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DESIGN OF WASHING MACHINE FOR CLEANING OF SMALL COMPONENTS

Tandale P, Shivpuje S, Ladkat S
pramodtandale11@gmail.com

Abstract— This paper provides a simple portable wash machine designed for cleaning of small components. This paper describes a cleaning problem, developing a cleaning process, integrating the process to production needs, selecting and sizing appropriate cleaning equipment. This report stands with a sole purpose to develop a small, efficient energy and time saving wash machine to counterpart the assembly process at TRM assembly department of KPCL to replace the existing heavy, large and inefficient for small sized components Washing Machine. Along with this the project promotes Reuse and Recycle policy of the company as all the components comprising the new design have been used from Scarp Field and throw away company material. The manufactured wash machine and its components were reverse engineered and analysis was carried out with help of CREO 1.0 and Hypermesh. The design based method reduces instability and is cost effective.

Index Terms— Availability, Cleaning, Design, Effective, Machine, Reuse, Simple, Turbulence.

I. INTRODUCTION

The Industrial Cleaning today is a complex undertaking. Each cleaning problem is unique from other because of many variables in a manufacturing process. Integrating the cleaning process with production and plant requirements through a proper equipment sizing and selection is very important.

Here, at TRM Assembly shop the wash machine is used to clean the components for grease, wax, flux, scale, chips, fines, shop dirt, oil contaminants before carrying out the assembly of GearBox. The project was a need to overcome the limitations of current Cabinet type washing machine like high cycle time, higher operating cost, uneconomical for small surfaces and notches and high maintenance cost.

The paper presents the design of washing principle to overcome the stated limitations and to take along the given constraints.

II. GIVEN DATA AND CONSTRAINTS

We were provided with the maximum size of components to be cleaned and its weight.
Maximum size: 40in x 40in x 60in.
Maximum weight: 150 kg.
Maximum cycle time: 40 minutes.
Availabilities –
Maximum Air pressure available: 6 bar.
Electric Supply: 1 phase 240 volts.
Required materials were to be used from Scrap Waste.
Deliverables:
A small wash machine for cleaning small component with least possible energy and time cycle.

III. METHODOLGY

Present work aims at the analytical design of main parts of Washing Principle and Wash Machine. As support to Reuse and Recycle policy all the components have been selected from the used waste scrapped products from KPCL.
Project methodology includes:

1. Deciding Wash Principle.
2. Design of main parts such as Tank, Base Stand, Support for Work piece, Air Nozzles etc.
3. Analysis of Designed Component and Optimization.
4. Design heaters and deciding their capacity to heat.
5. Design of Electric Circuit and Control Panel.
6. Availability of the required components in the Factory Scrap Departments.
7. Manipulating the design according to availability of the materials without compromising the efficiency.
8. Manufacturing of the entire machine Components.
9. Assembly.
10. Testing.

IV. WASHING PRINCIPLE

The requirements were to produce a washing idea which is very simple in application with less resources to input and fit for the purpose. For the purpose to achieve we studied the available washing machines in market and the one present on the site. Present washing machines studied were Single Stage Machine (Cabinet Washing Machine), Multistage Machine, Tunnel Cleaning Machine, Basket Rotating Machine, Customized Cleaning Machine Most of machine were comprising of pumps for high pressure pumping of water on the components, motors for automatic rotation of components, heaters and chemical caustic additives to enhance the water quality in order for effective and qualitative cleansing properties. Air compressor for dry cleaning and drying of the washed part. After studying these requirements we had to use them in our design. So we decided to make use of immersion type of washing machine which will save water as same water can be used for many number of cycles. To create turbulence in the washing area of the immersed part of the component we used air nozzles for blowing air of enough pressure to create the required turbulence enough to clean notches and critical areas. To enhance the washing water we decide to use the heating coils which are placed at the bottom of the tank. These coils are also been used from the oil heaters which had been there in the scrap. The chemical is also to be added in the water. To provide the high-pressure water for surface cleaning a pump is provide for the purpose with flexible hose to direct the flow. The temperature and pressure sensors are installed for better indication. The whole assembly with tank, heaters, and pump is mounted on the stand which is placed on the wheels to make it portable.

V. PROPOSED MODEL

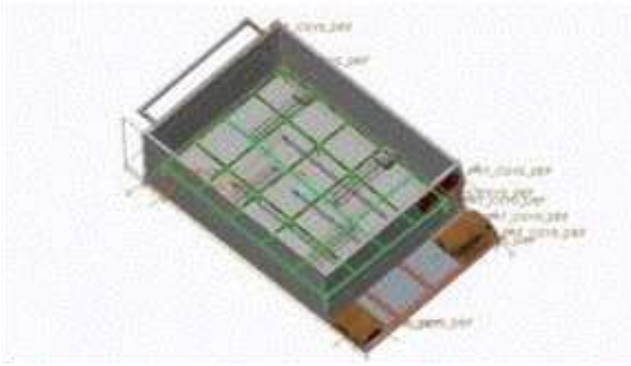

Figure 1 : A modeled assembly of the proposed design with help of Creo.

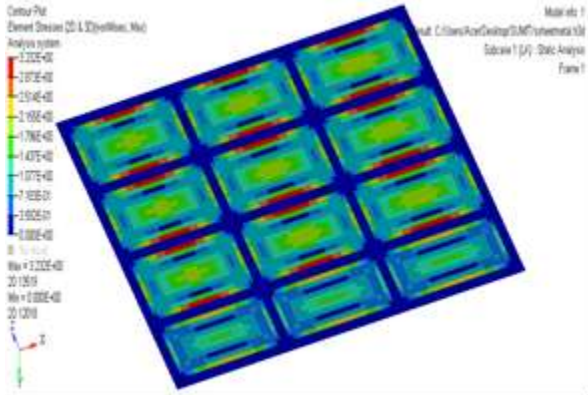

Figure 2 : Analysis for the bottom plate of the tank with the help of Hypermesh 11.0

VI. DESIGN AND ANALYSIS

A. Design of Bottom Plate

Bottom plate is assumed to be simply supported rectangular plate under uniform pressure.

Bottom plate is provided with stiffeners at span of 241.3mm and 381mm

B1=381mm , A1=241.3 mm

B1/A1 =381/241.3 =1.5789

As per table 6, page 118 TPS (Theory of Plates)

Mx= β q1 A12

My= β q2 A12

Mx = bending moment about X axis

My = bending moment about Y axis

q= (hydrostatic pressure + unit weight of plate)

Hydrostatic pressure

= γ A x γ = specific wt. density

γ = 9.81 for water

= 9.81 x (1.2192 x 0.9144) x 0.9144

= 10.003 kN

Hydrostatic force = 10.003/ (9.81) x (0.9144 x 1.2192)

= 0.9144 kg/m2

Pressure due to column of metal

= (0.1 + 0.00009177)

=0.10009177 kg/cm2

Mx = 0.055 x 0.1000917 x 24.132 = 3.2053 kg.cm

My= 0.043 x 0.10009177 x 24.132 = 2.873 kg.cm

Resulting Bending moment

Mx = √(Mx2 +My2) = 4.3043 kg.cm

Maximum allowable stress = 153 MPa ……(given data)

= 1560.16 kg/cm2

Minimum thickness of plate

1560.16 x (1 x t2) / 6 = 4.3045 f.s = 6

t = 0.1286 cm

= 1.28 mm

With corrosion allowance of 2mm

t = 1.28 + 2

= 3.28 mm

Thus the thickness of tank should be 4 mm.

Availability

4 mm thick sheet metal was not available in scrap field so it was decided to use an empty oil barrel. The empty oil barrel was cut off from the middle and the edges were grounded.

The holes were made on it as required for accommodating Heating coils, Temperature sensors, compressor pipe

B. Support Stand

Support stand was designed to support the work piece to be cleaned. It was manufactured from the steel bars available in the scrap field. The dimensions were decided according to the availability of space in the selected barrel.

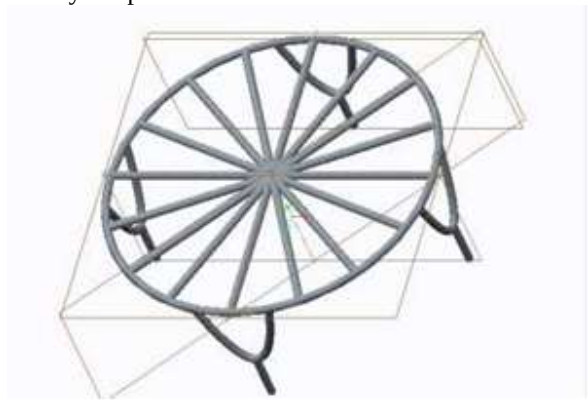

Figure 3 : Support stand designed with help of Creo and manufactured of Steel Bars

The above model was made and was reverse engineered in hypermesh software for its capacity to withstand the load of 150 kg.

C. Base stand

The whole assembly had to be put on a firm base so abase was to be designed. The base is supposed to take the load of tank, water in the tank, support stand placed in the tank, the weight of the component to be cleaned as well as motor assembly, piping system for drain and suction, compressor pipes, sensors, switch board heating coils etc. The base has to take about 1000 kg of load and is simply supported on 4 wheels to make it portable. A handle was also to be supported on the base. The proposed design was a steel mesh of L shaped cross section. It was modeled in creo and analyzed in hyper mesh.

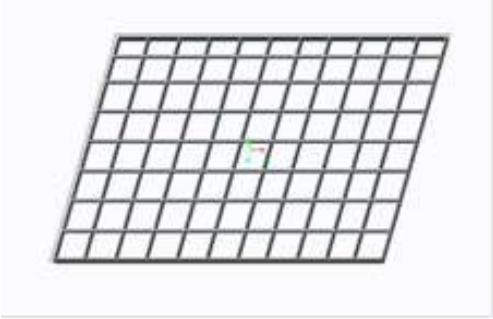

Figure 4 : Steel mesh made up of drainage sieves.

Availability

As the Needs of the base stand the available the available drainage sieves were decided to make use of.

Heating coil capacity selection
Known data:
• Mass of water (m)=110 kg
• Ambient temperature of water (t1)=25 0 C
• Required temperature of water after heating (t2)=60 0 C
• Assumption-specific heat of water (CP)=4.18 KJ/Kg.k
Calculation:
Required net heating capacity (Q) = mCp(t2 - t1)
= 110×4.18×(60-25)
= 16093 KJ
Let no. of heaters we use are 'n' and time of heating process is 't' min(t×60 sec)
Assume: capacity of each heater = 'x' KW
So, n × x × t × 60 = 16093
If we select time required to heating process = 60 min
So, n×x×60×60=16093
n×x=4.5
suppose we are using two heaters (n=2),
2×x=4.4
X=2.2 kW
Numbers of heaters we need to use are two, each with capacity of 2.2KW.

VII. ASSEMBLY

Assembling was done on the purpose to make the machine very handy and portable. Modeling was done of all the important parts in the assembly of the machine. With the help of creo software all the components were assembled as shown above. The drum was cut into halve and its edge was grounded. The two basestand supports were welded together to make up for the stand. The drum was then placed on the stand and was welded on it. Before the drum was being placed all the required holes on to the drums were made. The heating coils were put on the respective positions before the welding.

The wheels were welded on the base tank. The handle to push/pull was also welded on the base tank. The support was also fabricated from the steel bars. The assembly was now handed over the painting department, were it was painted with anti-corrosive paint and the oil paint to improve it aesthetically.

Next, electrical connections were made to connect pump and heating coil with the electric supply and sync with the control switches.

VIII. WORKING

Working Procedure of Small Component Washing Machine As Follows:

Cleaning: First tank is used for cleaning it includes component require to remove the contaminant from part surface. For best result we recommended to use solvent as an aqueous CW solution. High Efficiency and best safety heater are used for heating solution. Dial indicator type temperature is used to display the temperature which helps to control the solution temperature. Particles and contaminant are removed by means of solvent which added, air turbulence created by air nozzle. The hose help to cleaning the part by means of pressurized water. Finally, the small component part cleaning machine is switch off when complete by means of standard feature as per requirement.

Rust Prevention:

Drain out the solution when the given numbers of cycles are completed. When machine is in idle condition keep it dry without any solution, however it leads to corrosion of tank and other accessories too.

Outputs:
• Small Component Washmachine found to be cost effective.
• Trial taken and cleaned jobs found satisfactory. Fast cleaning is done & easy handling method which requires less power.
• Consumption of auto thinner reduced.
• Machine can be moved wherever it requires.
• Smaller in size helps to less floor space area.

Figure 6: Actual Machine (Running Condition)

Figure 7: Actual Machine (Stand Still Condition)

IX. COST ANALYSIS

1. Present washing machine calculations:
Preheating time =30 minutes
Cycle time = 10 minutes
Electrical units consumed =1 unit/45 second
Total unit consumed = 13-15 units
Total cost in Rs. =105.0

2. Small component cleaning machine:
Pre heating time= 45 min
Cycle time = 15 min
Per 30 min = 2 units
Total unit consumed = 4 units per cycle
Total cost in Rs. = 30

3. Total saving per cycle in Rs. = 105- 30
=75 Rs.

X. CONCLUSION

This project focused on modeling, design and control of Small component cleaning wash machine, with emphasis on lightweight, portable appliances. The machine was designed to meet the required limitations of the previous machine with a very cost effective manner. The machine developed suits the requirement thoroughly. The washing principle and the approach integrate with the current production rate. The machine was developed from the scrap materials to enhance reuse and recycle policy. This resulted in very much less production cost. And the design helped in constraining the manufacturing cost. Design based manufacturing was done. Wash machine gives very less maintenance and operating cost. About 75 rupees per cycle cost reduction was achieved. The machine is taken care of all the safety measures for operator and the job to be cleaned.

XI. ACKNOWLEDGEMENT

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