

A Peer Reviewed Open Access International Journal

# Design, Automation and Analysis of Chocolate Filling Machine

**R.Rajesh** 

PG student, Department of Mechanical Engineering, Vikas College of Engineering & Technology.

## **ABSTRACT:**

A chocolate filling machine is a machine which fills the tray of chocolate by filler. The present work is directed towards the modeling of chocolate filling machine of overall dimensions of 2m x1m x1.8m .The chocolate filling machine consists of Belt conveyor ,Motor, Gear box, Frame ,Control panel,Tray,Tray dropping assembly, Filling tank, Actuators and solenoid valves. We have modelled all the components of chocolate filling machine in a 3D CAD tool called SOLIDWORKS 2014 and assembled. We have also done the automation of chocolate filling machine.

Also performed structural analysis on frame by applying three different materials namely 6061 alloy, Alloy steel and Ductile iron in SOLIDWORKS SIMULATION package of loading 500N and 1000N .The three materials are compared with their results. The Ductile iron has obtained less stresses compared to the other materials.As 6061 alloy is failed for both the loads because the stresses induced are greater than the material yield strength.The ductile iron is cheap compared to alloy steel. So the best material for the frame would be ductile iron.

## INTRODUCTION TO CHOCOLATE FILLING MA-CHINE:

Chocolate filling machine consists of different parts

- Stepper motor
- Solenoid valve
- Material handling equipment
- Gear box

### T.Mastanaiah

Guide (Associate.prof), Department of Mechanical Engineering, Vikas College of Engineering & Technology.

- Belt conveyors
- Tray
- Tray drop mechanism
- Hopper
- Actuator

# **MATERILAL HANDLING EQUIPMENT:**



#### Fig: Industrial mezzanine.

Material-handling equipment is equipment that relate to the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. Material handling equipment is the mechanical equipment involved in the complete system. Material handling equipment is generally separated into four main categories: storage and handling equipment, engineered systems, industrial trucks, and bulk material handling.

#### **Engineered systems:**



Fig: engineered system.



A Peer Reviewed Open Access International Journal

Engineered systems are typically custom engineered material-handling systems. Conveyors, Handling Robots, AS/RS, AGV and most other automated materialhandling systems fall into this category. Engineered systems are often a combination of products integrated to one system. Many distribution centers will optimize storage and picking by utilizing engineered systems such as pick modules and sortation systems.

Equipment and utensils used for processing or otherwise handling edible product or ingredients must be of such material and construction to facilitate thorough cleaning and to ensure that their use will not cause the adulteration of product during processing, handling, or storage. Equipment and utensils must be maintained in sanitary condition so as not to adulterate or contaminate product.

#### **Industrial trucks:**



Fig: industrial truck.

Industrial trucks usually refer to operator driven motorized warehouse vehicles, powered manually, by gasoline, propane or electrically. Industrial trucks assist the material-handling system with versatility; they can go where engineered systems cannot. Forklift trucks are the most common example of industrial trucks but certainly aren't the extent of the category. Tow tractors and stock chasers are additional examples of industrial trucks. Their greatest advantage lies in the wide range of attachments available; these increase the truck ability to Material handling and efficiency.

# Types of material-handling equipment:

Bulk material-handling equipment is used to move and store bulk materials such as ore, liquids, and cereals. This equipment is often seen on farms, mines, shipyards and refineries. This category is also explained in Bulk material handling.

#### **On-rails transfer cart:**

On-rails transfer cart is a kind of material-handling equipment. It moves on the rails and can transfer heavy cargoes or equipment with the weight 1-300t between the workshops or warehouses in the factory. It is widely used in the line of metallurgy, coal, heavy manufacturing, automotive assembly, etc. Its power can be AC or DC. DC Power has rail transmit power and battery power, while AC power includes cable power and slippery touch line power. In addition, there is the manual rail transfer cart or towed rail transfer cart, also called motorized transfer trolley.

#### Cantilevered crane loading platform:

Cantilevered crane loading platforms are temporary platforms attached to the face of multi- storey buildings or structures to allow materials and equipment to be directly loaded on or shifted off floor levels by cranes during construction or demolition. They may be fixed or rolling and a variety of designs are used including fully fabricated and demountable types. The platforms are supported on needles (cantilevered beams) anchored to the supporting structure.

#### **CONVEYORS:**

Conveyors are another form of material handling. Conveyors can be used in a multitude of ways from warehouses to airport baggage handling systems. Some types of conveyors are unibilt, power and free, chain, towline and roller conveyor.

#### **Belt conveyors:**



#### **Belt conveyor:**

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor).



A Peer Reviewed Open Access International Journal

A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium - the conveyor belt - that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward.

The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.Today there are different types of conveyor belts that have been created for conveying different kinds of material available in PVC and rubber materials.

The belt consists of one or more layers of material. Many belts in general material handling have two layers. An under layer of material to provide linear strength and shape called a carcass and an over layer called the cover. The carcass is often a woven fabric having a warp & weft.

The most common carcass materials are polyester, nylon and cotton. The cover is often various rubber or plastic compounds specified by use of the belt. Covers can be made from more exotic materials for unusual applications such as silicone for heat or gum rubber when traction is essential.



Fig: chute conveyor.



Fig: wheel conveyor



Fig: roller conveyor



Fig: gravity roller conveyor

#### **STEPPER MOTOR:**

A stepper motor (or step motor) is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application.



#### **SOLENOID VALVE:**



Fig: solenoid valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.



A Peer Reviewed Open Access International Journal

Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

## **ACTUATOR:**

An actuator is a type of motor that is responsible for moving or controlling a mechanism or system. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.



Pneumatic rack and pinion actuators for valve controls of water pipes

### **Electric:**

An electric actuator is powered by a motor that converts electrical energy to mechanical torque. The electrical energy is used to actuate equipment such as multi-turn valves. It is one of the cleanest and most readily available forms of actuator because it does not involve oil.

# **Mechanical:**

A mechanical actuator functions by converting rotary motion into linear motion to execute movement. It involves gears, rails, pulleys, chains and other devices to operate. An example is a rack and pinion.

# PREPARATION OF CHOCOLATE & STOR-AGE TEMPARATURE INVOLVED IN VARIOUS STAGES:

### VARIOUS STAGES INVOLVED ARE AS BELOW

- Fermentation
- Conching
- Tempering
- Blending
- Storage



Chocolate is created from the cocoa bean. A cacao tree with fruit pods in various stages of ripening.

# **Blending:**

Chocolate liquor is blended with the cocoa butter in varying quantities to make different types of chocolate or covertures. The basic blends of ingredients for the various types of chocolate (in order of highest quantity of cocoa liquor first), are as follows:

• Dark chocolate: sugar, cocoa butter, cocoa liquor, and (sometimes) vanilla

• Milk chocolate: sugar, cocoa butter, cocoa liquor, milk or milk powder, and vanilla

•White chocolate: sugar, cocoa butter, milk or milk powder, and vanilla

The texture is also heavily influenced by processing, specifically conching (see below). The more expensive chocolate tends to be processed longer and thus have a smoother texture and "feel" on the tongue, regardless of whether emulsifying agents are added.



A Peer Reviewed Open Access International Journal

Different manufacturers develop their own "signature" blends based on the above formulas, but varying proportions of the different constituents are used. The finest, plain dark chocolate covertures contain at least 70% cocoa (both solids and butter), whereas milk chocolate usually contains up to 50%. High-quality white chocolate covertures contain only about 33% cocoa.

Producers of high quality, small batch chocolate argue that mass production produces bad quality chocolate. Some mass-produced chocolate contains much less cocoa (as low as 7% in many cases) and fats other than cocoa butter. Vegetable oils and artificialvanilla flavor are often used in cheaper chocolate to mask poorly fermented and/or roasted beans.

### Conching:



Various chocolate-making machinery

The penultimate process is called conching. A conche is a container filled with metal beads, which act as grinders. The refined and blended chocolate mass is kept in a liquid state by frictional heat. Chocolate prior to conching has an uneven and gritty texture. The conching process produces cocoa and sugar particles smaller than the tongue can detect, hence the smooth feel in the mouth. The length of the conching process determines the final smoothness and quality of the chocolate. High-quality chocolate is conched for about 72 hours, lesser grades about four to six hours. After the process is complete, the chocolate mass is stored in tanks heated to approximately 45–50 °C (113–122 °F) until final processing.

# **Tempering:**

The final process is called tempering. Uncontrolled crystallization of cocoa butter typically results in crystals of varying size, some or all large enough to be clearly seen with the naked eye.

Volume No: 2(2015), Issue No: 2 (February) www.ijmetmr.com This causes the surface of the chocolate to appear mottled and matte, and causes the chocolate to crumble rather than snap when broken.

## **INTRODUCTION TO CAD:**

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and designdocumentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provides the user with inputtools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations.

The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixilated) environments.

# Types of CAD Software:

# 2D CAD:

Two-dimensional, or 2D, CAD is used to create flat drawings of products and structures. Objects created in 2D CAD are made up of lines, circles, ovals, slots and curves. 2D CAD programs usually include a library of geometric images; the ability to create Bezier curves, splines and polylines; the ability to define hatching patterns; and the ability to provide a bill of materials generation.

### 3D CAD:

Three-dimensional (3D) CAD programs come in a wide variety of types, intended for different applications and levels of detail. Overall, 3D CAD programs create a realistic model of what the design object will look like, allowing designers to solve potential problems earlier and with lower production costs. Some 3D CAD programs include Autodesk Inventor, Co Create Solid Designer, Pro/Engineer Solid Edge, Solid Works, Unigraphics NX and VX CAD, CATIA V5.



A Peer Reviewed Open Access International Journal

#### 3D Wireframe and Surface Modeling:

CAD programs that feature 3D wireframe and surface modeling create a skeleton-like inner structure of the object being modeled. A surface is added on later. These types of CAD models are difficult to translate into other softwareand are therefore rarely used anymore.

#### **SOLIDWORKS:**

Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface. It is an easy-to-learn tool which makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.

#### **INTRODUCTION TO FEA:**

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

### INTRODUCTION TO SOLIDWORKS SIMULA-TION:

SolidWorks® Simulation is a design analysis system fully integrated with SolidWorks. SolidWorks Simulation provides simulation solutions for linear and nonlinear static, frequency, buckling, thermal, fatigue, pressure vessel, drop test, linear and nonlinear dynamic, and



Figure : simulation example RESULTS AND DISCUSSIONS:

The structural analysis of the chocolate machine frame is done by applying three different materials namely Ductile iron, 6061 alloy and Alloy steel for 500N and 1000Nloading conditions.

#### **FUTURE SCOPE:**

As chocolate filling machine is modelled the next step would be the modeling of coolers and packaging set up for the chocolates. The thermal analysis can be carried for heat stacking mechanism of chocolate machine. The structural analysis of tray could also be carried out while heat staking load will be on tray.

#### **REFERENCES:**

• "Filling Machine Selection Guide". Inline Filling Systems. Retrieved 24 May 2014.

- "Types of Packing Machine Applications". Econocorp. Retrieved 5 July 2014.
- Soroka, W, "Fundamentals of Packaging Technology", IoPP, 2002, ISBN 1-930268-25-4
- Yam, K. L., "Encyclopedia of Packaging Technology", John Wiley & Sons, 2009, ISBN 978-0-470-08704-6
- Watson, Traci (22 January 2013). "Earliest Evidence of Chocolate in North America". Science. Retrieved 3 March 2014.