Finite Element Method - Analysis Of Rotary Type Vegetable Cleaner Machine

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Abstract - Root vegetables and fruits should be cleaned before weighting and grading as in the harvesting process it leaves the soil and foreign materials stick to the vegetable surface. Soil and other foreign materials must be removed, especially for medium and heavy textured soils 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, polished and chemical free fruits and vegetables. At present time,washing of fruits and root vegetables is carried out manually which is 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 a requirement as to be design and develop a vegetable cleaning machine which will reduce the required human effort and make their task easy. Main objective of this study is design and develop a vegetable cleaning machine, using CAD model and FEM-Analysis Techniques. In this study, the design calculations and CAD modeling and Finite Element Analysis of the vegetable cleaner machine is present to conclude the safe design.

Keywords - cleaning process, vegetable cleaning,CAD model.

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1. Introduction

Root vegetables like potatos, sweet potatos, carrots, raddish, beet roots and similar vegetables need to be cleaned before transporting from field to the 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 chemicals, thus leading to the value addition of the product at the farm level. In the practical form contamination of vegetables is generally due to unsanitary cultivation and marketing practices. The microorganisms and pesticides involved with the food if they remaine unsanitized, it can be harmful for a public health point of view, because they can lead to health hazard. At present there is no primary processing equipment like vegetable washers available in the market for small farmers or 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 of the root crop before subjecting it to sorting, grading and eventually selling in the market.Manual washing of root vegetables is a backbreaking job for everyone who does the work. 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 for the utilisation of every farmer in India should be in affortable price.

Fig 1: Images of root vegetables

2.Design Calculations

1) Barrel dimensions
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) Torque calculation;
Considering total weight to be rotated is 150 Kg

$$150 \times 9.81 = 1471.5\ N$$
$$T = F \times r$$
$$T = 1471.5 \times 0.1 = 147.15\ N.m$$

3) Power calculation;

$$P=2\pi NT/60$$

$$P=(2\times\pi\times105\times147.15)/60= 1618 \text{ watt}$$

From the design calculations, following specifications are obtained.
690 Kg vegetables can be cleaned in 1 hour with 1.47 m length and 0.75 m diameter of barrel rotating at 28 revolutionper minute.
From the design calculations performed in previous research structure supporting the whole system is safe.

3. CAD modeling of vegetable cleaner

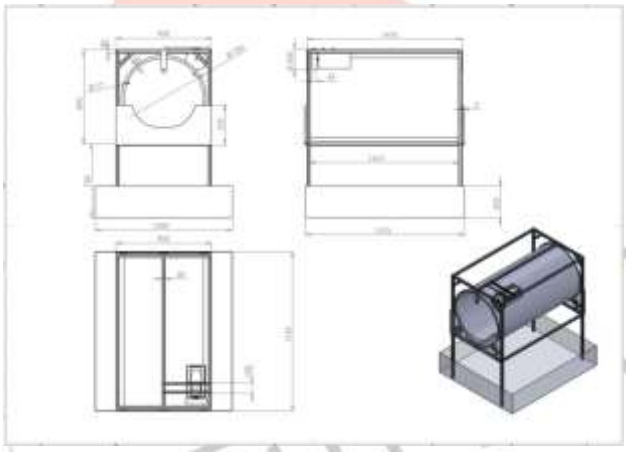


Fig. 2 Detailing Drawing Of Vegetable Cleaner

In fig.2 Detailed CAD drawing of vegetable cleaner machine is given. With the correct diamensions, all parts are explain. This diagram shows the front view, top view and side view with the complete model.

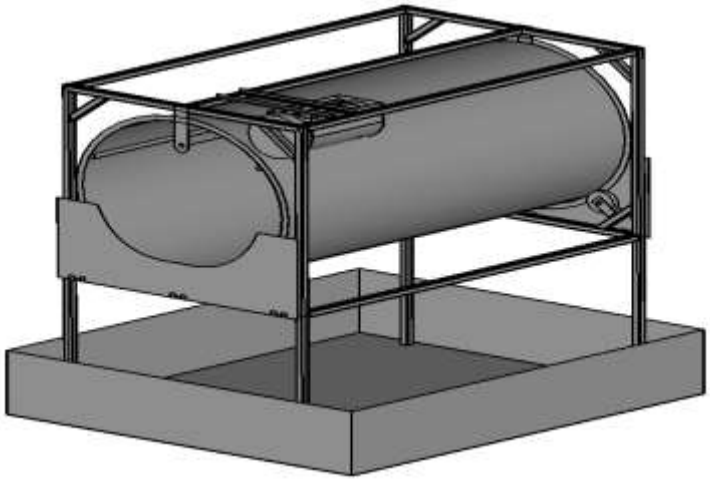
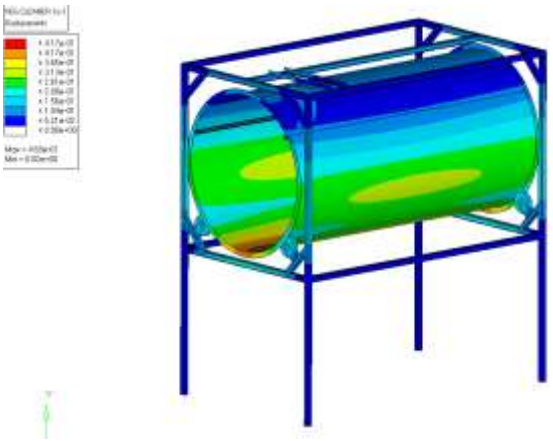


Fig. 3 CAD Model Of Vegetable Cleaner

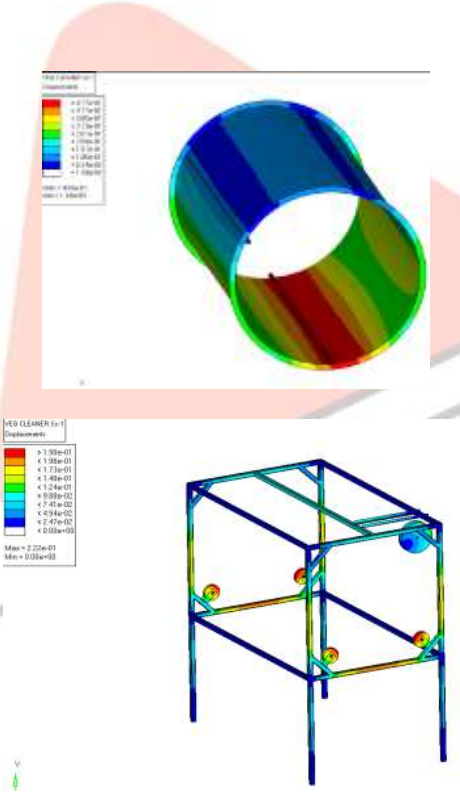
In fig.3 CAD – model of vegetable cleaner machine is given.

This is initial CAD model of the machine with the plane steel metal sheet. In which barrel, frame, and tank is provided with the motor.

4. Finite Element Analysis



Maximum Displacement = 0.46 mm
Fig. 4 FEA –MODEL

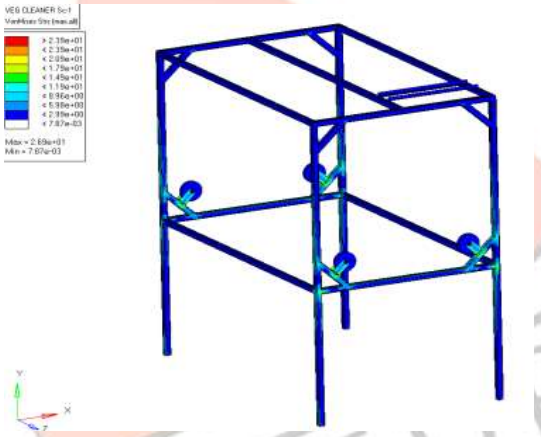


Maximum Displacement = 0.46 mm
FIG. 5 FEA - MODEL

In fig. 4 and 5 FEA – model of vegetable cleaner machine is given. This is a maximum displacement pattern form in which maximum displacement is to be 0.46 mm. It is shown in the result format on the barrel.

Maximum Stresses = 30.6 MPa

FIG.6 FEA – MODE



Maximum Stresses = 30.6 MPa

FIG.7 FEA- MODEL

In the given fig. 6 and 7 FEA – model of vegetable cleaner machine is shown in which the maximum stress pattern is shown that should be 30.6 MPa. Maximum stresses shows that barrel should be affected at this place. Blue pattern on the fig means that the design would be safe.

5. Results

From the Linear Static Analysis 0.46 mm maximum displacement and 30.6 MPa. Maximum stresses was obtained.
The tabular format of machine can be explain in below table as

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 the table the linear static analysis and material properties of the vegetable cleaner machine is shown, the stresses obtained in the structure are within the limit of Yield stress (215MPa) of material. Steel material for frame and barrel having component material SS304 which is tought with the density 7850 Kg/m^3 and it has a higher corrosion resistance than regular steel and is widely used .

6. Conclusion

The paper involves the detailed design and analysis of vegetable cleaning machine. In the present study, designed and analysed of vegetable cleaner machine as per the company requirement. The 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 yield point stress of that material. Which means that given design is in the safe zone.

7. References

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