Design & FEM - Analysis of Rotary Type Vegetable Cleaner Machine

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Abstract—*Vegetables of fruits and root vegetables should be cleaned before weighting and grading as harvesting process leaves soil and foreign materials stick to the vegetables. Soil and other foreign materials must be removed, especially for medium and heavy textured soil in which a pre-harvest irrigation is used to loosen the soil prior to hand harvesting. Washing of fruits and root vegetables is vital steps in any processing operation, which give attractive and chemical free fruits. At the present time, washing of fruits is carried out manually which very tedious and time consuming and expensive process. As we know that time and human power are the important concern now a days in every field so there is arequirement to design and develop a vegetable cleaning machine which will reduce the required human effort and make their task easy to work. The main objective of this study is to design and develop a vegetable cleaning machine, using CAD - Software and FEA-Techniques. In this paper, the design calculations and CAD modeling and Finite Element analysis of the vegetable cleaner is presented to conclude the safe design of machine.*

Keywords—Cleaning Process, Vegetable Cleaning, CAD, Hypermesh

I. INTRODUCTION

Root vegetables like potato, carrot, raddish, beet root, sweet potatoes and similar vegetables need to be cleaned before transporting from field to market. Washing of vegetables before selling it into the market, is an important primary process, which reduces the surface microbial load, while removing the field soil, dust and even residual pesticides and impurities, thus leading to the value addition of the produce at the farm level.Contamination of vegetables is generally due to unsanitary cultivation and marketing practices. The microorganisms and pesticides involved with the food if remained unsanitized, can be critical from a public health point of view, because they can be lead to health hazard or harmful. At present there is no primary processing equipment like vegetable washers available in the market for small farmers and traders. Since washing of root vegetables before selling is a consumer's requirement, an appropriate washer must be designed to reduce time and labor in cleaning the root crop before subjecting it to sorting, grading and eventually selling in the market.Manual washing of root vegetables is a back- breaking job for everyone who does this work in the field of farm. Normally many Indian farmers follow a traditional method of cleaning the carrots, radish in which the roots are washed manually by hands and feet. So that there is need to design a rotary type vegetable cleaner machine which every farmer in India can beafford and a solution to the farmers reducing the Labour requirement and the time of the farmers.

Fig. 1: Images of Root Vegetables

II. DESIGN CALCULATIONS

A. Barrel Dimensions

1) Cleaning in 1 Hour

Total weight / total time = 2750 kg / 4 hours
= 687.5 ≈ 690 kg/hour
[4min washing with 28 revolution per minute of barrel for single charge]
Charge loading and unloading time approx = 6 min
Total time required for single charge = 6 + 4 = 10 min
Hence,
60 /10 = 6 charge in 1 hour
Weight of single charge = 690/6 = 115 kg
Volume of single charge = 115/1080 = 0.107 m3
Total barrel should be filled 1/6 for better cleaning
Considering the length of barrel = 1.47 m

$$\frac{\pi}{4} \times d^2 \times l = 0.107 \times 6$$

$$\frac{\pi}{4} \times d^2 \times 1.47 = 0.107 \times 6$$

$$d = 0.75 \text{ m}$$

2) Speed of motor is 105 RPM.
3) Torque = 147.15 N.m.
4) Power = 1618 watt ≅ 2 HP.

Part	Cross section	Material	Result
Frame bending	30x30x2.6 mm	SS304 (215MPa)	24.34 < 215 MPa Safe
Frame buckling	30x30x2.6 mm	SS304 (215MPa)	6891.95 > 502.76 N Safe
Frame compression	30x30x2.6 mm	SS304 (215MPa)	1.76 < 215 MPa Safe

Table 1:

The given table can be explain different loading conditions, on the part of frame as bending, buckling, compression. From the design calculations, followingspecifications are obtained.

690 Kg vegetables can be cleaned in 1 hour with 1.47 m length and 0.75 m diameter of barrel dimension with rotation at 28 revolution per minute. From the design calculations performed in previous research structure supporting the whole system is in the safe zone.

III. CAD MODELING OF VEGETABLE CLEANER

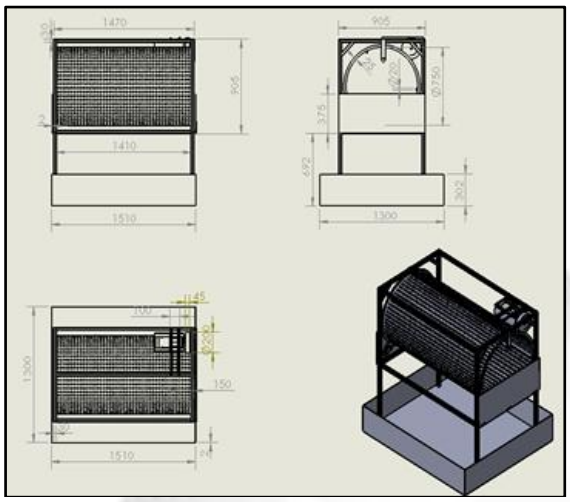


Fig. 2: Picture ofCAD - MODEL

In fig 2. CAD model picture with the design measurement ofthe vegetable cleaner machine is shown. This one is the finalized model of the machine.With the design of barrel, motor, frame – cage, and tank is supplied with the small outlet at corner portion.

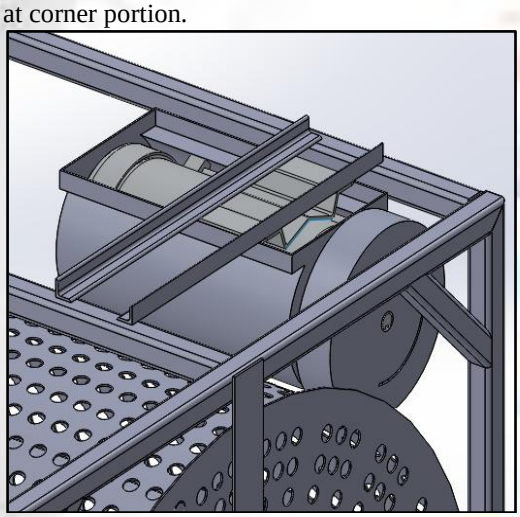


Fig. 3: CAD Model ofDrive System

In fig. 3 CAD – model of system is shown. With the rotor barrel of the vegetable cleaner machine with the sectioned part is shown. 105 RPM motor is run for suppling torque to the barrel system.

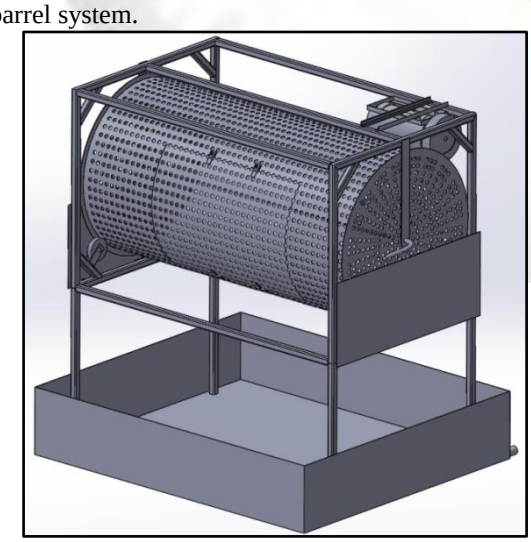
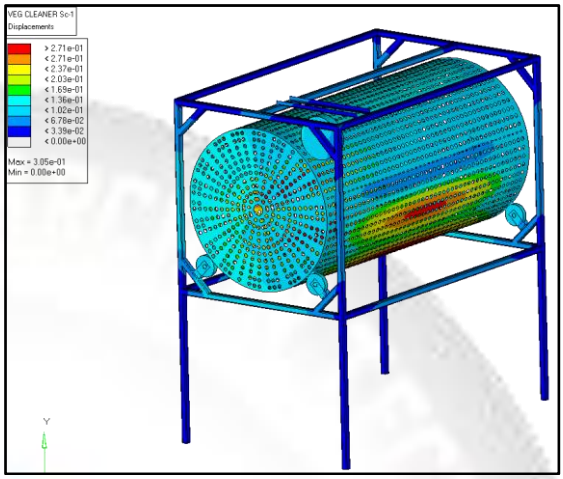


Fig. 4: CAD Model of Vegetable Cleaner

Fig .4 is the complete structure of the modified CAD model. Which means that vegetable cleaner machine is to be properly designed. This cad model is sutaible for medium loading condition with the side pannel door on barrel.

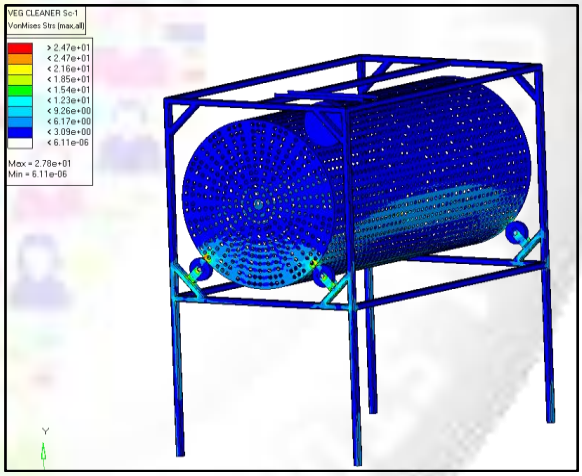
IV. FINITE ELEMENT ANALYSIS



Maximum Displacement = 0.3 mm

Fig. 5: FEA - MODEL

In given fig.5 FEA – model shows maximum displacement of the barrel with color pattern.Red color shows that maximum displacement on the barrel which gives the maximum loading effect in the running condition of the machine.



Maximum Stresses = 30.6 MPa

Fig.6: FEA - MODEL

The given fig. 6 shows that the maximum stress pattern on the FEA model. It means that on loading condition it would be in safe zone. Heavy material load does not affect the machine.

V. RESULTS

From the Linear Static Analysis 0.3 mm maximum displacement and 30.6 MPa Maximum stress obtained.

COMPONENT	FRAME	BARREL
MATERIAL	SS304	SS304
YOUNGS MODULUS	210000 N/mm^2	210000 N/mm^2
POISSONS RATIO	0.29	0.29
DENSITY	7850 Kg/m^3	7850 Kg/m^3
YIELD STRESS	215 N/mm^2	215 N/mm^2

From linear static analysis and material properties table, the stresses obtained in the structure are within the limit of Yield stress (215 MPa) of material. With the young's modulus 210000 N/mm^2, density of the steel material SS304 which is to be 7850 Kg/m^3.

VI. CONCLUSION

The paper involves the detailed design and analysis of vegetable cleaning machine. In this paper, designed and analyzed a vegetable cleaner machine as per the company requirement. Then FEM - analysis of vegetable cleaning machine for validation of design is performed and the results obtained are shown in the safe zone as the stresses obtained are less and within the limit of yield point stress of that material. Which gives a model should be an economical, simple to operate, compact and reliable means to wash fruits and vegetable.

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