Industrial Heat Treated ComponentWashing Machine Design

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***Abstract*—In Industry, there is a high production of machining component. After the machining, the chips, grease, wax, scale, chip, shop dirt, oil is not removed from the component. Manually it is not possible to clean all heat treated components within time. The company is facing the problem of cleaning of their heat treated automobile components and existing washing machine performance is not satisfactory due to quenching oil is not removed fully, washed components are not dried completely. We are designing the Industrial washing machine as per the specification and requirement provided by the customer.**

***Index Terms*—Water Tank, Oil Extraction system, Heater Arrangement.**

1.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. The industrial washing machine is used to clean the components for grease, wax, scale, chips, shop dirt, oil contaminants.

Washing is carried out before product after completion of manufacturing. The project is in need to overcome the limitations of current Batch type washing machine like high cycle time, higher operating cost, uneconomical for small surfaces and notches and high maintenance cost.

Washing is the need for cleaning grease, wax, and chip from machining, casting, welding, and heat treatment operation. Washing carried out before any processing is known as pre-wash and washing after any process is posted wash.

1.2 Industrial Washing Machine

An Industrial washing machine is a device used to wash industrial components. The term is mostly applied to machines that use water as opposed to dry cleaning (which uses alternative cleaning fluids and is performed by a specialistbusinesses) or ultrasonic cleaners. Detergent is added to the wash water and is sold in either powdered or liquid form.

Batch Type Washing Machine

In Batch Type, Industrial Washing Machineis used to remove oil, chip, and other industrial contaminations/dirt. The workpiece is washed by pressurized liquid passing through nozzles and rinsed and dried respectively in wash cabin.
The liquid is sprayed to the workpiece which is placed in a basket or on the loading platform. The washing principle is fixed nozzle arms and fixes platform.

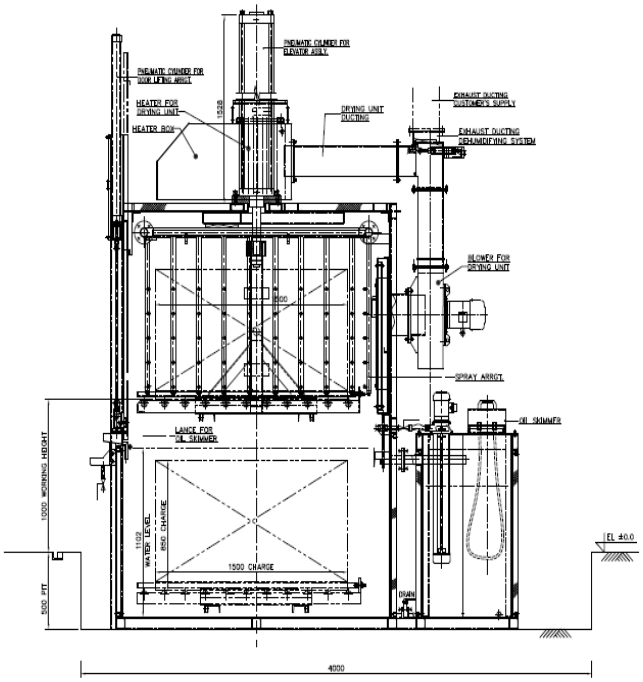


Fig.1Batch Type Washing Machine

2. NOMENCLATURE

L	*length of Tank*
W	*Width of Tank*
H	*Height of Water Level*
P	*Pressure*
G	*Specific Gravity of Liquid*
S	*Stress value of plate, psi*
t_a	*Actual plate thickness, in*
w	*load per unit of length lb/in*
I	*Moment of inertia*
x , y	*distance of the centroid*
Q	*Volumetric flow-rate*
A, a	*Area*
V	*Velocity of gas in m/s*
D	*Diameter*
s	*Allowable value for material*
E	*Weld joint efficiency factor*
W	*Weld joint strength reduction factor*
t_m	*Minimum Thickness*

3. LITERATURE SURVEY

Tandale P, Shivpuje S, Ladkat S, Simran K[1] 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 into production needs, selecting and sizing appropriate cleaning equipment.A sole purpose to develop a small, efficient energy and time-saving wash machine to counterpart the assembly process 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.

H. Mayer, H.L. Stark, S.Ambrose[2] Brief detailed of fatigue analysis to welds in pressure vessels, designers encounter practical difficulties with the methods required by national standards such as ASME Section VIII Div. 2. This paper discusses the main fatigue design stress parameters are stress intensity range and the principal stress range and evaluates these for their validity over the scope of fatigue conditions they are required to predict.

Song-In, Seung-Kee Koh[3] this paper introduce the structural integrity of a thick-walled pressure vessel containing residual stresses. Residual stress distribution due to autofrettage loading was calculated using an elastic-finite element stress analysis.

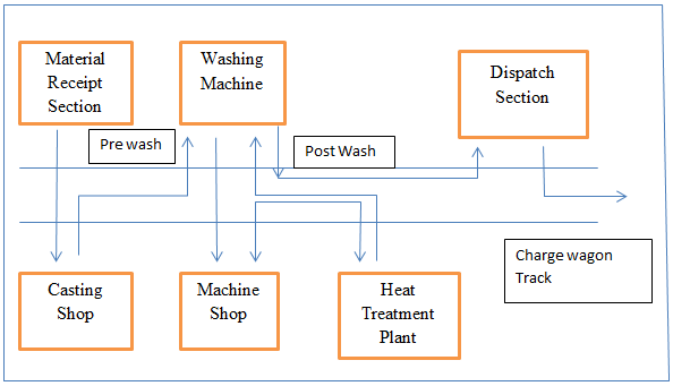
Jaroslav Mackerle[4] The paper gives a bibliographical review of finite element methods applied for the analysis of pressure vessel structure/components and piping from the theoretical as well as practical point of view. The listing at the end of the paper contains 856 categories these are: linear and nonlinear, static and dynamic, stress and deflection analysis, stability problem, thermal problem, fracture mechanics components, development of special finite element for a pressure vessel.

Eugene F. Megyesy[5]The paper gives all review of design calculation of cylindrical pressure vessel and square pressure vessel. The brief introduction about thickness calculation of tank design and stiffener calculation.

ASME Boiler and Pressure vessel code. Section VIII, Division –I [6]this code gives all introduction about pressure vessel. The brief introduction of design steps and their calculationof pressure vessel.

4. RELATED WORK

4.1 Shop Layout



4.2 Problem Statement and Objectives

Problem statement

1] Problem on cleaning of heat treated automobile components
2] Quench oil is not removed fully
3] Washing components are not dried completely
4] Machine takes lot of time to clean the part
5] Excessive consumption of detergent agent, water & electricity

Objectives

1] Design of Industrial Washing Machine
2] Design of Tank size
3] Stiffener design
4] Rearrangement of heater and blower
5] Spray pipe selection

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4.3 Customer Requirement

Description:

Single Chamber Type Immersion Pre / Post Wash Machine

4.3.1 Important Information available in Shop

1. Available Floor Space - width 3350 mm, height 4000 mm, length 4000 mm, working height above floor 1000 mm, pit 500 mm

2. Charge tray 1500 mm, width 900 mm, charge height (above tray) 800 mm

3. Energy supply- 415V, 50Hz, 3 Phase, AC

4. Supply temperature of water 25°C Tank water to be 50 - 80 °C,

5. Tank volume should 6000 ltr, Oil Separator tank 800 ltr,

6. Gross-charge-weight max. 1500 kg

7. Net approximate weigh of Washing Machine- 5100 kg

4.3.2 Material of Construction

1. Tanks and washing machine wall plates- SA 36 Gr. B (IS 2062 B)

2. Spray piping and spray nozzles of Stainless steel (SA 240 Gr 304)

3. Stiffener- SA 36 Gr.A (IS 2062 A) (Structural Carbon Steel)

4.3.3 Additional Required Features

1. Tank will be fully insulated

2. Water tank is for immersion with water bubbling, oil separation.

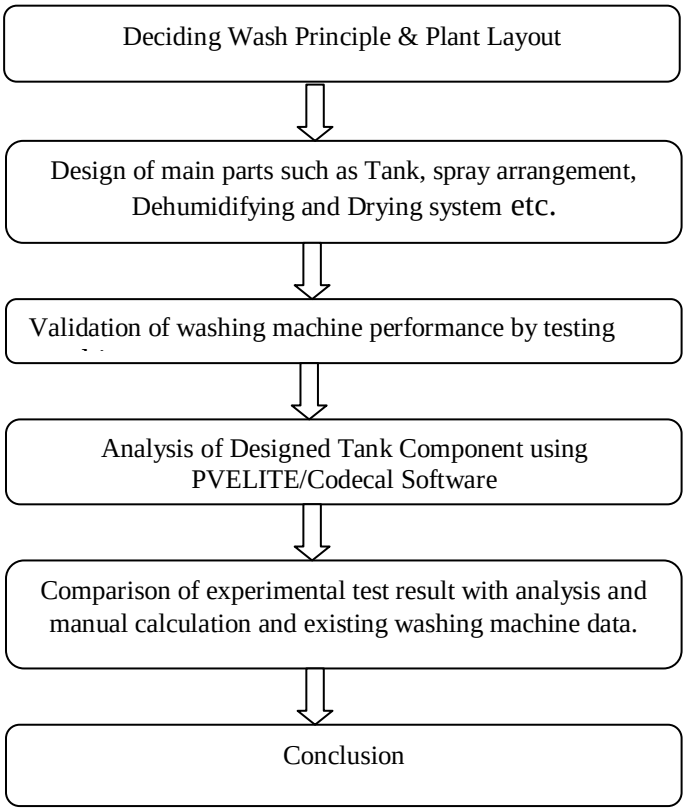
3. Upper Chamber for Rinse Spray, Hot Air Drying

4. Electrical tubular immersion heating system for water heating (36 kW).

5. Vertical pumps for Wash Spray and Rinse Spray (5 kW)

4.4. Methodology

For achieving the mentioned objectives following methodology is adopted. Present work aims at the analytical design of main parts of Washing Principle and Wash Machine. The flow chart given below indicates the detailed methodology of the project.



4.5 Design Calculation

Design of Batch Type Washing Machine

4.5.1 Sizing of Bottom Tank:-

A volume of The Tank= 6000 ltr. =6m^3
A volume of Oil Skimmer Tank = 800 ltr. = 0.8m^3
A volume of the Immersion Tank = Volume of the Tank - Volume of Oil Skimmer Tank

= 6000 ltr – 800 ltr
= 5300 ltr

Equation of Volume

V= L x W x H

So by using above formula, we can find out the size of Tank, The final dimension of Lower Tank is,

L= 2800mm
W= 1600mm
H= 1200mm

Sizing of Top Tank:-
Stroke Length = 1200mm
Total Height of both Tank = 2700mm

4.5.2 Thickness Calculation of Bottom Tank Plate:-

Here Material is selected as per ASME Section VIII- SA 36 Gr. B (IS 2062 B)

By using the following Equation we can find out the thickness of the plate is,

$$t=L\sqrt{\frac{\beta H\ 0.036\ G}{S}}$$

$$\beta=\frac{H}{P}$$

The internal pressure of Tank:-

P_{Design} = 1.46608 kg/cm^2

P_{Design} = 20.8532 psi

Add 10 stiffener in long side and 6 stiffeners in short side of Bottom Tank plate

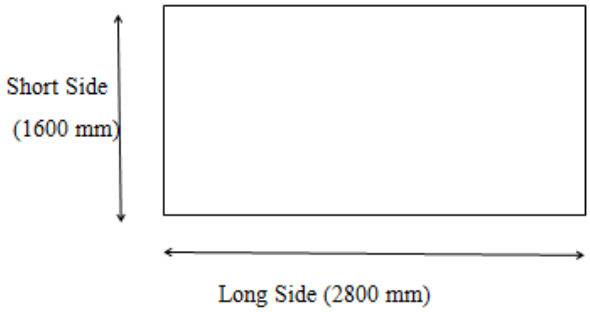


Fig.2 Top View of Bottom Tank

Long side Thickness
Take,
L= 2800 mm = 110.236 inch
L= 110.236/10 = 11.0236 inch

$$t = L\sqrt{\frac{\beta H\ 0.036\ G}{S}}$$

$$= 11.0236\sqrt{\frac{2.83194\ X\ 59.055\ X\ 0.036\ X\ 1}{17000}}$$

= 0.207 inch
t = 5.26 mm

Short side Thickness

Take,
L= 1600 mm= 62.992 inch
L= 62.992/6 = 10.498 inch

$$t = L\sqrt{\frac{\beta H\ 0.036\ G}{S}}$$

$$= 10.498\sqrt{\frac{2.83194\ X\ 59.055\ X\ 0.036\ X\ 1}{17000}}$$

= 0.197 inch
t = 5.01 mm
So,
Long Side Plate Thickness = 5.26 + Corrosion Allowance
= 5.26 + 2
= 7.26 mm
Long Side Plate Thickness = 8mm

Short Side Plate Thickness = 5.01 + Corrosion Allowance
= 5.01 + 2
= 7.01 mm
Long Side Plate Thickness = 8mm

Thickness of plate

The thickness of the Tank plate is 8mm as per the ASME Section VIII.

4.5.3 Design of Spray Piping

a.Pump Selection

We take 7.5 Kw Spray pump

Flow rate of pump = 100 lit/min
= 100/60 lit/sec

Flow rate of pump = 1.66 x 10^{-3} m^3/s

b.Pipe Size Selection

Given,

Flow-Rate (Q) = 1.66 x 10^{-3} m^3/s

Velocity (V) = 1.2 m/s

By using continuity equation we can find out Area of Pipe,

$$Q = A \times V$$

So,

$$Q = A \times V$$

$$A = V/Q$$

$$D^2 = \frac{4 \times 1.66 \times 10^{-3}}{\pi \times 1.2}$$

= 42mm

D = 2 in

As per the ASME B31.3 to find out Min. thickness of Pipe,

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$$t_m = [\frac{PD}{2(SEW)+(Py)}]$$

$$=[\frac{20.853\ X\ 2.374}{2(20000\ X\ 1\ X\ 1)+(20.853\ X\ 0.4)}]$$

= 0.001237 in

= 0.03142 mm X 12.5 Mill Tolerance

= 0.03534 mm

So, Take a SCH 10S is satisfying the above thickness.

Pipe Size = 2" X SCH 10S

c. Air Heater Selection

We take 1 Kw power of Air Heater. In this we divide 36 coils in both sides. In one side has 16 coils and other side has 16 coil.

5. Result and Discussion

5.1. Electricity Consumption

Electricity Consumption of old machine = 6 units per cycle

Electrical Consumption of New machine = 4 units per cycle

% of Electrical units saving = 33.33%

Average Old Machine Reading	Average New Machine Reading
6 unit	4 unit

Table 5A.Average Consumption Difference of Electrical Meter Readings of Machine

5.2. Dehumidifying & drying Timing

Dehumidifying & drying Timing of old machine = 6 & 5 min per cycle

Dehumidifying & drying Timing of New machine = 3 min per cycle

% of Time Saving = 45.45%

	Water tank capacity	Immersion Washing Avg. Time	Spray Washing Avg. Time	Dehumidifying Avg. Time	Drying Avg. Time
Old	5000 ltr	5 min	5 min	6 min	5 min
New	6000 ltr	3 min	3 min	3 min	3 min

Table 5B.Average Time Consumption Difference of Machine

5.3. Water Consumption

Water Consumption of old machine = 70 to 80 ltr per cycle

Water Consumption of New machine = 40 to 50 ltr per cycle

% of Saving Water = 37.5%

Old Machine	New Machine
70 to 80 lit per cycle	40 o 50 lit per cycle

Table 5C.Average Water Consumption Difference of Machine

6. Conclusion

In this report a batch type washing machine design is presented. As per the customer requirement the design is expected to reduce the operation time, resizing of Tank, Thickness calculation, Stiffener selection, to reduce material weight. Design of Spray arrangement, Dehumidifying, and drying system is undertaken and completed.

Redesign of washing machine is approved by customer for improvement in performance on the basis of reduction in washing consumable like water, detergent, electricity; time of washing per batch is achieved with 40 % of reduction.

Rearrangement of heater, blower, ensure ease of fabrication and saving in material of construction.

7. References

[1] Tandale P, Shivpuje S, Ladkat S, Simran K, "Design of Washing Machine for Cleaning of Small Components" Volume 3, Issue 4, April 2015, PP 30-36.

[2] H. Mayer, H.L. Stark, S.Ambrose, "Review of fatigue design for pressure

vessels" International Journal of Pressure Vessel and Piping 77 (2000)775-781.

[3] Song-In, Seung-Kee Koh," Residual stress effects on the fatigue life of an externally grooved thick-walled pressure vessel" International Journal of Pressure Vessel and Piping 79(2002) 119-126.

[4] Jaroslav Mackerle, "Finite element in the analysis of Pressure Vessel and Piping an addendum: A bibliography (2001-2004)" International Journal of Pressure Vessel and Piping 82(2005)571-592.

[5] Eugene F. Megyesy, "Pressure vessel Handbook" Pressure vessel publishing INC, Tulsa USA

[6] ASME Boiler and Pressure vessel code. Section VIII, Division -I, 2013