

DESIGN & MANUFACTURING OF CORK FITTING MACHINE

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Abstract - Cork is a material which has been used for mankind for the last 5,000 years and it is a strategic material used for multiple applications, from wine bottles to aeronautics. Many of current cork materials are composites, in particular cork materials for floor and wall coverings and several other building and industrial applications. Recent developments in cork research have shifted from the classical cork-wine relationship to quality and environmental issues, exploitation of cork industry residues and new cork based materials. In recent years a number of new cork based composite materials were developed.

Filling is a task carried out by machine that packages liquid product such as cold drink, water, wine. The existing automated machines of filling and capping involves placing bottle by conveyor and filling and capping at time. These methods are expensive and time consuming. In this paper design and manufacture corking machine is done that will meet requirement of the wine growers who need good quality product at reasonable price. This manual corking machine will be good alternative for expensive traditional ones.

Key Words: Material properties, cork, chemical composition.

1. INTRODUCCION

Corking machine meets the requirements of those wine-growers who need a good quality product at a reasonable price. This corking machine is a good alternative to the traditional manual ones, which are less accurate in the bottling operation and therefore might result in damaging the cork. Corking machine is almost entirely made of stainless steel to make cleaning easier. Moreover all those parts which could come into contact with the corks are made of materials that do not react with the air (such as stainless steel, Plexiglas, chromium plated steel), in order to prevent all chances of polluting corks with rust splinters or whatever other substances bad for health. Even the internal mechanisms, such as connecting rods and levers, are galvanized. All the parts which come into contact with the bottle are made either of rubber or pvc to avoid the breaking off of splinters from the glass.

There are several types of machine which can operate automatically but that causes more capital cost. Some are PLC based, Hydraulic or pneumatic machines can lead to good quality of product.

In this paper, design of low cost, manually operated cork fitting machine is done, which meets the small scale company demands.

Design is done for two types of bottles who's dimensions are

Table 1. Dimensions of bottle

750 ML BOTTLE	375 ML BOTTLE
height-30 cm	height-24 cm
width-8 cm	width-6 cm
neck size-	neck size-
height-10 cm	height-6.5 cm
width-2.8 outer	width-2.6 outer
2.5 inner	2.2 inner

2. DESIGN METHODOLOGY

There are different types of closures used in bottling industry.

2.1 Selection of cork

There are a variety of types of cork stoppers, depending upon the quality and purpose of the wine. There are various types of cork available in market but as per company requirement we have selected synthetic cork. This cork is basically low in cost and easily available as compared to previously used crown metal caps. These are stoppers made molded from synthetics of either medical or food grade plastics, they were designed much like cork stoppers, and more preferable than natural and metallic.

Dimension of cork:

Material-synthetic

Height-4.5 cm

Width-3 cm



a) Front View

b) Top View

Fig 1. Picture of Synthetic cork

2.2 Design of Machine

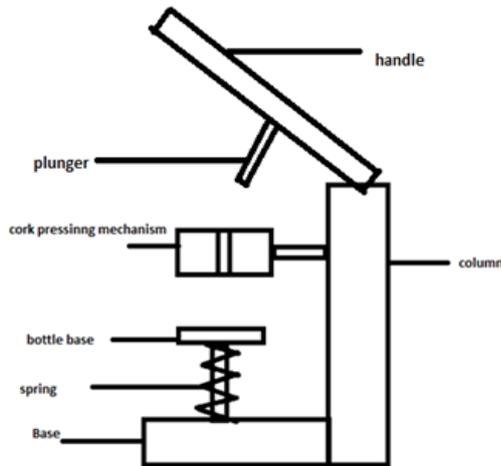


Fig.2 Schematic structure of machine

Table 2. Nomenclature

Nomenclature	
P- axial load, N	n- number of active coils
d- diameter of wire ,mm	T- Shear stress, N/mm ²
C- spring index	G-modulus of rigidity, N/mm ²
	K _s -Wahl stress factor

F_B by experiment :-

force required to push the cork in bottle is 13 kg

Weight of bottle without wine = 300-900 gm

Considering average weight = 500 gm

Selecting maximum weight = 900gm + 750gm

$$= 1.65 \text{ kg}$$

Taking weight = 2 kg for safety.

So total Weight on the base on which bottle to be placed is

$$= F_B + \text{weight of bottle}$$

$$= 2 \text{ kg} + 13 \text{ kg}$$

$$= 15 \text{ kg} \approx 19 \text{ kg for safety.}$$

Now design of spring for bottle base:

The stiffness of spring should be capable of holding 19 kg without compressing.

Selecting spring material steel.

Weight applied 19 kg.

So,

$$P_{\max} = 19 \times 9.81 = 186.39 \text{ N}$$

$$\tau = k_s \frac{8 P_{\max} C}{\pi d^2}$$

For steel material

$$\tau = 400-450 \text{ N/mm}^2$$

Calculation of Wahl stress factor:

$$k_s = \frac{4C - 1}{4C - 4} + \frac{0.615}{C}$$

Considering C= 6

$$k_s = \frac{4 \times 6 - 1}{4 \times 6 - 4} + \frac{0.615}{6}$$

$$k_s = 1.2525$$

Substituting values in equation (1)

$$400 = \frac{1.2525 \times 8 \times 19 \times 9.81}{\pi \times d^2}$$

$$d = 2.9 \approx 3 \text{ mm}$$

So the wire diameter of a spring is 3mm

Considering the deflection of a spring is 10mm

$$\delta = \frac{8 \times P_{\max} \times C^3 \times n}{Gd}$$

Assume,

$$G = 80000 \text{ N/mm}^2$$

$$n = \frac{10 \times 80 \times 10^3}{19 \times 8 \times 9.81 \times 6^3} \times 3$$

$$n = 7.45 \approx 9$$

So, the number of active coils is 9

Assembly mechanism spring-Material-spring

$$\tau = 350-400 \text{ N/mm}^2$$

$$F = 4 \text{ kg} = 39.24 \text{ N}$$

$$\tau = k_s \frac{8 P_{\max} C}{\pi d^2}$$

$$350 = \frac{1.2525 \times 8 \times 39.24 \times 6}{\pi \times d^2}$$

$$d = 1.465 \approx 2 \text{ mm}$$

So the wire diameter of a spring is 2mm

Considering the deflection of a spring is 4mm

$$\delta = \frac{8 \times P_{\max} \times C^3 \times n}{Gd}$$

Assume,

$$G=80000 \text{ N/mm}^2$$

$$n = \frac{4 \times 80 \times 10^3}{8 \times 39.24 \times 6^3} \times 2$$

$$n = 9.4 \approx 9$$

So, the number of active coils is 9

Side stand spring-

Material-spring

$$\tau = 350-400 \text{ N/mm}^2$$

$$F=2 \text{ kg}= 20 \text{ N}$$

$$\tau = k_s \frac{8 P_{\max} C}{\pi d^2}$$

$$350 = \frac{1.2525 \times 8 \times 20 \times 6}{\pi \times d^2}$$

$$d = 1.045 \approx 1 \text{ mm}$$

So the wire diameter of a spring is 1 mm

Considering the deflection of a spring is 8mm

$$\delta = \frac{8 \times P_{\max} \times C^3 \times n}{Gd}$$

Assume,

$$G=80000 \text{ N/mm}^2$$

$$n = \frac{8 \times 80 \times 10^3}{8 \times 20 \times 6^3} \times 1$$

$$n = 18.51 \approx 19$$

So, the number of active coils is 19

2.3 Construction

Design of machine is first carried out on Autodesk Inventor as a design software. It is a 3D mechanical engineering design visualization and simulation software. Autodesk inventor is a parametric and feature based solid modeling tool it allows you to convert the basic 2D sketch into a solid model using very simple modeling options. It creates digital prototyping as opposed to physical prototyping by integrating 2D AutoCAD drawings and 3D data into a single digital model. It can quickly and easily create stunning renderings, animations and presentation that improve communication. It can easily generate and share production-ready drawings for manufacturing teams. The automatic updating feature allows easy

changes in models. It has a simulation environment that allows motion simulation, static and model finite element analysis (FEA) of parts, assemblies, and load-bearing frames

Main parts of the design

Handle

Bottle base and locking arrangement

Cork compressing mechanism

Frame structure

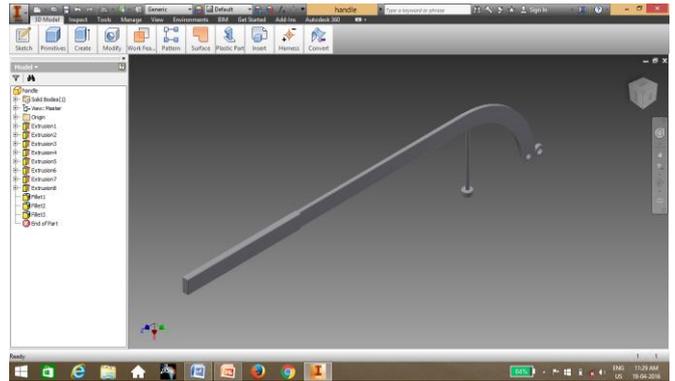


Fig.3 Model of handle

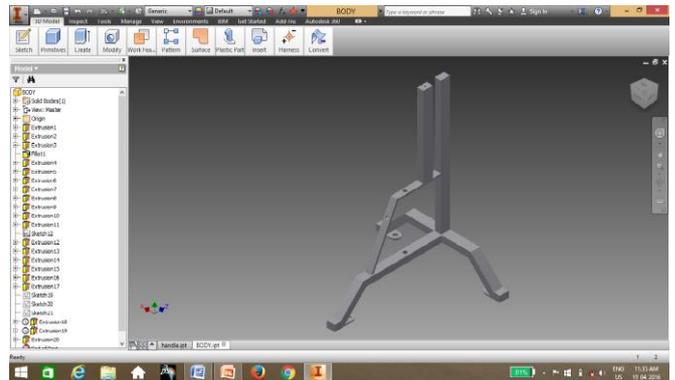


Fig.4 Model of frame

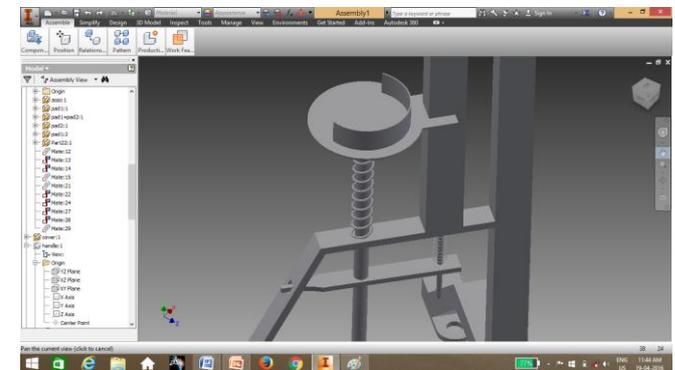


Fig.5 Model of Bottle base and base locking mechanism

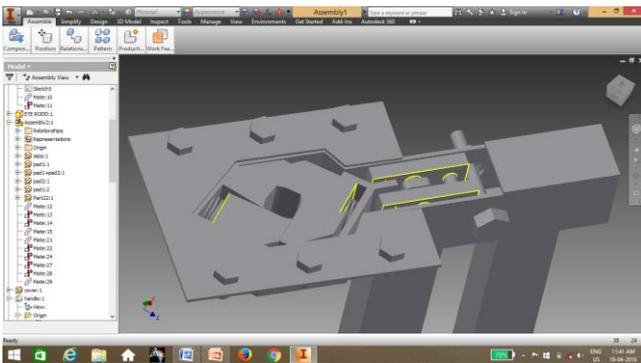


Fig.6 Model of Compression mechanism

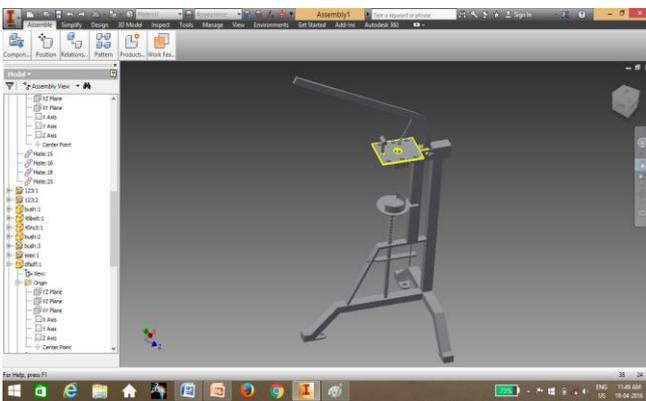


Fig.7 Assembly

3. MANUFACTURING OF MACHINE

Manufacturing of machine is carried out in fabrication workshop. For manufacturing of machine different processes are carried out. Following are the processes used in manufacturing of machine,

- Cutting Process
- Drilling Process
- Welding Process
- Shaping Process
- Grinding Process

Grinding is the most common form of abrasive machining. It is a material cutting process which engages an abrasive tool whose cutting elements are grains of abrasive material known as grit. These grits are characterized by sharp cutting points, high hot hardness, chemical stability and wear resistance. The grits are held together by a suitable bonding material to give shape of an abrasive tool. Welding - A weld is made when separate pieces of material to be joined combine and form one piece when heated to a temperature high enough to cause softening or melting. Filler material is typically added to strengthen the joint. Welding is a dependable, efficient and economic method for permanently joining similar metals. In other words, you can weld steel to steel or aluminium to aluminium, but you cannot weld steel to aluminium using traditional welding processes.

Selection of the welding process

The selection of the joining process for a particular job depends upon many factors. There is no one specific rule governing the type of welding process to be selected for a certain job. A few of the factors that must be considered when choosing a welding process are:

- Repetitiveness of the operation
- Location of work
- Materials to be joined
- Size of the parts to be joined
- Time available for work
- Skill experience of workers
- Cost of material

After considering above factors we selected arc welding process for joining of various parts of our machine

Cutting processes

a) Sawing

Sawing is used to cut the correct sized work piece from a large raw material stock. There are several types of saws Hacksaws: straight blade, moving in a reciprocating motion; Band saws: straight blade ends welded together to make a loop, moving continuously in one direction; Circular saws: blade in the shape of a circular disk, rotating continuously. Hacksaw and circular saw has been used for cutting purpose of various parts of the machine.

b) Shaping process

Shaping uses a single-point tool that is moved horizontally in a reciprocating motion along a slide. It is used to create a planar surface, usually to prepare rectangular blocks that can later be used as work pieces for machining on a milling machine etc. The machine is simple – a typical machine is shown in Figure 4, along with a short description of its operation. Shaping machine have been used for surface planning of stainless steel pads used in compression mechanism of our mechanism

Drilling process

The geometry of the common twist drill tool (called drill bit) is complex; it has straight cutting teeth at the bottom – these teeth do most of the metal cutting, and it has curved cutting teeth along its cylindrical surface. The grooves created by the helical teeth are called flutes, and are useful in pushing the chips out from the hole as it is being machined. Clearly, the velocity of the tip of the drill is zero, and so this region of the tool cannot do much cutting. Therefore it is common to machine a small hole in the material, called a centre-hole, before utilizing the drill. Centre-holes are made by special drills called centre-drills; they also provide a good way for the drill bit to get aligned with the location of the centre of the hole. There are hundreds of different types of drill shapes and sizes; here, we will only restrict ourselves to some general facts about drills.

- Common drill bit materials include hardened steel (High Speed Steel, Titanium Nitride coated steel); for cutting harder materials, drills with hard inserts, e.g. carbide or CBN inserts, are used;

- In general, drills for cutting softer materials have smaller point angle, while those for cutting hard and brittle materials have larger point angle;

- If the Length/Diameter ratio of the hole to be machined is large, then we need a special guiding support for the drill, which itself has to be very long; such operations are called gun-drilling. This process is used for holes with diameter of few mm or more, and L/D ratio up to 300. These are used for making barrels of guns;

- Drilling is not useful for very small diameter holes (e.g. < 0.5 mm), since the tool may break and get stuck in the work piece

Turning - Turning is a cutting operation in which the part is rotated as the tool is held against it on a machine called a lathe. The raw stock that is used on a lathe is usually cylindrical, and the parts that are machined on it are rotational parts – mathematically, each surface machined on a lathe is a surface of revolution. There are two common ways of using the lathe. If a hole needs to be drilled in the end face of the part, then a drill can be mounted in the tailstock. The cylindrical part is held in the chuck, and the spindle rotates the part at high speed. Turning operation on the lathe has been used to produce cylindrical bushes used in the machine



Fig. 8 Image of actual manufactured machine

The fig.8 shows the actual machine which we have fabricated for cork fitting in bottling industry.

4. CONCLUSION

Cork has proved to be a highly adaptable material, giving rise to products of low and high incorporated technology. The continuing interest, the increasingly detailed characterization and society's growing requirements for natural, renewable and sustainable raw materials will

create novel market areas. After study of above literature we got to know about various types of corks used in bottling industry such as natural corks, synthetic corks, screw caps etc.

The problems arises in corking of bottles like

1. The Self Adjusting Bottle Base

2. Corks do not go into bottle mouth deep enough.

3. The Cork Plunger penetrates or damages the corks.

are eliminated with newly designed machine which facilitates easy operation over the old problems.

The existing machines used in market currently are expensive and not suitable for small scale production, so that we have design and manufactured the machine. Which is hand operated, portable ,and less expensive.

REFERENCES

- [1] Gil, L. Cork composites: A review. *Materials* 2009, 2, 776–789.
- [2] Gil, L.; Moiteiro, C. Cork. In *Ullmann's Encyclopedia of Chemical Technology*, 6th ed.; Wiley-VCH Verlag: Berlin, Germany, 2003.
- [3] Soumodip Sarkar, "Message in a bottle: process innovations in the cork stopper fightback", Department of Management & CEFAGE-UE, Universidade de Évora, Largo Marques de Marialva, Palacio do Vimioso, Evora 7002-554, Portugal
- [4] S. P. Silva, M. A. Sabino, E. M. Fernandes, V. M. Correlo, L. F. Boesel, and R. L. Reis, "Cork: properties, capabilities and applications", 2005 Institute of Materials, Minerals and Mining and ASM International Published by Maney for the Institute and ASM International DOI 10.1179/174328005X41168
- [5] V. Dlust and F. Battistutta: 'Method to prepare cork for food purposes', EP1044773 A1, European Patent Office, Munich, 2000.
- [6] G. V. J. Luis: 'Method of decontaminating cork and making same more flexible and installation for performing said method', WO2004004995, World Intellectual Property Organization, Geneva, 2004.
- [7] J. M. Valverde, J. F. D. Carrillo, E. S. Sinencio and R. P.-A. Valverde: 'Method for sorting cork stoppers', ES2140309, Oficina Española de Patentes y Marcas, Madrid, 2000
- [8] H. Pereira, B. Melo and R. Pinto: Holz als Roh- und Werkstoff, 1994, 51, 301–308.
- [9] T.Kalaiselvi , R.Praveena, Aakanksha. R, Dhanya.S, 8 August 2012 "PLC Based Automatic Bottle Filling and Capping Machine User Defined Volume Selection", International Journal of Emerging Technology and Advanced Engineering, volume 2, Issue 8, pp- 134-137.