

Review on Capsule Filling Machines

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Abstract: Encapsulation also known as capsule filters, capsule filling machines or encapsulation machines are mechanical devices widely employed in pharmaceutical and industrial industries. These are machines fill soft or hard gelatin capsule of various gelatin sizes with powder, active granules, semisolid or liquids containing active pharmaceutical ingredients or a Combination ingredients and solution is describe the active pharmaceutical ingredients and excipients encapsulation is the word used to describe process of filling empty capsule with content. The instrumentation of capsule filling machines operating by the tamp-filling principle has been described only once, using strain gauges. The pneumatic system replaces the conventional springs situated between tamping pins and the upper part of the tamping head. It was found that the use The pneumatic tamping head is limited to the control of fill weight during tamping. Major adjustments of fill weight at the set-up stage of the machine should be made by alteration of the tamping pin and powder bed height settings. Briefly state the primary goal of the project, such as designing, optimizing, or analyzing a capsule filling machine. describe the boundaries of the project, specifying the aspects of the capsule filling machine to be addressed, whether it's design, efficiency, optimization, or another focus area Outline the methods, techniques, or approaches used in the project, whether it involves modeling, simulation, experimental testing, data analysis, or a combination of these. Highlight the importance or relevance of the project, emphasizing how its outcomes contribute to advancements in pharmaceutical manufacturing, healthcare, or related field. Provide a glimpse of the expected outcomes or potential contributions resulting from the project, such as improved efficiency, optimized processes, or innovative designs.

Keywords: Capsules, Gelatin, Soft and Hard gelatin capsule, Advantages and Disadvantages , Capsule-filling machines, Types of capsule-filling machines Their Working Principle

I. INTRODUCTION

1.1 Capsule :-

Capsules are solid dosage forms in which the drug substance is enclosed within either a hard or soft soluble shell. Generally the shells are formed from gelatin. The capsule may be regarded as a “container” drug delivery system, which provides a tasteless/odorless dosage form without the need of a secondary coating step, as may be required for tablets. The term capsule is derived from the Latin word capsula, meaning a small container. Capsule occupy a significant position in the drug development. They are often believed as the primary oral dosage form because of their manufacturing process compared to other dosage forms.

Advantages of Capsules :-

- They are economical
- They are easy to handle and carry.
- Capsules mask the taste and odor of unpleasant drugs and can be easily administered.
- They are attractive in appearance
- They are slippery when moist and, hence, easy to swallow with a draught of water.

Disadvantages of Capsules:-

- The drugs which are hygroscopic absorb water from the capsule shell making it brittle and

- hence are not suitable for filling into capsules.
- Shorter shelf life. Capsules expire more quickly than tablets.
- More expensive.
- May contain animal products.

II. BASIC COMPOSITION OF CAPSULE

Gelling Agent:

They provide a gel like consistency to the capsule shell, providing it stability and thickness to allow filling of materials inside the shell.

Coloring Agent:

As the name indicates, it's purpose is to coat the capsules with different appealing colours.

Flavouring Agent:

This is seldom used ingredient, it's purpose is to mask the taste of capsules and make it palatable for patients by adding different flavourants.

Plasticizer:

It provides stability and makes the capsule shell's polymer film flexible and elastic.

They are added as fillers in capsule dosage form and also to increase bulk and ensure content uniformity.

Storage and Stability:

Finished hard-gelatin capsules normally contain an equilibrium moisture content of 13% to 16%.

This moisture acts as a plasticizer and thus is critical to the physical properties of the shells. At lower moisture contents (< 12%), shells become too brittle; at higher moisture contents (> 18%), they become too soft. It is best to avoid extremes of temperature and to maintain a relative humidity of 40% to 60% when handling and storing capsules.

Quality Control Test for Capsules:

1. Disintegration Time Test

Disintegrative of hard and soft gelatin capsules is evaluated to ensure that the drug substance is fully available for dissolution and absorption from the gastrointestinal tract. The compendial disintegration test for hard and soft gelatin capsules follows the same procedure and uses the same apparatus described in the article "Quality Control Tests for Tablet."

The capsules are placed in the basket rack assembly, which is repeatedly lowered 30 times per minute in to a thermostatically controlled bath of fluid at 37^oC and observed over the time described in the individual monographs.

To fully satisfy the test, the capsules disintegrate completely into a soft mass with no firm core and only some fragments of the capsule shell.

2. Dissolution Test

Drug absorption and physiological availability depend on the drug substance being in the dissolved state at the site of drug absorption. The rate and extent of dissolution of the drug from the capsule dosage form is tested by a dissolution test. This test provides a means of quality control in ensuring that different batches of the drug product have similar drug characteristics and that a given batch has similar dissolution as the batch of capsules that was shown initially to be clinically effective. The compendial dissolution test for capsules uses the same apparatus, dissolution medium, and test as that for uncoated and plain coated tablets. However, in instances in which the capsule shell interferes with the analysis.

Weight Variation Test

A. Hard Gelatin Capsule:

Ten hard gelatin capsules are usually weighed individually and the contents are removed. The emptied shells are individually weighed and the net weight of the contents is calculated by subtracting the weight of the shell from the respective gross weight. The content of active ingredient in each capsule may be determined by calculation based on the per cent drug content in the formulation.

B. Soft Gelatin Capsule:

For soft gelatin capsules, the gross weight of 10 gelatin capsules is determined individually.

Then each capsule is cut open with a suitable clean, dry cutting instrument (e.g., scissors or a sharp open blade), and the contents are removed by washing with a suitable solvent (that dissolves the fill but not the shell). The solvent is allowed to evaporate at room temperature over a period of about 30 minutes, followed by weighing of the individual washed shells. The net contents are calculated by subtraction and the content of active ingredient in each of the capsules can be determined by calculation based on the per cent drug content in the formulation.

Stability Test :

Stability testing of capsules is performed to determine the physicochemical stability of the drug substance in the finished drug product under specified package and recommended storage conditions intrinsic stability of the active drug molecule and the influence of environmental factors (e.g. temperature, humidity, light), on formulation components, and the container and closure system. The battery of stress-testing, long-term stability and accelerated stability tests help determine the appropriate storage conditions and the product's anticipated shelf life.

Types of Capsules:

Generally capsules are of two types:

1. Hard gelatin capsules
2. Soft gelatin capsules

1. Hard Gelatin capsule:

It is the capsule in which medicament(s) with or without excipient in the dry powder form are enclosed in a shell which consist of cap & body.

Hard gelatin capsules consists of two pieces in the form of cylinders closed at one end. The shorter piece is called the cap. This cap fits over the open end of longer piece called body. The drug substance is placed in the body and the caps are slid over it, hence enclosing the drug substance.

2. Soft gelatin capsule :

Soft gelatin capsules are one piece , hermetically sealed , and are made up of gelatin in which glycerin or polyhydric alcohol (sorbitol) are added , containing liquid , suspension or semisolid enclosed in it.

What is Gelatin ?

Gelatin is a heterogeneous product derived by irreversible hydrolytic extraction of treated animal collagen.

Type A: It is derived from acid treated precursors. This type of gelatin possesses an isoelectric point in the region of pH 9.0.

Type B: it is derived from an alkali treated precursor of bones. This type of gelatin possesses an isoelectric point in the region of pH 4.7.

III. CAPSULE FILLING MACHINE

A capsule filling machine, also known as a capsule filler, encapsulator, or encapsulation machine, is a type of pharmaceutical processing equipment used for filling empty capsules with different substances, including powder, pellets, tablets, granules, liquids, or different combinations, which contain active pharmaceutical ingredients (APIs)

1. Capsule filling machines can be classified into two categories according to their uses and functions: professional capsule-filling machines and personal capsule-filling machines
2. Manual capsule fillers are mainly designed for personal use in manufacturing processes requiring less or an exact amount of prescribed ingredients to be filled in the capsule, while semi and fully automatic capsule fillers are widely used for pilot production or medium.

What is a capsule-filling machine?

The capsule filling machine, simply called the capsule filler, is equipment utilized to fill empty capsules with pharmaceutical ingredients. These capsule-filling machines can be classified into two categories according to their uses and functions: professional capsule-filling machines and personal capsule-filling machines.

The professional capsule-filling machine is used in the pharmaceutical industry for large-scale production and higher efficiency. These are primarily automatic filler machines that fill a set amount of medication or pharmaceutical ingredients into the capsule.

Whereas the personal capsule filling machine is utilized for small-scale capsule production. Such capsule fillers allow the individual or a small business to fill the capsule with the necessary prescribed medication when required.

Capsule Filling or Encapsulator Machine :

Working Principle :

Some of the most common operating principles of a capsule machine include rectification which eliminates bad gelatin capsules. All the devices should also be able to separate capsule caps and dose them with different substances. They should also be capable of rejoining caps and ejecting filled capsules. So, if anyone asks you how capsule machines work, take them through the following steps. The first step includes placing the machine on a flat space. You then disassemble the capsules; that is, open them and make sure the short lids are on top while the longer ones are on the bottom facing upwards. The equipment then fills the empty caps with different materials and closes it. The entire process depends on the model and features. Some eliminate excess drug mixtures automatically while others require manual operation. Either way, the last step is to eject filled capsules.

Capsule Encapsulation Machinery: Parts and Working Principle :

Most capsule filling machines or encapsulators have a 200-300 bed hole, a loading tray, a powder tray, and a pin plate. They also have a sealing rubber-cap-plate, a lever, and a cam handle.

Let us discuss some of the most significant parts;

Capsule Hopper :

This level-sensor-activated part (for automatic capsule filling machine) holds all the empty capsules you might want to fill. It comes in a cylindrical, cubic, or conical shape and we make it with stainless steel materials. You will come across a capsule hopper with two, level sensors placed on low and high levels respectively. These hoppers open and close automatically based on the filling process.

Powder Hopper:

This part comes with a screw feeding mechanism whereby a screw conveyor transfers powder from the hopper to the filling section. A Powder hopper accommodates the substance you feed into a capsule machine through the power port. It also has a level sensor that regulates the amount of power fed into the hopper.

Powder Dosage Filling Device :

The part plays a significant role in supplying a precise amount of powder into the filling parameters. It has a level sensor that regulates powder quantity from the hopper to the filling element automatically. Based on the size of the encapsulator, the filling process occurs when the powder held on the dosing disc becomes compressed by an air jet and released to the filling funnels. Note that some of the capsules filling machines have two power dosage devices.

Complete Closed Rotary Turret:

This part allows the capsules to filter out excess powder and move to the block containing cups. The extra amount goes back to the hopper.

Mechanical Drive System :

The part is designed to create a linear, rotary, or oscillatory motion. It harmonizes all the moving parameters in a capsule machine. We have the main drive, motor drive, and a vacuum pump.

Lubrication System :

The presence of numerous moving parts calls for a reliable lubrication system. It prevents wear and tear of mechanical parts. Furthermore, it reduces friction during motion as well.

Vacuum System :

This part connects the capsule loading panel to the capsule hopper as well as the powder loading part to the powder hopper. The vacuum system ensures capsules remain intact by separating empty capsules.

Every capsule filler has its unique working principle. The step-by-step working process of the capsule filling machine is as follows:

- Positioning of translucent and colorless capsules in the capsule filling tray.
- Removing the capsule caps from the body
- Filling the capsule body with prescribed pharmaceutical ingredients
- Rearranging the capsule caps onto the capsule body
- Expulsion of the filled capsules from the machine

All capsule-filling machines or encapsulates have the same working principle.

IV. TYPE OF CAPSULE FILLING MACHINES

Different types of capsule filling machines are available in the market depending on the need for capsule fillers in the pharmaceutical industry. The capsule fillers can be divided into three broad types:

1. Hand or manual-operated capsule-filling machine
2. Semi-automatic capsule filling machine
3. Automatic capsule filling machine
4. Capsule loading machine

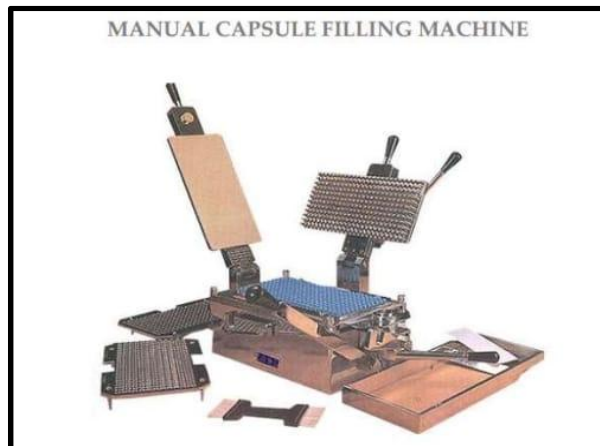
1. HAND OR MANUAL-OPERATED CAPSULE FILLING MACHINES: -

A manual capsule filling machine is mostly employed on an individual basis, but it can also be utilized in industries where accurate amounts of substances must be filled.

In one press, a Capsule Filling Hand Operated Machine can manufacture about 300 capsules. The loading trays of these capsule filling machines accommodate a volume of 300 holes. A powder tray is also included with the unit. The pin plate serves as a machine filter as well as a sealing plate for capsule caps. The machine is coupled to a cam handle with an average loading tray of 300 holes. With the above-mentioned good features, a manual capsule filling machine is capable of creating capsules to the user's specifications.

All of the above are prerequisites for a manual capsule filling machine.

Manual Capsule Filling Machine has become most versatile & most preferable choice of Smallscale pharmaceutical production, smaller batches and other trial productions. The Machine is widely used in Research Laboratories, Academic Institutions, Herbal/Ayurvedic preparation, pharmaceutical, cosmetic, food, veterinary, biotech and medium to small scale manufacturing industries.



MANUAL CAPSULE FILLING MACHINE (MODEL 100 HOLES & MAKE: OPTICS)

- 100 Holes-Manual Operation
- 1200 to 1500 capsules/hour
- SS 304 Contact Parts with MS Body
- Standard Size 0 (size has to be confirmed while ordering)
- 1 set of SS Loading Tray, SS Powder Tray and Brush
- Extra Loading tray/plate is at extra cost
- Make: Optics

2. MANUAL CAPSULE FILLING MACHINE (MODEL 300 HOLES & MAKE)

TECHNICAL SPECIFICATIONS:

- 300 Holes-Manual Operation
- 5000 to 6000 Capsules/Hour (Around approximately 60,000 Capsules per 8 Hour Shift)
- SS 304 Contact Parts
- Dimensions: 405 mm(L) X 300 mm(W) X 455 mm(H)
- With any one size of Capsule change part & standard Size • Extra change part of any Size at extra cost
- Capsule size Combinations: Size 00/0, Size 0/1/2, Size 3/4 and Size 5
- It Weighs around 60 kg. Approximately
- Make: Lodha LLP

The machine can be operated very easily and gives negligible rejections, with no weight variations. The design is functional for simplified operations giving precise result it is sturdy, easily movable and can dismantled and reassembled easily even by unskilled persons.

Production Output: Fill 300- holes plate in 30 second & provide output up to 36,000 Capsule/hour

Interchangeability: The machine is manufactured to suit capsule size combination 00/0/1/2 or 3/4/5

SALIENT FEATURES:

- **Low investment high output**
- Significant difference in your production department
- Simple to operate, can be handled by semi skilled person
- No setting system for any change part.

Machine stop automatically after loading is complete

TECHNICAL SPECIFICATIONS :

- 300 Holes-Manual Operation
- 5000 to 6000 Capsules/Hour (Around approximately 60,000 Capsules per 8 Hour Shift)

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- Extra change part of any Size at extra cost
- Capsule size Combinations: Size 00/0, Size 0/1/2, Size 3/4 and Size 5
- It Weighs around 60 kg. Approximately

WORKING PRINCIPLE OF MANUAL CAPSULE FILLING MACHINE :-

The manual capsule filling machine has three basic steps, which are:

1. Loading empty capsules: The cap and body of the capsule are detached and inserted into the loading tray while checking the front knob
2. The empty capsules are poured with the filling materials.
3. Filling medication: The operator manually fills the capsules with the desired amount of powder or granules using a spoon or a spatula
4. The filling material is pressed into the body of the capsule, where it is equally dispersed throughout the cavity
5. Closing capsules: The operator manually locks the capsules by pulling the locking lever.

2. SEMI-AUTOMATIC CAPSULE FILLING MACHINE :-

A semi-automatic capsule filler can also be defined as a hybrid capsule filling machine which is a combination of both manual and automatic capsule filling machines.

The semi-automatic capsule-filling machine is less dependent on the operator. It is designed in such a way that it can fill and rearrange the capsule caps on its own as per the set computer programming, provided the machine meets the strict hygiene requirements of the pharmaceutical industry. Moreover, it can be adjusted for manual operations to produce limited quantities of capsules as and when required. The strong construction and robust design of a semi-automatic capsule filling machine makes it a highly durable and low-maintenance machine equipment for the pharmaceutical industry.



Semi-automatic Capsule Filling Machine gives output of 25,000 to 30,000 capsules per hour and is suitable for filling capsules of all sizes with powder, pellets & granules. It is comparable to the best because of its outstanding mechanical & functional features. This innovative design & precision manufacturing meets the requirements of cGMP. Machine is the most ideal choice in Semi-Automatic Capsule Filling Machine available in the market.

- Programmable Logic Control (PLC) & display of all operations
- All the drive elements and the cabling at the right-side separate panel
- Crevice free smooth stainless-steel pharmaceutical grades

- Modified design of drug hopper reduces time for dismantling & unloading of powder
- Loader station which accepts too less change over time of different capsule size change parts
- Filling station which accepts too less change over time of powder to pellets
- Holes per plate - Size 00 - 360 Holes / Size 0 - 480 Holes / Size 1, 2 - 540 Holes/ 3, 4 & 5 - 600 Holes
- Loader Drive - 0.25 H.P. Fix speed 45 sec/plate
- Filling Table Drive - 0.5 H.P. Speed 2 to 14 RPM Like 2,3,4,5,6,7... Through VFD - No Gear Auger Drive - 1.5 H.P. 325, 350, 375 & 400 through mechanical pulley
- Display - 4 Line Black
- Vacuum Pump - 3 H.P.

Technical Details (MOC) of Manufacturing Parts:

1. Machine Stand: Fabricated with M.S. Angel
2. Machine Covering: Fabricated with S.S.304 X 20 swg (1mm) Thick sheet.
3. Product contact parts: S.S.316 Quality
4. Loading ring: Magnesium
5. Cam & Clutches: EN-24 Harden
6. Gears: EN-353 Harden
7. Shafts: EN-8 Grinded
8. Brackets: C.I. casted

SALIENT FEATURE :

- Compact GMP model
- Higher production output up to 30,000 capsules per hour.
- Loader gets disengaged automatically after one complete rotation of the loading ring.
- PLC controlled digital display of all operations.
- Augur with four speeds to fill different types of powder & pellets.

Modified design of drug hopper reduces time for dismantling and unloading powder.

- Auto-drug hopper in-feed mechanisms reduce weight variations & improve productivity.

WORKING PRINCIPLE OF A SEMI-AUTOMATIC CAPSULE FILLING MACHINE :-

The working principle of a semi-automatic capsule filling machine involves both automated and manual processes.

The following are the main stages in the semi-automatic capsule filling process.

1. Loading capsules and material to be filled: The empty capsules and the filling materials are poured into their own hoppers - capsule hoppers and powder hoppers, respectively.

The operator manually loads the capsules and fillings and moves the cap and body trays

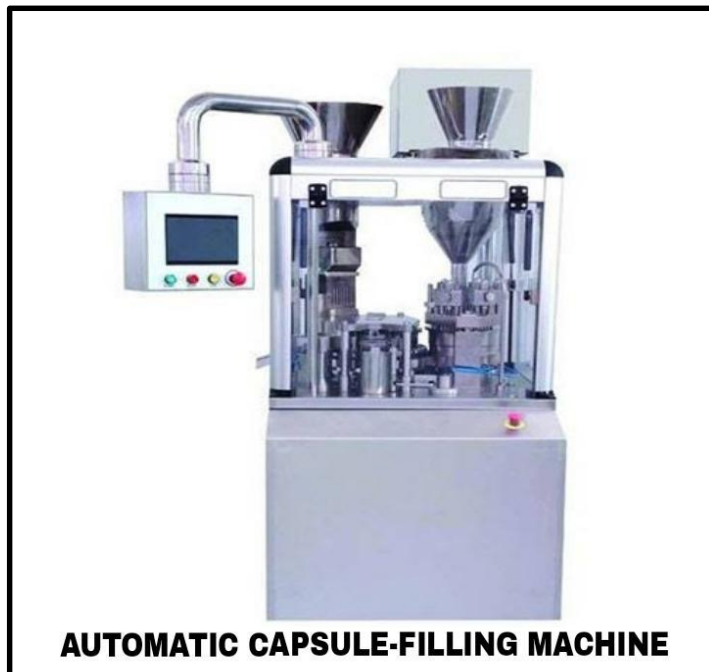
2. Separating capsules: The machine automatically separates the capsule caps from the bodies
3. Filling medication: The auger in the machine regulates the powder filling process, with a precise speed adjustment mechanism using the dosing disc. The powder is pressed from the hopper to the empty capsule shell using the vibrating action of the auger. The powder is physically pushed to the body of the capsule, where it is equally dispersed throughout the cavity
4. Locking capsules: The machine automatically locks the capsules.

3. AUTOMATIC CAPSULE FILLING MACHINE :-

WORKING PRINCIPLE OF AUTOMATIC CAPSULE-FILLING MACHINE

Automatic capsule fillers can automatically do the following tasks: capsule separation, filling, and capsule locking, without any need for operator assistance or supervision. Therefore, such machines can significantly improve the production efficiency of the manufacturing unit and significantly reduce their labor costs.

Automatic capsule filling machines could be divided into continuous and intermittent motion motion machines. Here will discuss the working principle of the intermittent motion automatic capsule filler since it is used by most of the pharmaceutical industry.



DESCRIPTION

Automatic Capsule Filling Machines are the most advanced hard capsule filling equipment developed to improve the quality & speed of production. Machine complies as per current GMP standards. It is a well-versed version with much more superior electronic & new advanced loading. Separating system makes the machine suitable for capsules from any suppliers across the globe.

SALIENT FEATURES:

- Compact GMP model
- Machine stands superior to other machines in the market by its high-speed cam dividing (indexing) device mechanism.
- Machine is equipped with complete safety and protection devices, operation is steady and credible.
- Compact, sturdy, covered with stainless steel panels, hood covered with acrylic guard.
- Fill weight adjustment within seconds.
- Tamping Mechanism' for powder filling enables capsules to be filled with minimum weight variation.
- Variable AC frequency drive for speed adjustment.
- Faulty capsule and filled capsule ejection stations with individual air controls.
- Simple to operate and easy to maintain.
- Special purpose gauges are provided for quick and easy change-over.
- Appropriate sensors ensure continuous flow of powder and empty capsules for uninterrupted operation of the machine.
- The control panel of the machine is equipped with Programmable Logic Control (PLC) system enabling visual display of the operating parameters besides ensuring accuracy, reliability and reduced operator fatigue. of the machine is as follows capsule loading and separation, reject capsule disposal, powder (Bulk) filling, capsule closing (locking) and its ejection completely automatically

Automatic Capsule Filling Machine Lab Model

Automatic Capsule Filling Machine Lab Model is designed especially for small lab scale and R&D operations. Machine good enough for filling powder as well as pellets into different size of capsules sizes. Lab Automatic Capsule Filler suitable to fill size #00, 0, 1, 2, 3 & 4 capsules with help of format parts. Machine working stations like Capsule Feeding, Separation, Powder Dosing, Capsule Joining and Capsule Ejection all operations synchronize with one motor only

The Capsule Filler is controlled with programmable logic controller and touch screen HMI with a very user-friendly operating platform. Machine supplied with Venturi for vacuum generation hence no need for vacuum pump.

Lab Model Capsule Filler is compact in size that it can be places onto platform in laboratory, drug store or pharmacy. This lab model capsule filler suitable to fill up to 3000 capsules per hour with variable speed options by provided VFD system. LI-LCF LAB is good enough for both type of HPMC and Veg.

SPECIAL FEATURES OF AUTOMATIC CAPSULE FILLING MACHINE LAB MODEL:

- Compact GMP model sturdy design.
- Machine is equipped with complete safety and protection devices; operation is steady and credible.
- Compact, sturdy, covered with stainless steel panels, hood covered with acrylic guard.
- Efficient capsule separation by means of vacuum.
- Filling accuracy within + 3-5% depending upon products
- Programmable Logic Control with MMI system.
- Quick Fill weight adjustment.
- Tamping Mechanism for powder filling enables capsules to be filled with minimum weight variation.
- Variable AC frequency drive for speed adjustment.
- Simple to operate and easy to maintain.

CAPACITY:

- For powder filling: 3000 capsule/Hr.
- For Pellets Filling: 2000 capsule/Hr.
- For Tablets: 2000 capsule/Hr.

4. CAPSULE LOADING MACHINE (MODEL 300 CLM & MAKE):

A capsule loading machine is an integral part of the capsule filling process in pharmaceutical manufacturing.

The equipment has been ideal for medium/large scale pharmaceutical companies. The equipment is simple to operate and it saves time & labor. The automatic capsule loader is compact and occupies minimum space; it gives higher production with a much better standard of accuracy.

ADVANTAGE :-

Loader automatically loads empty capsules in the loading plate for manually operated capsule filling machines, hence it takes normally 5 minutes to load empty capsules in 300 holes loading plate manually, this machine cuts down that time to only 30 seconds. With the help of one Capsule Loader you can fill loading plates of 2-3 capsule filling machines. Thus, increase the production on one hand and reduce the number of operator & equipment costs on the other hand.

Production Output :Fill 300- holes plate in 30 second & provide output up to 36,000 Capsule/hour

Interchangeability: The machine is manufactured to suit capsule size combination 00/0/1/2 or 3/4/5

SALIENT FEATURES :

- Low investment high output
- Significant difference in your production department
- Simple to operate, can be handled by semi skilled person
- No setting system for any change part
- Machine stop automatically after loading is complete

V. CONCLUSION

It appears you're looking for an analogy or metaphor using a "capsule filling machine" in the context of drawing conclusions or a project conclusion.

Imagine a "capsule filling machine" as the process of gathering and assembling information, observations, or evidence. Each piece of data or insight is like a capsule waiting to be filled. When the machine operates effectively, it carefully selects, organizes, and fills these capsules, representing the process of collecting and analyzing information.

The "conclusion" could be compared to the completed capsules—a synthesis of all the gathered elements. Like a well-functioning machine producing finished capsules, reaching a conclusion involves assembling and organizing the information in a coherent and meaningful manner, resulting in a final outcome or decision.

Is this along the lines of what you were exploring? If you have specific aspects or details you'd like to incorporate or discuss regarding this analogy, please let me know!

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