DESIGN OF MANUAL VEGETABLE SLICING MACHINE

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Abstract

A vegetable slicing machine was designed and constructed. It can be powered manually which takes care of power failure problems, and can be used in rural area where there is no electricity supply. The vegetable is fed into the machine through the hopper made of aluminium sheet to the slicing drum which carries slicing blades made of stainless steel. The chute constructed of stainless steel accepts the sliced vegetable and released it out with the aid of gravitational force. The result obtained shared that the rotating speed has significant effects on the slicing capacity, slicing efficiency, and sliced vegetable geometry. The higher the rotating speed, the higher the slicing capacity and the lower the slicing efficiency.

Introduction

From time immemorial, the use of knives and plastic graters were the major tools for slicing and grating vegetable items such as tomatoes, pepper, carrot, onions, and so on. But as time went on, technology began to advance and different manufacturers looked forward to how to eradicate time wastage when using knife to cut and injuries caused by knives (Bird, 1995).

In the past years, knives were the common tools used for slicing and cutting vegetables to smaller sizes. But as time went on, it was noticed that, for one to cut just a little quantity of vegetables, it will take long time in doing that and in some cases, it causes injuries as a result of carelessness.

Due to these inconveniences, technology is been devised to help ease the working operation of slicing and to eradicate time wastage. This vegetable slicing machine is employed and applicable where vegetables of small quantities are to be sliced and this in turn, makes it more suitable in environments where students, bachelors, etc are residing, (Morling, 1974).

Specific Objectives

- to ease cutting of vegetables
- to save time
- to showcase African technology
- to be affordable at low prices
- to serve as a reference for further improvement

Design Methodology

Useful design equations relating, efficiency and effort were considered in selecting the engineering materials used for the design.

Knives and its Types

A knife is a device used for cutting and slicing vegetables and other items. It is commonly made of a blade and a handle. The blade is a sharp surface with pointed edge used for the slicing and cutting, while the handle which is normally made of plastic or wood, is used as a support in holding the straight end of the blade.

There are different types of knives, some of which are:

Cheese knife: These are knives commonly used for cutting cheeses on a cheese board.

Steak knife: This is a type of knife for cutting steaks (i.e. a thick slice of good quality beef), and with a special type of blade.

Bread knife: This type of knife is generally applicable for cutting and slicing breads at different sizes. Also, this bread knife uses a serrated blade as its blade.

Carving knife: This is a large sharp knife used for cutting vegetables and cooked meats.

Steels and Aluminum

In this design, stainless steel and aluminum were the metals used. The stainless steels were used in the body frame, the cutter, the cutter seat and the handle due to its ability to resist corrosion. Aluminum sheet was used to produce the collector where the sliced item is being made to go in. Looking at steel as whole, steel is an alloy of iron and carbon (Harrison, and Nettleton, 1982). Pig iron is a relatively impure material containing up to 10% carbon, silicon, manganese, phosphorus and sulphur. The manufacture of steel from pig iron involves the progressive oxidation of these impurities which are lost as slag or gases. Since steels are produced from pig iron, there is the tendency of it getting rusted and as a result of this; chromium and Nickel were added to it to make it stainless thereby, giving it the ability to resist corrosion.

Aluminum is an element obtained from the reduction of alumina (Al_20_3) via the electrolytic process. Some of its properties that made it suitable for the collector are:

- It is durable
- It is light in weight
- It has a controus, white and attractive appearance
- It does not corrode easily
- It is usually available with low cost of purchase

Properties of Steel

The properties of steels are highlighted below:

- Physical properties
- Mechanical

Physical Properties of Steels

The physical properties of steel relates to the atomic structure and composition of steels as well as to how they react with the surrounding. They include:

- **Magnetism:** This is the ability of steels to be magnetized
- **Corrosion resistance:** This is the ability to withstand corrosion.

Though steel rusts in wet environment and oxidizes if heated in air, it can withstand corrosion by the addition of chromium and Nickel to it which will the form C_20_3 on the surface (Ashby and Jones, 1994) which is called stainless steel.

Mechanical Properties of Steels

The mechanical properties of steels relates to the behavior of steels under static and/or dynamic forces as well as its ability to withstand such forces. These are:

Hardness: This is the ability of steels to resist indentation.

Durability: This is the property which allows steels to be stretched or changed in shapes without breaking and to retain the new shape on removing the external load.

Impact resistance: This is the ability of steel to withstand impact load/force.

Bending ability: This has to do with ease of which steel can bent.

Materials Selection and Design Equations

Material Requirements

To satisfy operational requirements and design purposes of the vegetable slicer, materials were adequately selected after considering their properties. Stainless steel was mostly used for most of the component parts while aluminum was used for the detachable collectors. The following factors influenced the choice:

- **Availability:** They are highly available in the market with low cost of purchase.
- **Compositions:** The compositions of chromium and Nickel in the stainless steel are about 3-4.5% and 2-2.5% respectively. While the composition of copper, Nickel and Magnesium in Aluminum were about 3-5-4.5%, 1.8-2.3% and 1.2 to 1.7% respectively.

- **Its properties:** This has to do with its physical and mechanical properties as earlier discussed.

Design Procedure

The design process is a scheduled plan for realizing an estimated goal. The estimated goal in this case is to design of a manual vegetable slicing machine. Design covers a wide range of activities from the conception of ideas to the preparation of working drawings (McCarthy and Repp 1987). This machine is therefore, designed such that it can slice vegetables such as tomatoes, fresh pepper, carrot etc. to smaller pieces with minimal strength. It will have other special characteristic which makes it very unique when produced such as:

- **Durability:** This is the ability of lasting long without breakage
- **Portability:** The device is freely and easily moved without stress or any form of inconveniences.

Working Principle of the Vegetable Slicing Machine

This device is designed in such a way that when vegetable are placed inside the machine, the rotary motion of the cutters from the handle is made to crush these vegetables thereby, reducing their sizes to its minimum. With the aid of the collector, the sliced vegetables is collected.

Maintenance of Machine

There are three types of maintenance in engineering at large, these are:

- Planned maintenance
- Preventive maintenance
- Corrective maintenance

To be on the safe side, it is always advisable to utilize the preventive type of maintenance for this very device.

The following maintenance guidelines should be adhered to in the use of the machine:

It should be washed and cleaned thoroughly after usage.

Little force should be applied when slicing in order to avoid a little clearance between the handle diameter and the cutter pipe diameter.

Design equations

To calculate for the torque or twisting moment (T), of the cutter shaft, we have

$T/j = \ /r$

Where T = is the torque

J = polar moment of inertia of the shaft

٦ = the shear strength

r = the radius of the shaft (Riley, Sturge and Morris, 2001)

Given that,

٦ = 620MPa

r = 3mm, d = 6mm

L = 50mm

J = ?

But $J = \frac{{}^{A}cl^4}{32}$

$J = \frac{3.142 \times (6)^4}{32}$

$J = \frac{4072.032}{32}$

$= 127.25mm^4$

T/j = ٦/r

$T = J٦/r = \frac{127.25 \times 620}{3}$

$= \frac{78895}{3}$

T = 26298.33N-mm

But power (P), = $\frac{2n \ NT}{60}$

where N = is the number of revolution per minute and it is given as 20rpm

T = is the torque.

$P = \frac{2 \times 3.142 \times 20\ 26298.33}{60}$

$= \frac{3305174.1}{60}$

P = 55086.2.W

$P = 55.08 \times 10^3 W$

Angle of twist ( ) of the rotating shaft, = TL/FJ

Where G = Modulus of rigidity of stainless steel

And is given as 86 GPa = 86×10^9N/m = $86 \times 10N^3/mm^2$

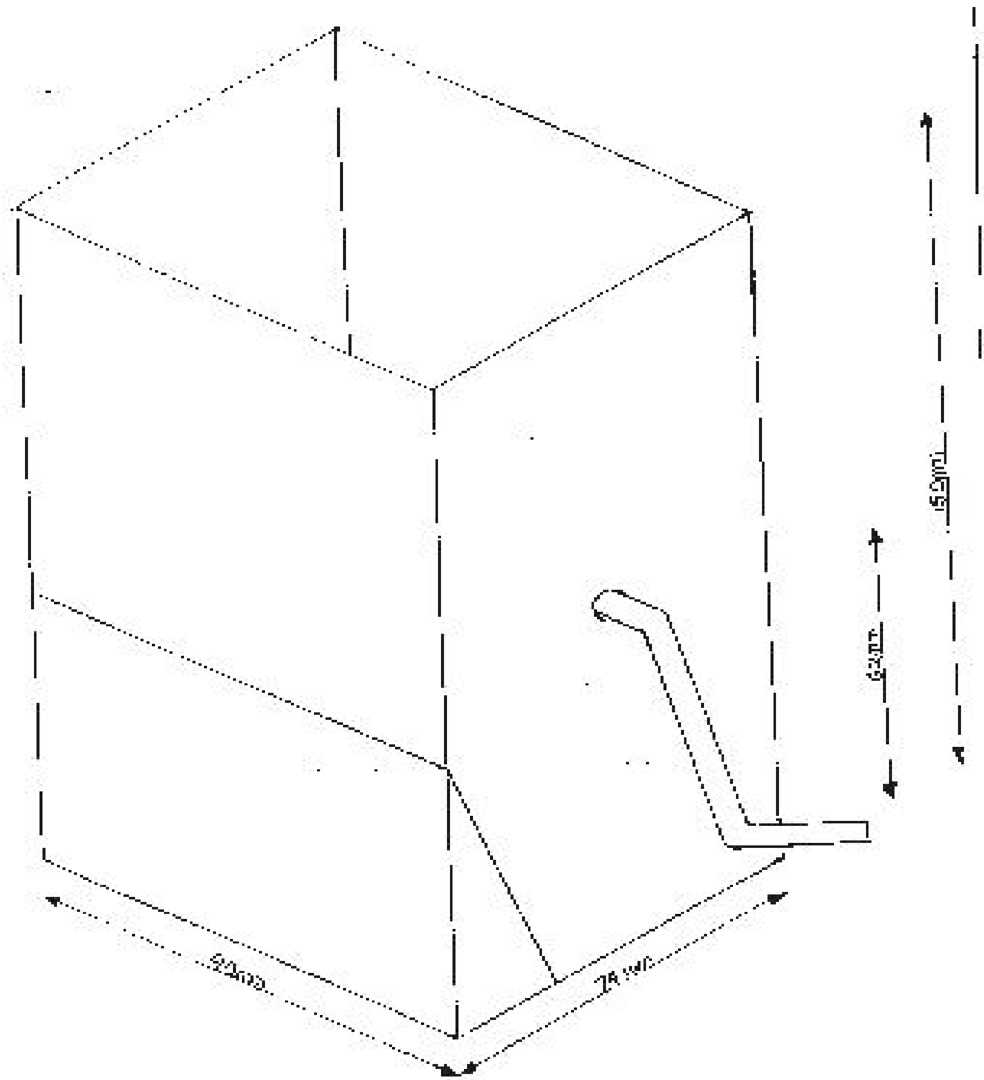
$\Theta = \frac{26298.33 \times 50}{86 \times 103 \times 127.25}$

$= \frac{1314916.5}{10943500}$

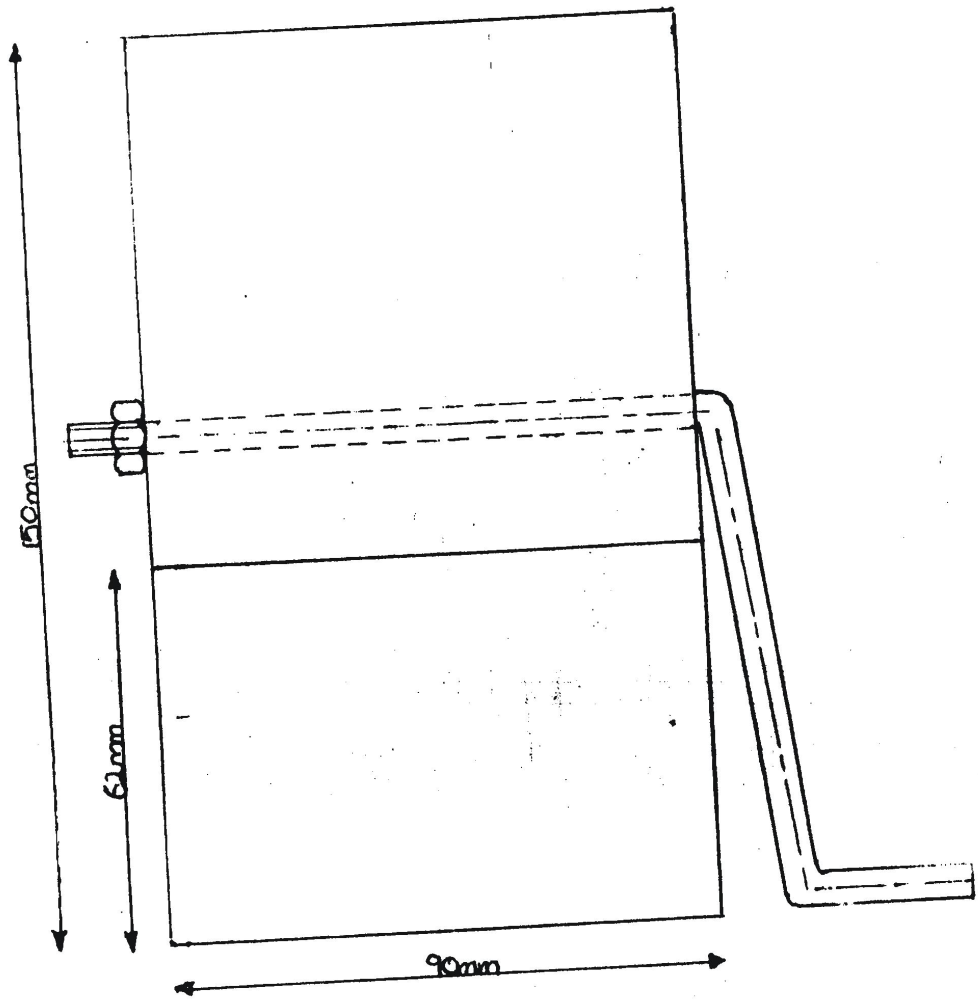
$\Theta = 0.12^0$

Detail Drawings

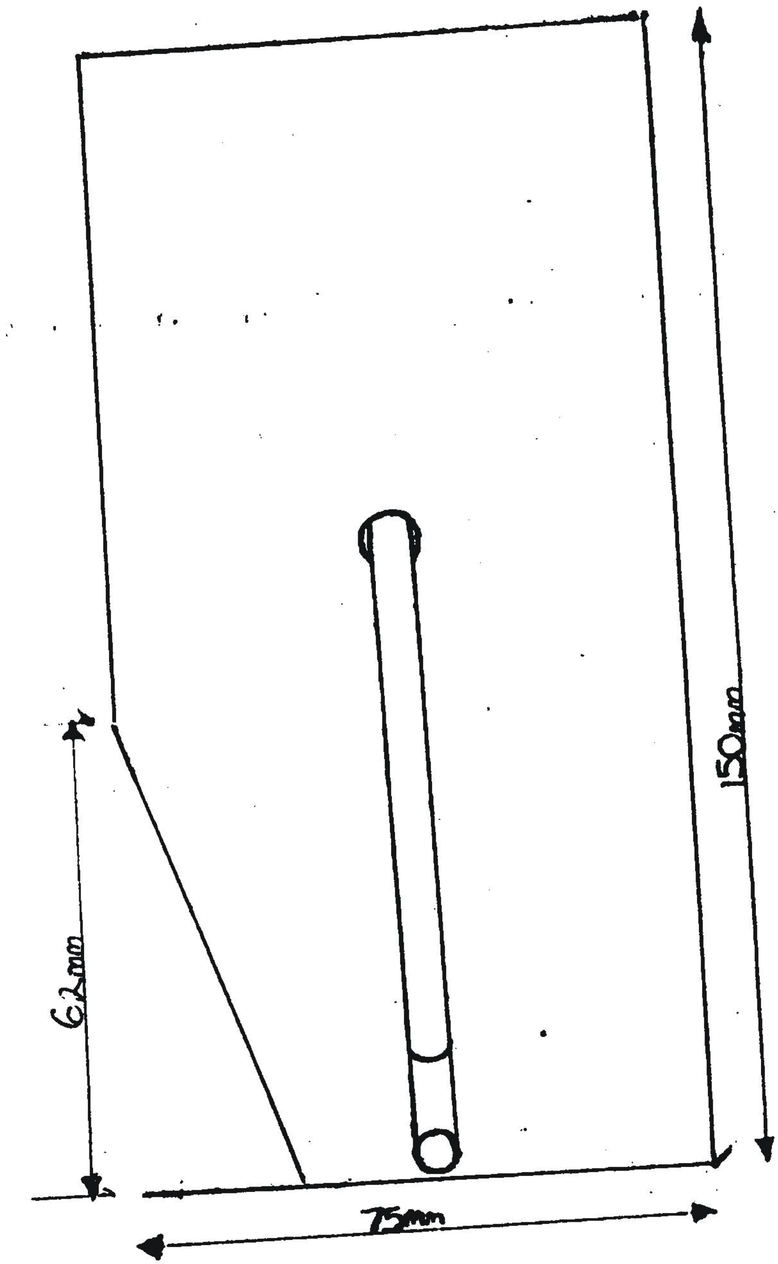
Isometric View of the Vegetable Slicing Machine



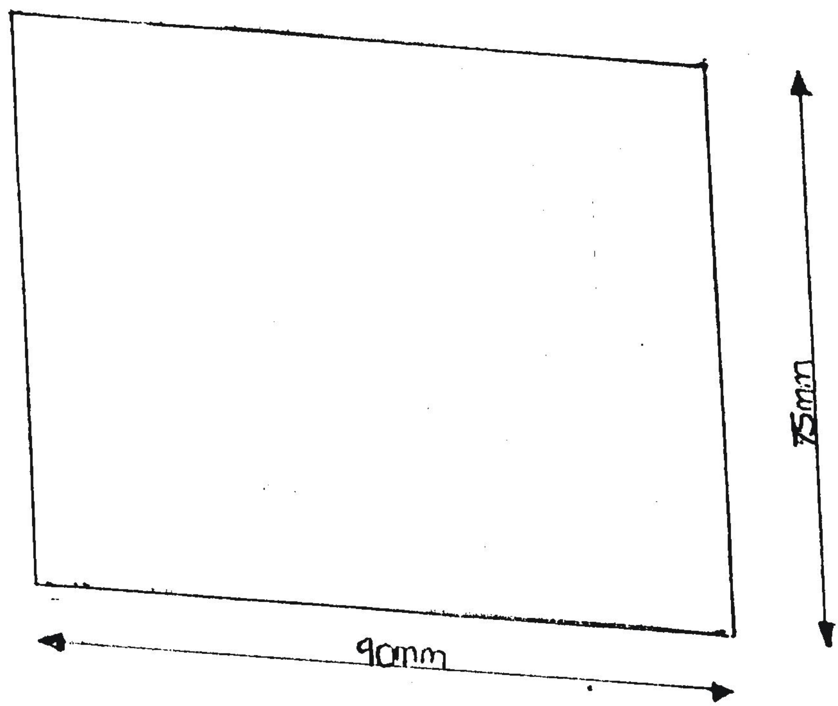
Front View



Side View



The Plan



Conclusion

The design demonstrates that simple member elements can be assembled to make a functional engineering device. The device here is house equipment used mostly by singles or in situations where a small quantity of vegetable is sliced. Engineering materials that cannot rust were selected to make up the design. Simple design equations involving angle of twist, shear strength and power were related in the course is going through the design process.

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