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Design and Fabrication of Steam Incorporated Floor Cleaner

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ABSTRACT
The cleaning system is supposed to be system that uses steam which can clean up things that are used by human in day to day life. The commercial detergent washers are compared with the system and it was found that the washing is very convenient and soapy forms are not produced that made the washing very clumsy. The removal of bacterial populations formed on surface of any material would be totally eradicated. The surface to be cleaned firstly cleaned using vacuum cleaner which is placed at the bottom of the cleaner and then given bath with steam with high pressure from 2 bar to 4 bar by which removal of dirt and stain particles were washed off very comfortably.
High pressure steam would be generated by heat the water in the tank which will mounted on the system itself. The reason behind using the steam for washing purpose is the less wastage of water and alsoits availability. The development of steam based cleaning system has revolutionized the process of washing. One can choose an appropriate type of high power steam cleaners for challenging cleaning applications in office, commercial and industrial settings. The steam does that thing that commercial washing systemcannot do. A steam can remove grease and grime while for normal cleaning requires expensive detergents. The multi cleaning system cannot beonly used for industrial use but also for the housework stuff.
So our prime focus is to use the steam and make multiple cleaning and make surface disinfectant. The floor cleaner was designed and modeled in Auto- CAD and analysis is done on FUSION 360 software.
Keywords : High pressure steam, Auto-CAD, FUSION 360

I. INTRODUCTION

Fully automatic machines available in the market are of high ranges. So, keeping the focus on cost factor, they are not affordable to all. The organization committee of hostels, hospitals, hotels can't afford these costs. Hence, there is need to develop floor cleaning machine which is cost effective using renewable sources. In crowdie places such as railway stations floors are not regularly cleaned due to hectic work of sweepers and non-availability of machines because of this, hygienic environment is not maintained. In India, especially in summer there is power crisis, in majority of places. Hence floor cleaning using floor cleaning machine is difficult without electricity. To overcome this problem, an alternative is made by using solar energy. Considering assembly, weight, handling design machine is flexible. Provision is made for water spraying.
Main mottos of research are:
• To reduce the human effort and cost.
• To make the environment sanitary.
Cleaning is the essential need of the current generation. Basically in household floors the floor has to be cleaned regularly. Different techniques are used to clean the different types of surfaces. The reasons for floor cleaning are:

- Injuries due to slips on the floors are cause of accidental injuries or death. Bad practice in floor cleaning is a major cause of accidents.
- To beautify the floor.
- Debris and obstructions are to be removed.
- Allergens and dusts are to be removed.
- Surface wear to be avoided.
- To make the environment sanitary (kitchens).
- Traction should be maintained at optimum level, so that no slip will occur.

Floor cleaning is achieved by different technique which might be of different kinds. Different types of floor need different type of treatment. The floor should be totally dry after the cleaning process. Otherwise it may result in hazard. On some floors sawdust is used to absorb all kinds of liquids. This ensures that there will no need of preventing them from spill of. The sawdust has to be swept and replaced every day. This process is still used in butchers but it was common in bars in

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the past. In some places tea leaves are also used to collect dirt from carpets and also for odor removing purposes. Different types of floor cleaning machines are available today such as floor buffers, automatic floor scrubbers and extractors that can clean almost all types of hard floors or carpeted flooring surfaces in very less time than it would have taken using traditional cleaning methods. Again the cleaning would be different for different floorings.

II. OBJECTIVES

- Present work is aimed at working of a steam incorporated floor cleaner machine that could clean the floor of a common Indian household.
- The machine should avoid objections on its path. Proper cleaning is achieved by the motion of the scrubber which is relatively in rotational motion.
- The cleaning process is done by primarily vacuuming the floor followed by steam cleaning and drying the floor with scrubber.
- The floor should be completely dry after the process since wet floors leads to different problems.
- There may be oily surfaces also, to counteract the situation proper disinfectants should also be used.

III. LITERATURE REVIEW

- **V.Vadivel1,.Thangapandiyan, N.Varun raj, K.Ramachandran M. Sivaraja S** works on a project work targets to use automatic floor cleaner for large floor in house-hold purposes and office floors. The cleaning purpose is specifically carried out by continuous relative motion between a scrubber and the floor surface. During the cleaning and moving operation of vehicle a propulsion mechanism such as driven wheels and guide wheels for the dry tracking on the floor surface to be cleaned, suction of water is carried out by vacuum pump, scrubbing action is done by the scrubber directing water towards rear end.

- **Mahesh P. Deore1, Vaibhav B. Chaudhari, Akshay P. Deshmukh, Roshan V. Dandage, A. A. Mule** research therecent developments in floor cleaning machine is propose an apparatus which is capable of performing cleaning of floor and corners effectively, semi-automaticwater spray, cleaning of byre, dry as well as wet cleaning tasks. This floor cleaning machine is designed by keeping the basicconsiderations for machine and operational cost reduction, efforts reduction, environment friendly and easy handling.

- **Li Hung Goon, Ahmad Nur Iman Md Isa, Chia How Choong, W.A.F.W. Othman**In this they have built a low-cost and simple automatic floor polisher to ease the life of modern living. This small cleaner and polisher robot is capable of the polishing and vacuuming the floor automatically without colliding with the furniture or any other obstacles. This automatic floor cleaner can be remotely switched on or off using a Bluetooth phone.

- **Ningbo (CN) Jianquank Fang , Ningbo (CN)** has devloped an automated floor cleaning apparatus , has an automatic cleaning robot and a washing base the rear end of the robot body of the automatic cleaning robot is provided with a mop mechanism , the mop mechanism comprises a rotation component rotatably connected to the robot body and a crawler - type wiping cloth sleeving outside and rotating along with the rotation component.

- **Maximilian Rosenzweig, Montreal (CA); Vrdoljak Ognjen, Laval (CA)**

The invention relates generally to a steam mop, and more particularly to a steam mop including a water pump that is actuated by the movement ofa user to pump water from a reservoir to a boiler for generating steam to be distributed toa steam nozzle coupled thereto and pad for application to a surface to be cleaned.

IV. MANUFACTURING OF STEAM INCORPORATED FLOOR CLEANER

Manufacturing involves turning raw material to finished products, to be used for various purposes. There are a large number of processes available. These processes can be broadly classified into four categories.

1 Casting processes
2 Forming processes
3 Fabrication processes
4 Material removal processes

4.1Casting Processes:

These processes only processes where the liquid metal is used. Casting is also the oldest known manufacturing process.

Basically it consists of inducing the molten metal into a cavity of mould of the required form and allowing the metal to solidify. The object

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after solidification removed from the mould. Casting processes are universally used to manufacture a wide variety of products. Casting is the most flexible and cheapest method and given high strength of rigidity to the parts which are difficult to produce by other manufacturing processes. The principle process among these sand casting where sand is used as the raw material. The process is equally suitable for the production of a small batch as well as on a large scale.

4.2Forming Processes:

These are solid state manufacturing processes involve minimum amount of material wastage. In forming process metal may be heated to temperature which is slightly below. This solidify temperature and large force is applied such the material flows and act in desired shape. The desire shape is controlled by means of a set of tool ties and dies, which may be closed during manufacturing.

These processes are normally used for large scale production rates. These are generally economical and in many cases improve the mechanical properties. These are some of the metal forming processes.

4.3Fabrication Processes:

These are secondary manufacturing processes where the starting raw materials are produced by any one of the previous manufacturing processes desired. Its assembly involve joining pieces either temporary or permanent. So that they would be perform the necessary function. The joining can be achieved by either or both of heat and pressure joining materials. Many of the steel structure construction, we see are first rolled and then joined together by a fabrication process is Gas welding.

4.4Material removal processes:

These are also a secondary removal manufacturing process, where the additional unwanted material is removed in the form of chips from the blank material by a hard tools so as to obtain the final desired shape.

Material removal is normally a most expensive manufacturing process. Because more energy is consumed and also a lot of waste material is generated in this process. Still this process is widely used because it deliver very good dimensional accuracy and good surface finished. Material removal process are also called machining processes.

4.5WELDING:

Welding is a process of joining two metal pieces by the application of heat. Welding is the least expensive process and widely used now a days in fabrication. Welding joints different metals with the help of a number of processes in which heat is supplied either electrically or by mean of a gas torch. Different welding processes are used in the manufacturing of Auto mobiles bodies, structural work, tanks, and general machine repair work. In the industries, welding is used in refineries and pipe line fabrication. It may be called a secondary manufacturing process.

4.6 GAS WELDING

It is a process of welding through the spot melting of a metal by the flame of a gas-fed welding torch. For higher flame temperature, a mixture of a gaseous fuel and industrially pure oxygen is used. Oxygen and acetylene are fed by hoses into a welding torch, where they are blended. In this We use Gas welding for joining of plates. When metals are welded using gas welding equipment, fuel gases are mixed with oxygen to produce a concentrated flame at a high temperature. This flame directly strikes a weld area and melts the materials in question (often, but not always, with the addition of filler material).

The melted section of each piece of metal forms something called a melt or weld pool where the liquid metals diffuse into one another and, once cooled, form a strong joint. This form of welding can be used for many common types of metals.
Completion of weld requires the welder to slowly remove the flame from the joint, giving it time to harden without oxidation.

Most commonly, oxygen is mixed with gases like acetylene, hydrogen, propylene, butane, and others. The choice of gas used for welding depends on the type of project, cost, and flame control.

4.7 DRILLING:

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled. Here the holes are drilled before the joining of plates with definite measurements.

4.8 METAL CUTTING OPERATIONS:

1. Blanking:

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Blanking is the operation of cutting a flat shape from sheet metal. The product punched out is called the "blank" and the required product of the operation the hole and the metal left behind is discarded as waste.

2. Punching or Piercing:

It is a cutting operation by which various shaped holes are made in sheet metal. Punching is similar to blanking except that in punching, the hole is the desired product. The material punched out from the hole being waste.

3. Notching:

This is cutting operation by which metal pieces are cut from the edge of the sheet, strip or blank.

4. Perforating:

This is a process by which multiple holes are very small and close together are cut in a flat sheet metal.

5. Trimming:

This operation consists of cutting unwanted excess of material from the periphery of a previously formed component.

6. Shaving:

The edge of a blanked part are generally rough, uneven and un-square. Accurate dimensions of the part are obtained by removing a thin strip of metal along the edges.

7.Slitting:

It refers to the operation of making incomplete holes in a work piece.

8. Lancing:

This is a cutting operation in which a hole is partially cut and then one side is bent down to form a sort of tab. Since no metal is actually removed and there will be no scrap.

9. Nibbling:

The nibbling operation, which is used for only small quantities of components, is designed for cutting out flat parts from sheet metal. The flat parts from simple to complex contours. This operation is generally substituted for blanking. The part is usually moved and guided by hand as the continuously operating punch cutting away at the edge of the desired contour.

Forming Operations:

Different forming operations are shown in fig 4.1

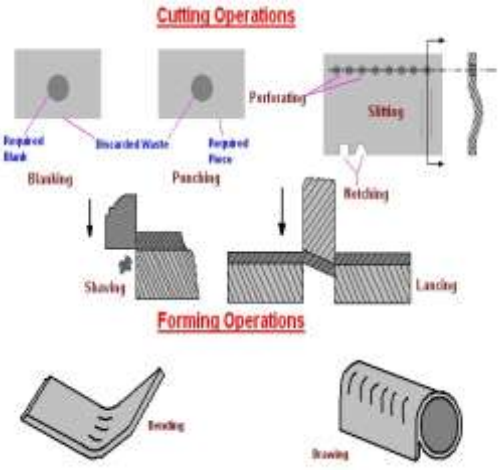

Fig 4.1 Types of forming operations

Bending:

In this operation; the material in the form of flat sheet or strip is uniformly strained around a linear axis which lies in the neutral plane and perpendicular it's the length wise direction of the sheet or metal.

Drawing:

This is a process of forming a flat work piece into a hollow shape by means of a punch which cause the blank into a die cavity.

Squeezing:

Under the operation, the metal is caused to flow to all portions of a die cavity under the action of compressive forces.

4.9 FINAL FABRICATED MODEL

Fig 4.2 shows the completed fabricated model of Steam incorporated floor cleaner.

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Fig 4.2 Fabricated model of Floor Cleaner

V. DESIGN MODEL OF STEAM INCORPORATED FLOOR CLEANER

5.1 DESIGN PARAMETERS

1. Material Strength 2. Yield Strength 3.Tensile Strength 4.Steam Boiling point 5. Enthalpy of Steam 6. Entropy of Steam

5.2 DESIGN MODEL

Isometric view of Floor cleaner machine is shown in fig 5.1

Fig 5.1 Isometric view of floor cleaner

Side view and front view of floor cleaner is shown in fig 5.2 and fig 5.3

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Fig 5.2 Side view of Floor cleaner

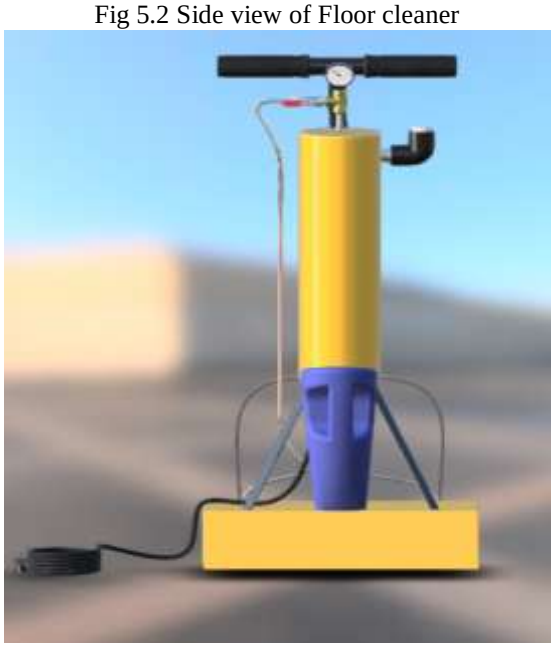

Fig 5.3 Front view of Floor Cleaner

5.3MODEL DIAGRAM

The dimension of the model is shown in fig 5.4

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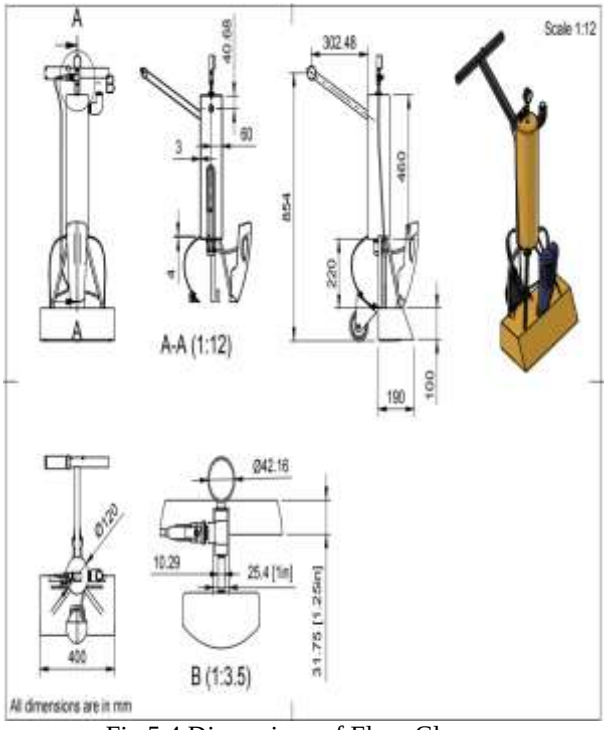

Fig 5.4 Dimensions of Floor Cleaner

VI. CALCULATION OF STEAM INCORPORATED FLOOR CLEANER

When water is heated from normal room temperature at 3 bar pressure.

At 3 bar, property values of steam.

hfg = 2163.2 KJ/kg hg= 2724.7 KJ/kg hf=561.5 KJ/kg

vf= 0.001074 m^3/kg vg= 0.60553 m^3/kg

T= 133.5 C Cp= 4.19 KJ/kg

$ms \cdot hfg = Q = c_p \, dT \, m / t$

where

ms= Mean steam consumption rate (kg/s)

hfg= Specific enthalpy of evaporation of steam (KJ/kg)

Q= Mean heat transfer rate (KW or KJ/s)

m= mass of secondary fluid (Kg)

Cp= Specific heat capacity of the secondary fluid (KJ/Kg C)

dt= Temperature rise of the secondary fluid (C)

t= Time for the heating process (seconds)

$ms \cdot hfg = Q = c_p \, dT \, m / t$

Q= 4.2 . 4.19 . (133.5-13.5) / 900 S = 2.34 KJ/s

ms = 2.34/2163.2 = 0.00108 Kg/s

= 3.89 Kg/hr

- Area of the cross section of the pipe = π r^2

  = 3.14 . 6 ^2 = 0.113 m^2

- Steam velocity = Volume flow / area cross section of pipe

  = 3.89 . 0.60553 /0.113 = 20.83 m/s

VII. MATERIAL SELECTION

MILD STEEL

The term 'mild steel' is also applied commercially to carbon steels not covered by standard specifications. Carbon content of this steel may vary from quite low levels up to approximately 0.3%. Generally, commercial 'mild steer' can be expected to be readily weldable and have reasonable cold bending properties but to specify 'mild steel' is technically inappropriate and should not be used as a term in engineering. Mild steel is the most widely used steel which is not brittle and cheap in price. Mild steel is not readily tempered or hardened but possesses enough strength.

Mild steel Composition

- ✓ Mild steel contains –C45
- ✓ Carbon 0.35 to 0.45 % (maximum 0.5% is allowable)
- ✓ Manganese 0.60 to 0.90 %
- ✓ Silicon maximum 0.40%
- ✓ Sulfur maximum 0.04%
- ✓ Phosphorous maximum 0.04%
- ✓ Mildest grade of carbon steel or mild steel contains a very low amount of carbon - 0.05 to 0.26%.

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- ✓ Tensile strength – 63-71 kgf/mm^2
- ✓ Yield stress -36 kgf/mm^2
- ✓ Izod impact valve min -4.1 kgf m
- ✓ Brinell hardness (HB) – 229

VIII. DESIGN AND ANALYSIS OF STEAM INCORPORATED FLOOR CLEANER

8.1 ANALYSIS BY USING FUSION 360 SOFTWARE

Steps to be followed

STEP 1: Model the boiler part of the machine

STEP 2: Creating an N mesh around the wall of boiler for the analysis purpose.

STEP 3: The material properties are entered manually.

STEP 4: The loading conditions are set according to our requirement.

STEP 5: Initial temperature was set to room temperature.

STEP 6: The variation in the structure under the load is calculated by the Calculix tool available in the FEM menu of Free CAD.

Study 1 - Static Stress

General

Contact Tolerances	0.1 mm
Remove Rigid Body Modes	No

Mesh

Average Element Size (% of model size)	
Solids	1
Scale Mesh Size Per Part	No
Average Element Size (absolute value)	-
Element Order	Parabolic
Create Curved Mesh Elements	Yes
Max. Turn Angle on Curves (Deg.)	60
Max. Adjacent Mesh Size Ratio	1.5
Max. Aspect Ratio	10
Minimum Element Size (% of average size)	20

Adaptive Mesh Refinement

Number of Refinement Steps	0
ResultsConvergenceTolerance(%)	20
Portion of Elements to Refine (%)	10
Results for Baseline Accuracy	Von Mises Stress

Materials

Component	Material	Safety Factor
Boiler:1/Boiler (1):1	Steel, Mild	Yield Strength

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Steel, Mild

Density	7.85E-06 kg / mm^3
Young's Modulus	220000 MPa
Poisson's Ratio	0.275
Yield Strength	207 MPa
Ultimate Tensile Strength	345 MPa
Thermal Conductivity	0.045 W / (mm C)
Thermal Expansion Coefficient	1.2E-05 / C
Specific Heat	480 J / (kg C)

Mesh

Type	Nodes	Elements
Solids	1010630	603628

Fixed1

Type	Fixed
Ux	Yes
Uy	Yes
Uz	Yes

Result Summary

Name	Minimum	Maximum
Safety Factor		
Safety Factor (Per Body)	3.044	15
Stress		
Von Mises	0.00849 MPa	68.01 MPa
1st Principal	-3.993 MPa	71 MPa
3rd Principal	-25.01 MPa	2.041 MPa
Normal XX	-8.301 MPa	8.632 MPa
Normal YY	-6.318 MPa	70.88 MPa
Normal ZZ	-24.96 MPa	13 MPa
Shear XY	-5.848 MPa	12.57 MPa
Shear YZ	-13.21 MPa	15.23 MPa
Shear ZX	-5.396 MPa	5.641 MPa
Displacement		
Total	0 mm	0.01589 mm
X	-0.01479 mm	0.001757 mm
Y	-0.004344 mm	0.004316 mm
Z	-0.009196 mm	2.729E-04 mm
Reaction Force		
Total	0 N	11.4 N
X	-5.865 N	5.716 N
Y	-5.374 N	5.614 N

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Z	-2.741 N	9.926 N
Strain		
Equivalent	3.774E-08	2.751E-04
1st Principal	4.299E-08	3.17E-04
3rd Principal	-1.221E-04	1.073E-07
Normal XX	-8.89E-05	5.214E-05
Normal YY	-1.646E-05	3.144E-04
Normal ZZ	-1.135E-04	4.929E-05
Shear XY	-6.779E-05	1.457E-04
Shear YZ	-1.531E-04	1.766E-04
Shear ZX	-6.254E-05	6.539E-05

Reaction Forces

Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	Component (X,Y,Z)	Magnitude	Component (X,Y,Z)
Fixed1	178.3 N	178.3 N	73945 N mm	-136 N mm
		0.3588 N		73945 N mm
		0.1185 N		-0.9027 N mm

Selected Entities

Fig 9.1 selected boundaries

IX. CONCLUSION

The product thus developed is fully operational and gives desired motion. It is being tested in a room which results in successful outcome. The problems now are the weight of the equipment, storage capacity, restricted cleaning areas etc. This will be the next development stages. This not only decreases cost but also increases reliability of the instrument.

Overall the concept is very much helpful and there is scope of a lot of development in mechanical parts. The optimization will continue till achieving the best one. Overall the project is successful to its intent. Also by making it fully automated can reduce human efforts.

By using suitable composite materials we can reduce the boiler weight which will reduce the weight of machine. And by adding suitable sensors this product will be able to detect as well as move in the direction of dust and thus resulting in better cleaning of floors. As a whole this is a successful product developed that can be used in current Indian house-hold.

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