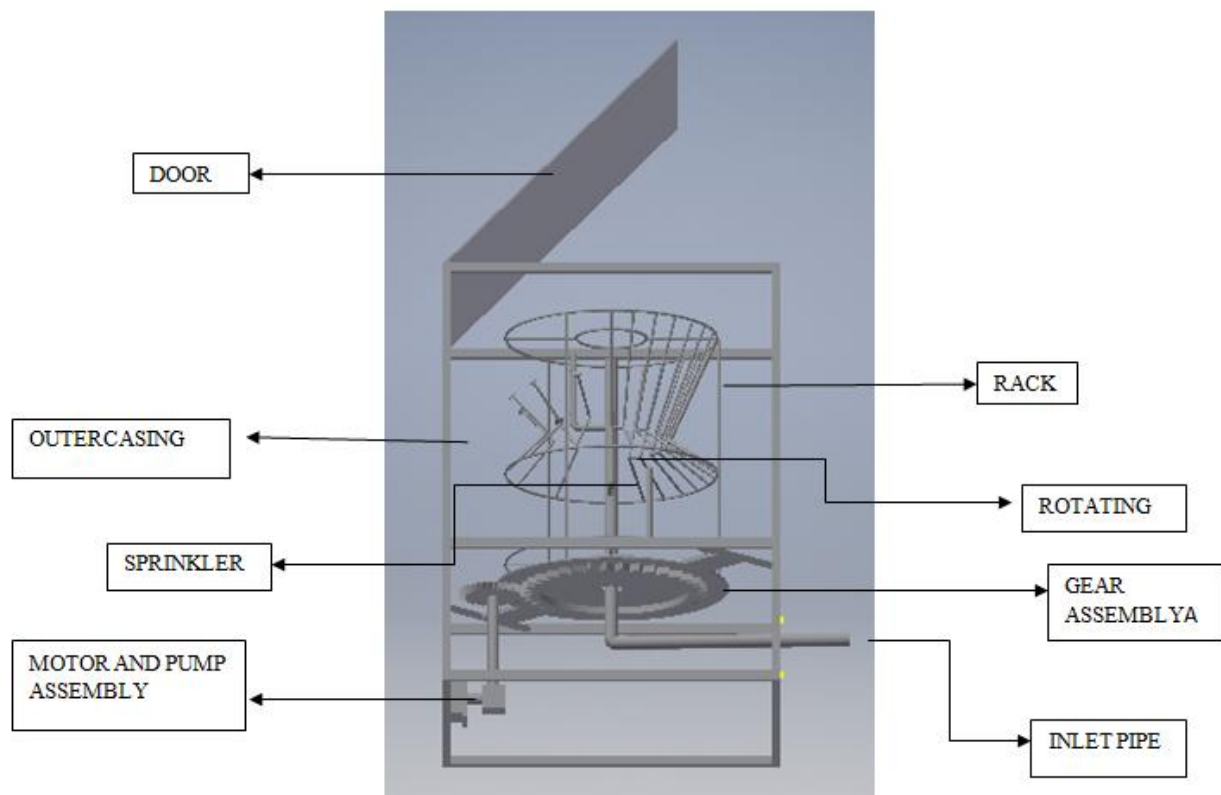


Fig.3 Alternate New Solution of Dish Washing Machine

IX. EXPECTED RESULTS AND DISCUSSION

By considering the parameters such as No of plates washed, Quantity of water used in washing, Quantity of detergents used, Time of washing, Quantity of water used in rinsing, Time of rinsing, the results will be compared with the existing Dishwashers which are available in market. On the basis of this comparison the results are expected.

X. ACKNOWLEDGE

Authors of this paper are thankful to Head of department, Prof.S.R.Bhandari ,PrincipalDr.M.M.Bhagwat for constant support and motivation.We thank deeply to invaluable guidance rendered to us all occasion by all others to directly or indirectly contribute to our humble performance

REFERENCES

- [1] Sagor P. Jamode and Sachin T. Bagde"Design and Development of Utensils Washer"International Journal on Recent and Innovation Trends in Computing and CommunicationISSN:2321-8169Volume:3 Issue: 2 182–184 IJRITCC|February 2015.
- [2] WorkjeAbrahamse, et.all“Review of intervention studies aimed at household energy conservation”. Journal of environmental psychology. 25(2005)273-291
- [3] Odesola, I. F &AfolabiOlusegum Adigun, “Design, Fabrication & Performance Evaluation of a Domestic Dish Washing Machine.” AFFREV STECH, An International Journal of Science and Technology Bahir Dar, Ethiopia, Vol.1 (1) January-March, 2012: 164-173 ISSN: 2225-8612.
- [4] Prof. Mark J. Jackson, et al. “Comparison of Consumption between the Dishmaster Faucet and Automatic Dishwashing Machines”.TAP091125_MET_10930, 25th November, 2009.
- [5] Prof. Dr. Rainer Stamminger, Natalie Anna Fuss, et al. Thesis on “Determination andVerification of Possible Resource Savings in Manual Dishwashing.”17th May, 2011.
- [6] V.B.Bhandari-“Design Of Machine Element” ISBN-13:978-0-07-068179-8 (2011), Tata McGraw Hill publication
- [7] KalaikhathirAchchagam–“Data Book of Engineers” (2007), PSG College of Technology, Coimbatore, India pp. 4.1-4.38; 7.71-7.78.