ISSN : 2455-9679
Impact Factor : 4.256

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"DESIGN AND FABRICATION OF PART CLEANING MACHINE"

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ABSTRACT

Every part manufactured in industry requires proper cleaning after all the manufacturing processes are performed, before being brought to assembly. Part cleaning thus becomes a very important topic of discussion in industry and more so in chemical and pharmaceutical based industry where very high quality of hygiene is maintained. The machine developed can be used for variety of tasks ranging from cleaning various components like tablet press, flanges, supporting lugs, gear, medical instruments and tools, pharmaceutical vessels, rings, coil and spring to almost every small component and product developed from CNC and lathe machines. The machine can also perform surface finishing and sanitization operation as per the needs.The designing has been accomplished on CAD software and later structural analysis of the final design has been performed on ANSYS software.The machine can use water, steam, light chemicals and many other similar fluids in its operation. These pressurized fluids are used to clean chips and burrs, small dirt particles, and oil and grease from the part. It also can perform sterilization and surface finishing operation with these fluids accordingly.

Key Words: Cleaning, nozzles, pressure, fluids, structural analysis.

I. INTRODUCTION

The main features would be cost efficiency as the cost to make machine is very less as compared to other cleaners available in the market. Another major problem with traditional or existing machine is that they are mostly operated with the help of long wires to overcome this problem we are using a mechanism that uses least of the space and keeps it keenly confined. A need for development of economically feasible part cleaning machine for removal of contaminants (oil,dirt, burr &chips, and other particles) from essential components of the manufacturing industry.Parts cleaning is essential to many industrial processes, as a prelude to surface finishing or to protect sensitive components. Almost all machined parts coming out of a machine tool are covered in some type of metalworking fluid residue. Depending on the next step in a part's life, a certain amount of cleaning is in order. A major factor in determining the type of necessary cleaning is the degree of cleanliness specified by a customer. Components would be loaded on Rotary basket, which is rotated manually by the user in slow speed. During the rotation, the solution from the tank is pumped with the help of High-Pressure pump to wash chamber of Top Loading spray washer through inline filter multiple and spray nozzles located above, below, and to the sides of the rotary table to attain higher degree of cleaning results. From Rotary Table Washer Wash chamber, it drains back to the tank via a recovery filter.The quantity of parts to clean dictates machine size and how fast the cycle time needs Our Cleaning Machine is designed for fast, effective spacesaving, economical and high levels of cleanliness can be achieved for low cost and little effort.

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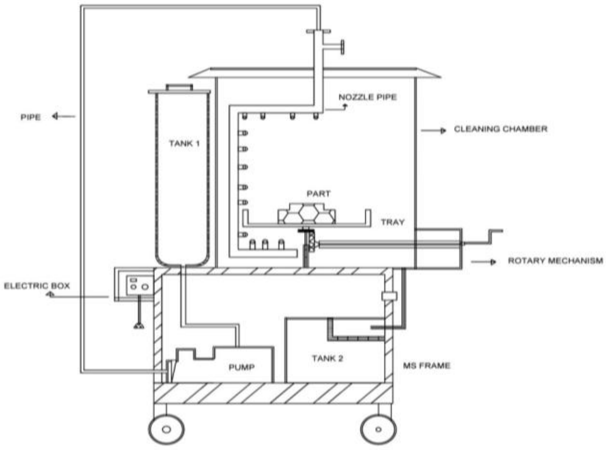

BLOCK DIAGRAM

II. Literature review

Alexander et alhave replaced Rigidly jointed perimeter frame panels by equivalent orthotropic plates with properties representing both axial and shearing deformation characteristics. The research presented a closed form solutions for three standard load cases,a uniformly and a triangularly distributed load, and a point load at the top.[1]

M**.** Kitanoet al have used CFD analysis to solve the unsteady three-dimensional viscous flow in the entire impeller and volute casing of a centrifugal pump. The calculations at the design point and two off design points were carried out with a multiple frame of reference. Results obtained show that the flow in the impeller and volute casing is periodically unsteady. The pressure fluctuations are also reflected to impeller inlet and affect the mass flow rate through blade passages.[2]

K.Thin et al have analyzed a centrifugal pump by using a single-stage end suction centrifugal pump. The pump is driven by 1HP electric motor and the design is based on Berman Method. The head and flow rate of this pump are 10 m and 0.179 m3/s and the motor speed is 2900 rpm. Performance analysis of centrifugal pump is carried out after designing the dimensions of centrifugal pump. Centrifugal pump was chosen because it is the most useful mechanical rotodynamic machine in fluid work.[3]

FJT Kuo et alhave shown that one of the fundamental objectives in the mathematical modeling of two-phase flow is to understand and to formulate the interaction forces between two phases. For this purpose, a well-defined two-phase flow situation, flow of bubbles through nozzles, was set up in the laboratory. Individual bubbles were injected into the water stream and their trajectories were recorded to provide data for evaluation and comparison with theories.[4]

T.V. Kumar et al have highlights the problem of floor cleaning machines being used to only clean floors dry surface this making it useless in rainy season. Therefore a machine which can work in both dry and rainy season is developed. Development of a multi-purpose floor cleaning machine capable of vacuuming, mopping, and Heating is described. Furthermore, in some cases, the robot will need to run through the floor multiple times to ensure complete cleaning. This paper tries to make the most of the floor cleaning machine’s capabilities.[5]

PG Hillet alhave existing data on the condensation of steam and moist air in supersonic nozzles are compared with predictions based on nucleation and drop-growth theory. The usefulness of the nozzle experiments for testing the validity of nucleation theory is demonstrated. It is concluded that, if the surface tension is assumed independent of curvature, and the classical liquid-drop theory (based on a stationary liquid drop) is used, the theory is in general agreement with the data.[6]

III. Methodology

To start with the project the first step was identification of a problem. For this many different research paper of distinguished authors in various fields of interest were studied. Through this project we try to provide a cost effective and compact product which will be used for part cleaning purposes. A need for development of economically feasible part cleaning machine

for removal of contaminants (oil, dirt, burr & chips and other particles) from essential components was identified.

In the next step basic design was developed and modeling of critical components was performed using Auto-cad

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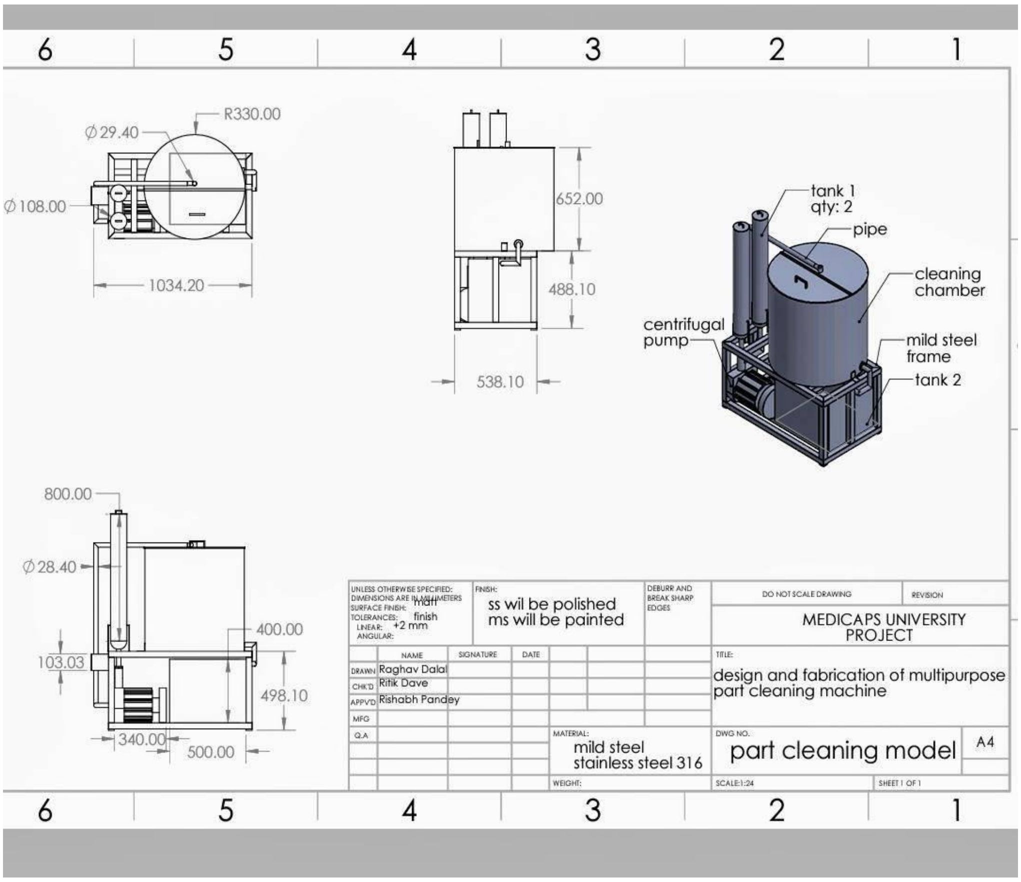
2019. Different 2D and 3D models were developed and structural analysis of critical components was performed using ANSYS 18.1 software. The reports generated during this phase provided us with design data andspecifications through which final design specifications were achieved.
The next step involves procurement of material and components for fabrication based on design parameters. The fabrication of the machine takes the next step after which various tests are performed and quality standards are checked during the testing period of the machine.
In the final step of the project final report is developed and with the help of various data and reports generated throughout the project, results and final model are presented.



3D Model of part cleaning machine

IV. DESIGN PARAMETERS

Parameter	Data
material	Mild steel, Stainless Steel 316
Box dimensions (mm	L= 1034 , B = 538, H= 1140
Cleaning fluid	Water , steam, light chemicals
Pump (1 HP)	Self-priming centrifugal pump
No. of nozzle	12 (solid stream type)
Mechanism	Rotary gear mechanism

Design parameters

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V. CALCULATIONS

Total number of nozzles -12
Pressure to achieve – 1.5 to 2 bar
Power of centrifugal pump – 1 HP to 2HP
Pipe dia.: - 1 inch = 25.4 mm
Nozzle height – 975 mm (approx.)
We know that
$P = \rho \times g \times h + P_o$
Therefore, to achieve 2bar (200 Kpa) at top: -
$P = (1x\ 10^{6}\ g/m^{3} \times 9.8067 \times 0.975) + 2 \times 10^{8.}\ g/\ ms^{2}$
$P = 208859532.5\ g/ms^{2}$
P = 208.895 Kpa = 2.08 bar
Therefore, required pressure at bottom = 2.08 bar

Discharge through nozzle

Q= A x v
$V= \sqrt{\{2 gH / (1+ 4 fl/D \times a^{2} / A^{2)}\}}$
Where;
D = dia. of pipe
A = pipe area at nozzle
And a = outer nozzle area
Putting values in the equation
$V = \sqrt{(19.1295/ 4.256)}$
$V = \sqrt{4.4924}$
V = 2.119 m/s
Area of nozzle = $\pi/4 \times d^2 = \pi/4 \times (0.0053)^2\ m^2$
Area of nozzle = $2.340586 \times 10^{-3}\ m^2$

Now, Discharge (Q) = A x V

$Q = 2.809 \times 10^{-3} \times 2.119$
$Q = 5.95227 \times 10^{-3}$
Therefore Q = 0.00595227 m³/s
For 12 nozzles the discharge will be
$Q_{12} = 0.00595227 \times 12$
$Q_{12} = 0.07142724\ m^3/s$

For centrifugal pump

$P = \rho \times g \times h \times Q$
P = 1000 x 9.81 x 1 x 0.07142724
P = 700.70122 Watts
P = 0.939277 HP APPROX= 1 HP power required.

VI. MODELLING&SIMULATIONS

FRAME :-

LOAD	1961 newtons (200 kg)
MATERIAL	Mild steel square pipe
ANALYSIS	Equivalent stress
UNIT SYSTEM	Metric (mm, kg, N, s, mV,)
MESH TYPE	rectangular

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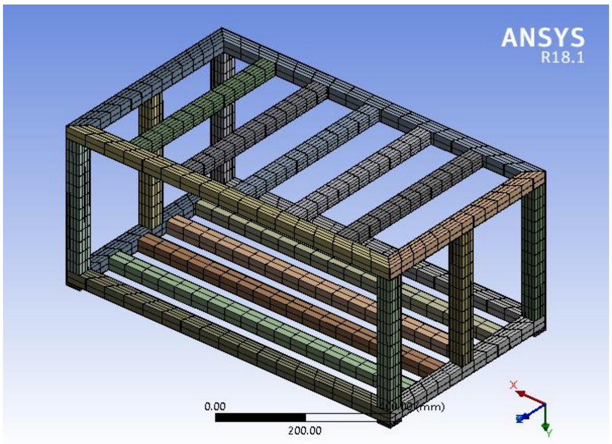
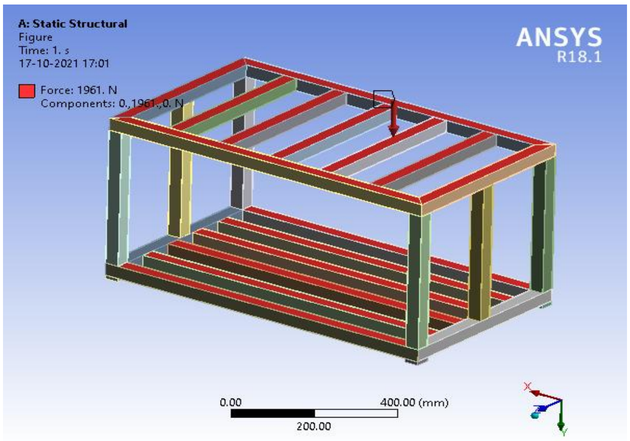
NOZZLE TUBE :-

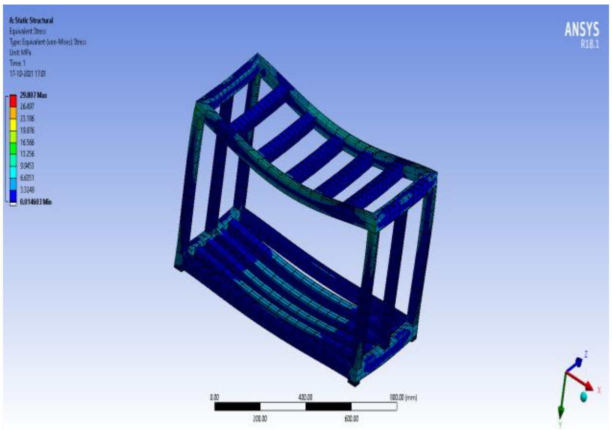
LOAD	.7mpa (7 barg) pressure
MATERIAL	Stainless steel 316
ANALYSIS	deformation
UNIT SYSTEM	Metric (mm, kg, N, s, mV,)
MESH TYPE	triangular

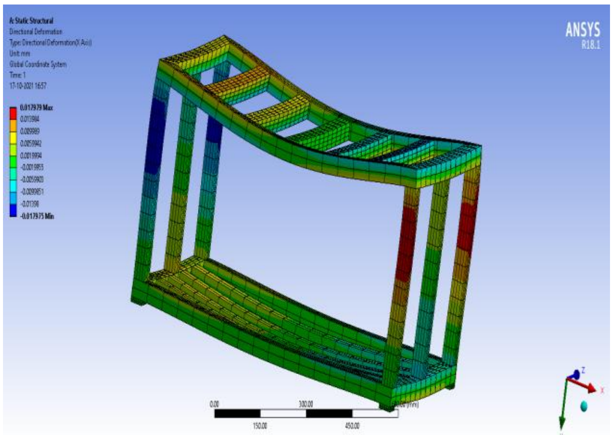


Static Structural Loads

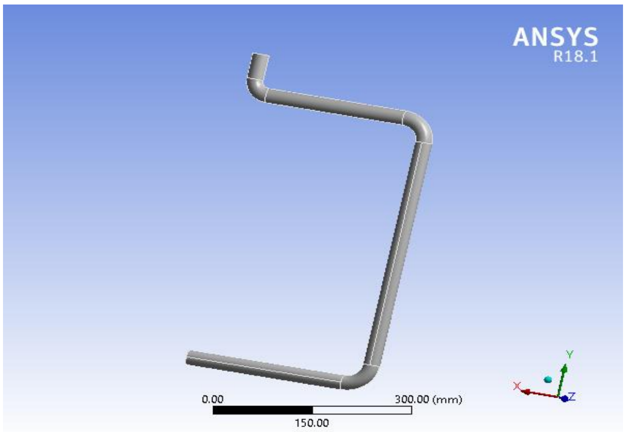


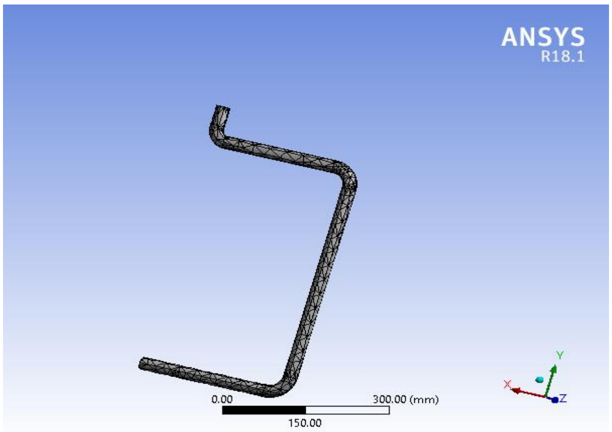
Directional Deformation





Stress distribution of frame





Static Structural Loads

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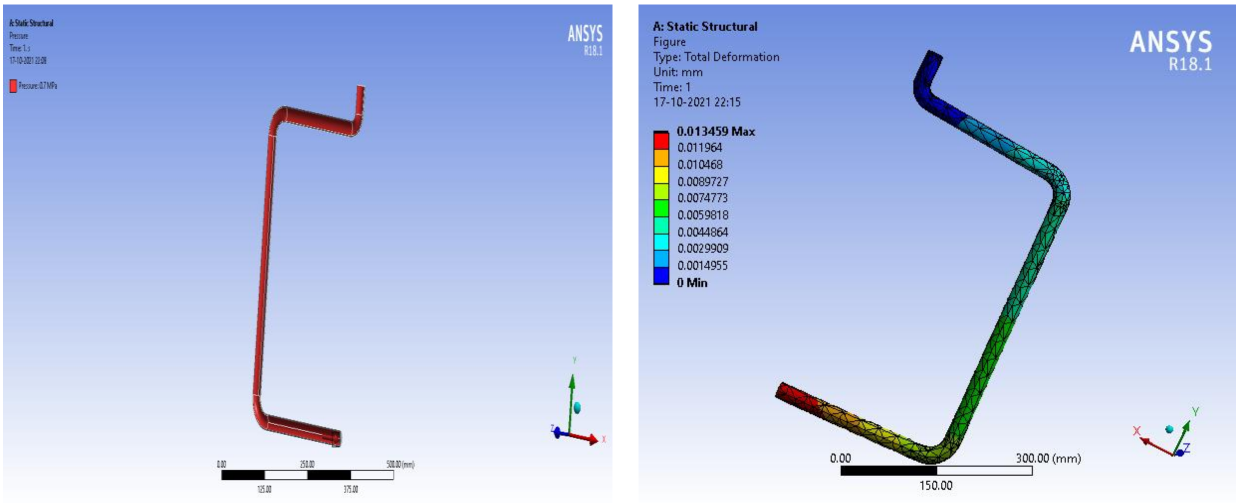

Stress distribution of Nozzle tube

VII. RESULT &CONCLUSION

A model of the above discussed machine is proposed. Design and analysis of the machine provides a firm base for its further implementation. The proposed machine will provide a cost effective and compact alternative to the current products. During Structural analysis of the frame, it was observed that the Cent can withstand weight of 200 kg and the pressure at the top of the nozzle stands at 2.08 bar. If in worst case all pipes get blocked the pipe can still withstand 6-7 bar of pressure which ensures safety of the machine and user. Also, the discharge achieved through the nozzle is 5.95227 x 10 -3 m^3/s and combined discharge through 12 nozzlesis 0.07142724 m^3/s.

Thorough cleaning of parts can be achieved and steam can be used for sterilization functions.
Dirt removal after cleaning is achieved through filters and fluid recovery system ensures complete reuse and recycling of the fluid used.

While visiting industries during training period we realized the importance and need of industrial part cleaning machine in any industry. These machines prevent any types of chips and burrs and other contaminants to pass through. These particles can highly damage the working of the machine and can cause part damage. Thus, we aim to provide a more economical and feasible model for the machine which serves its purpose while conforming to expected quality standards.

VIII. FUTURE SCOPE

The machine has various aspects which can be upgraded and develops a lot of future opportunities. Some notable ones are: -

1. Introduction of UV lamp in cleaning chamber which will allow the machine to perform sanitization operations.
2. Introduction of automated rotary mechanism instead of manual rotary mechanism, allowing more ease of operation to the user.
3. Drying of cleaned parts by using waste heat energy of the industry in a separate chamber after part cleaning operations.
4. Automatic spraying system can be introduced. A timer controlled spraying mechanism will result in further increase in efficiency of the machine.
5. Introduction of hot water for cleaning using industrial waste heat.

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