

TABLET COMPRESSION

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INTRODUCTION

- ✓ The manufacturing of oral solid dosage forms such as tablets is a complex multi-stage process under which the starting materials change their physical characteristics a number of times before the final dosage form is produced. Traditionally, tablets have been made by granulation, a process that imparts two primary characteristics compressibility and fluidity.
- ✓ After the preparation of granules (in case of wet granulation) or slugging (in case of dry granulation) or mixing of ingredients (in case of direct compression), they are compressed to get final product. The compression is done either by single punch machine (stamping press) or by multi station machine (rotary press).
- ✓ The tablet press is a high-speed mechanical device. It 'squeezes' the ingredients into the required tablet shape with extreme precision. It can make the tablet in many shapes, although they are usually round or oval.
- ✓ Each tablet is made by pressing the granules inside a die, made up of hardened steel. The die is a disc shape with a hole cut through its centre. The powder is compressed in the centre of the die by two hardened steel punches that fit into the top and bottom of the die. The punches and dies are fixed to a turret that spins round. As it spins, the punches are driven together by two fixed cams an upper cam and lower cam. The top of the upper punch (the punch head) sits on the upper cam edge .The bottom of the lower punch sits on the lower cam edge.

TYPES OF COMPRESSION MACHINES

There are following 2 types,

- i. **SINGLE PUNCH/SINGLE STATION/ECCENTRIC PRESSES**
- ii. **MULTI-STATION/ROTARY PRESSES**

➤ **SINGLE PUNCH/SINGLE STATION/ECCENTRIC PRESSES**

- ✓ Single punch tablet press also known as eccentric press or single station press is the simplest machine for tablet manufacturing.
- ✓ This machine uses single set of station tooling (a die and a pair of upper and lower punches).
- ✓ The compaction force on the fill material is exerted by only the upper punch while the lower punch is static such action equivalent to hammering motion and as a result, the single punch press is referred to as stamping process.
- ✓ The single punch tablet press usually produces about 60-85 tablets/min .

WORKING MECHANISM OF SINGLE PUNCH MACHINE

The working cycle is as follows

- i. **FILLING**
- ii. **WEIGHT ASDJUSTMENT**
- iii. **COMPRESSION**
- iv. **EJECTION**

FILLING:

- ✓ Upper punch is withdrawn from the die by the upper cam, bottom punch is low in the die so powder falls in through the hole and fill the die.

WEIGHT ASDJUSTMENT

- ✓ Bottom punch move up to adjust the powder weight, it raises and expel the extra powder.

COMPRESSION:

- ✓ Upper punch is driven into the die by upper cam.
- ✓ Bottom punch is raised by lower cam. Both punch heads pass between the heavy rollers to compress the tablet.

EJECTION:

- ✓ Upper punch is withdrawn by the upper cam. Lower punch is pushed up and expel the tablets.
- ✓ Tablet is removed from the die surface by the surface plate.



TYPES OF SINGLE PUNCH MACHINE

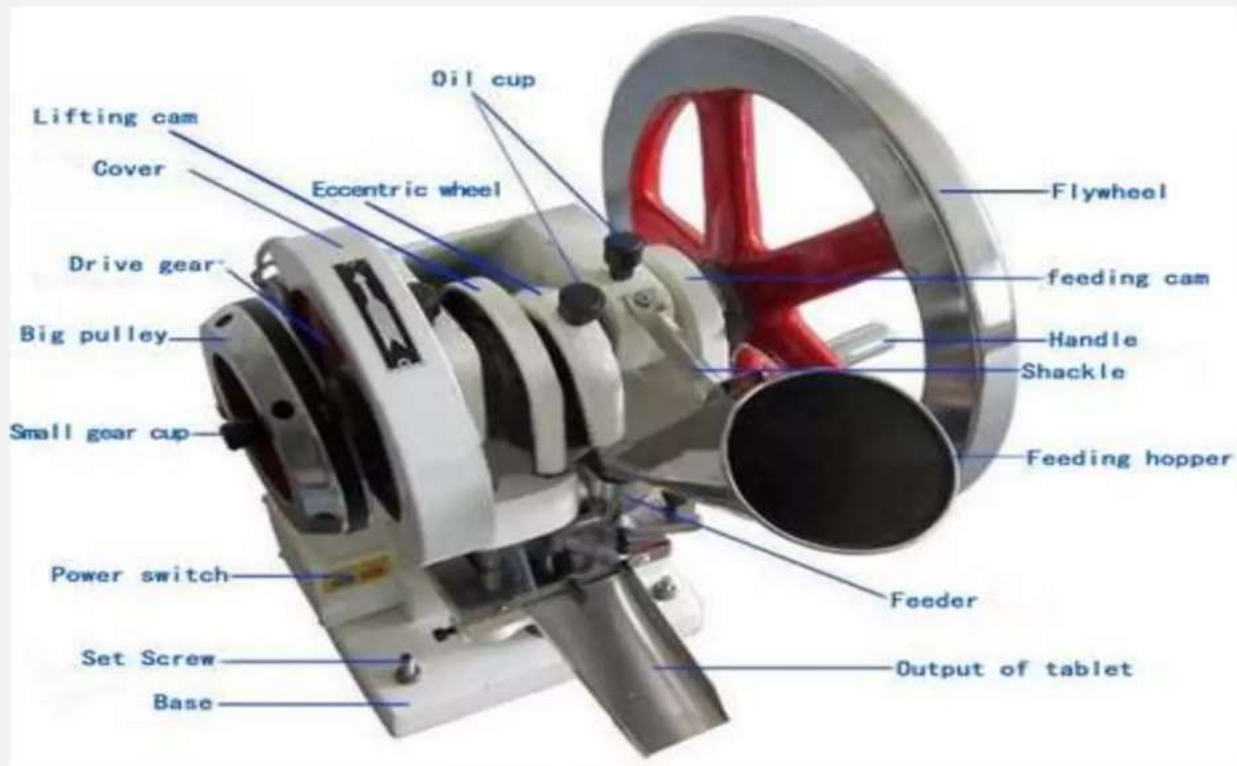
The different series of the single punch tableting machine includes,

- i. Automatic Single Punch Tableting Machine**
- ii. C&C600B Series Single Punch Tablet Press**
- iii. TDP - Benchtop Model Single Punch Tablet Press**
- iv. TDP-1 Benchtop Model Single Punch Tablet Press**
- v. TDP-5 Benchtop Model Single Punch Tablet Press**
- vi. TDP-30 Benchtop Model Single Punch Tablet Press**

PARTS OF A SINGLE PUNCH TABLET PRESS

- ✓ **Hopper:** It is used to hold the materials (drug or the drug with excipients/ granules) to be compressed and supply the material to the die and removes the tablet after its compression
- ✓ **Dies:** Dies defines the shape and the size of the tablet by allowing the lower and upper punch to come close together to compress the material.
- ✓ **Lower and upper punches:** These are used for compressing of the materials (drug or the drug with excipients/ granules) within the dies.
- ✓ **Cam track:** This is the component used for guiding the movement of the punches.
- ✓ **Capacity regulator:** To adjust the position of the lower punch to accommodate the required quantity of materials by the die.
- ✓ **Ejection regulator:** To adjust the position of the lower punch, so that its highest position is at par with the surface of the die.
- ✓ **Driving wheel:** It helps in the movement of the lower punch, the upper punch and hopper shoe and also check their movement.

PARTS OF A SINGLE PUNCH TABLET PRESS



ADVANTAGES OF SINGLE PUNCH TABLET PRESS

- ✓ The single punch structure is rational and small.
- ✓ Easy to operate and it operates at a high utilization ratio.
- ✓ It can manufacture odd shaped products with a diameter of up to 20mm.
- ✓ It is ideal for development of tablets and small batch production.
- ✓ Single punch tablet press utilizes a high amount of pressure to reduce weight variations between tablets while maintaining a low noise level at the same time.

TYPES OF COMPRESSION MACHINES

MULTI-STATION/ROTARY PRESSES

- ✓ Multi-station press is a mechanical device that unlike the single punch tablet press has several tooling station which rotates to compress granules/powder mixture into tablets of uniform size, shape (depending on the punch design) and uniform weight.
- ✓ It was developed to increase the output of tablets.
- ✓ In rotary press, the compaction force on the fill material is exerted by both the upper and lower punches leaving the powder granules to be compressed in the middle. This is known as accordion type of compression.
- ✓ The capacity of a rotary tablet press is determined by the rotation speed of the turret and the number of stations on the press.

PARTS OF A ROTARY PRESS

- ✓ HOPPER
- ✓ FEEDER SYSTEM
- ✓ PUNCHES
- ✓ DIE SYSTEM
- ✓ TURRET
- ✓ CAM TRACKS
- ✓ TABLET PRESS FILLING STATION & WEIGHT CONTROL
- ✓ COMPRESSION ROLLERS
- ✓ EJECTION CAM
- ✓ TAKE OFF BLADE AND DISCHARGE CHUTE
- ✓ TOUCH SCREEN CONTROL PANEL
- ✓ SEALING SYSTEM
- ✓ ELECTRIC MOTORS, GEARS AND BELTS
- ✓ LUBRICATION SYSTEM
- ✓ HYDRAULIC PUMP UNIT

PARTS OF A ROTARY PRESS

TABLET PRESS HOPPER

- ✓ The tablet compression process starts from here.
- ✓ Hopper is basically a material feeding section.
- ✓ It is the point where we put all powder/grains intended to compress into tablets.
- ✓ Tablet press hoppers come in a wide range of shapes and designs. Whatever the shape, it should be such that the material can flow seamlessly into the tablet compression chamber.
- ✓ Since it is in direct contact with the material, it is made of stainless steel.
- ✓ Depending on the design of a tablet press machine, powder can be filled manually or using other automated systems.
- ✓ Hoppers may feature optimal flow angles to facilitate flow, especially where it is nearly impossible to adjust formulation.
- ✓ Some hoppers may have feature vibratory rods. This is done carefully to enhance product flow and to prevent possible product separation.



PARTS OF A ROTARY PRESS

TABLET PRESS FEEDER SYSTEM

Feeders feed powder/grains to the dies.

Tablet press machine feeder system is made up two critical components,

i. FEEDER HOUSING

ii. FEED PEDDLES

➤ FEEDER HOUSING

- ✓ Material from the hopper will enter the die system through the housing.
- ✓ The feeding process should be consistent and accurate to produce high quality tablets.
- ✓ The feeder housing is made of stainless steel 316L since it is in contact with the product.
- ✓ The product must not stick on the feeder housing as it will cause inconsistencies during the feeding process.

➤ FEED PEDDLES

- ✓ Number of high speed rotary tablet press machines have a feed peddles.
- ✓ The feed peddles ensures consistent and accurate material feeding into the die systems.
- ✓ Without a feed peddle, especially if the machine is operating at a high speed, there could be chances of some dies being filled half way. This may result in tablets with varying thickness or the degree of compaction.



PARTS OF A ROTARY PRESS

TABLET PRESS PUNCHES

- ✓ To produce the desired tablets, punches move within the die, thereby compressing powder into the desired tablets.
- ✓ In any tablet press machine, it has Upper punch system, the tablet press upper punches are on the upper section of the rotary system. They move vertically, in and out of the die bore.
- ✓ The lower punches are on the lower section of the rotary system of the tablet press machine. During the tablet compression process, the lower punches remain within the die bore throughout the entire cycle.

TABLET PRESS DIE SYSTEM

- ✓ To produce the desired tablets, punches move within the die, thereby compressing powder into the desired tablets.
- ✓ The movement of tablet press machine punches, takes place within the die bore or cavity. Therefore, the punch and die must be machined together to ensure compatibility.
- ✓ It is in the die cavity where the powder is compressed into desired tablets of definite thickness and size.
- ✓ It is the die cavity that determines both the thickness and size of a tablet.

PARTS OF A ROTARY PRESS

TABLET PRESS TURRET

- ✓ A rotating turret is an essential part of the rotary tablet press machine in the pharmaceutical industry.
- ✓ The rotating turret have holes that host the die system of a tablet making machine and punch guides to hold punches
- ✓ It is precisely machined to ensure both die pockets and punch guides are fully aligned for optimal tablet making process.
- ✓ Turrets are the heart of tablet press tooling.
- ✓ It is the tablet press machine turret that determines the number of stations.
- ✓ This helps to determine the production capacity of the machine for every complete rotation of the turret .



PARTS OF A ROTARY PRESS

TABLET PRESS CAM TRACKS

- ✓ Cam tracks are critical tablet compression machine parts that play an integral role in ensuring seamless tableting process.
- ✓ The main work of the cam tracks is to guide the upper and lower punches in different stages in the tablet compression process.
- ✓ That is, as the turret rotates, it is the cam tracks that move the punches in an up and down motion.
- ✓ This helps to control filling, compression and ejection of already processed tablets.
- ✓ For example, as the upper cam withdraws top punches from the die, powder flows in filling the cavity .On the other hand, the lower cam track pushes the bottom punches upwards within the die cavity. This makes the die to be overfilled by material, allowing for accurate adjustment of the die content.
- ✓ To achieve a maximum compression force, the upper cam track drives the top punch and the lower cam adjusts the bottom punch. With the tablet compressed to the desired specifications, the upper cam withdraws top punches. On the other hand, the lower punches move upwards to expel the compressed tablets with the help of lower cam.



PARTS OF A ROTARY PRESS

TABLET PRESS FILLING STATION & WEIGHT CONTROL

- ✓ With the help of different movements of the cam systems, material will flow into the die cavity depending on the position of the punches.
- ✓ A critical procedure in tablet compression process is the Weight control by controlling the depth of dye filling.
- ✓ With the help of lower cam track, the bottom punch moves upwards to a predetermined height.
- ✓ This ensures the die cavity is filled to a required depth according to required weight of tablet before any compression process begins.
- ✓ At this time as the bottom punch moves up, the excess powder may overflow. Therefore, to avoid wastages, the excess powder automatically moves to the next die cavity, which is just about to be filled.

PARTS OF A ROTARY PRESS

COMPRESSION ROLLERS

- ✓ Tablet compression machines have a series of rollers that exert a sufficient amount of force to compress the powder.
- ✓ Most machines have two sets of rollers.

PRE-COMPRESSION ROLLERS

- ✓ These are the very first rollers in rotary tablet press.
- ✓ Basically, these rollers apply a small amount of force on the upper and lower punches. This gives the initial compression force.
- ✓ The aim of this process is to remove entrapped air that could be in the die or powder particles.

MAIN COMPRESSION ROLLERS

- ✓ Main compression rollers exert a predetermined amount of force (final compression force) for the formation of tablets. The compression force at this stage is higher than the pre-compression force.
- ✓ It is important that the rollers remain stable with no vibration during the entire process. This is to ensure consistency of the tablets' thickness and size.



PARTS OF A ROTARY PRESS

TABLET PRESS EJECTION CAM

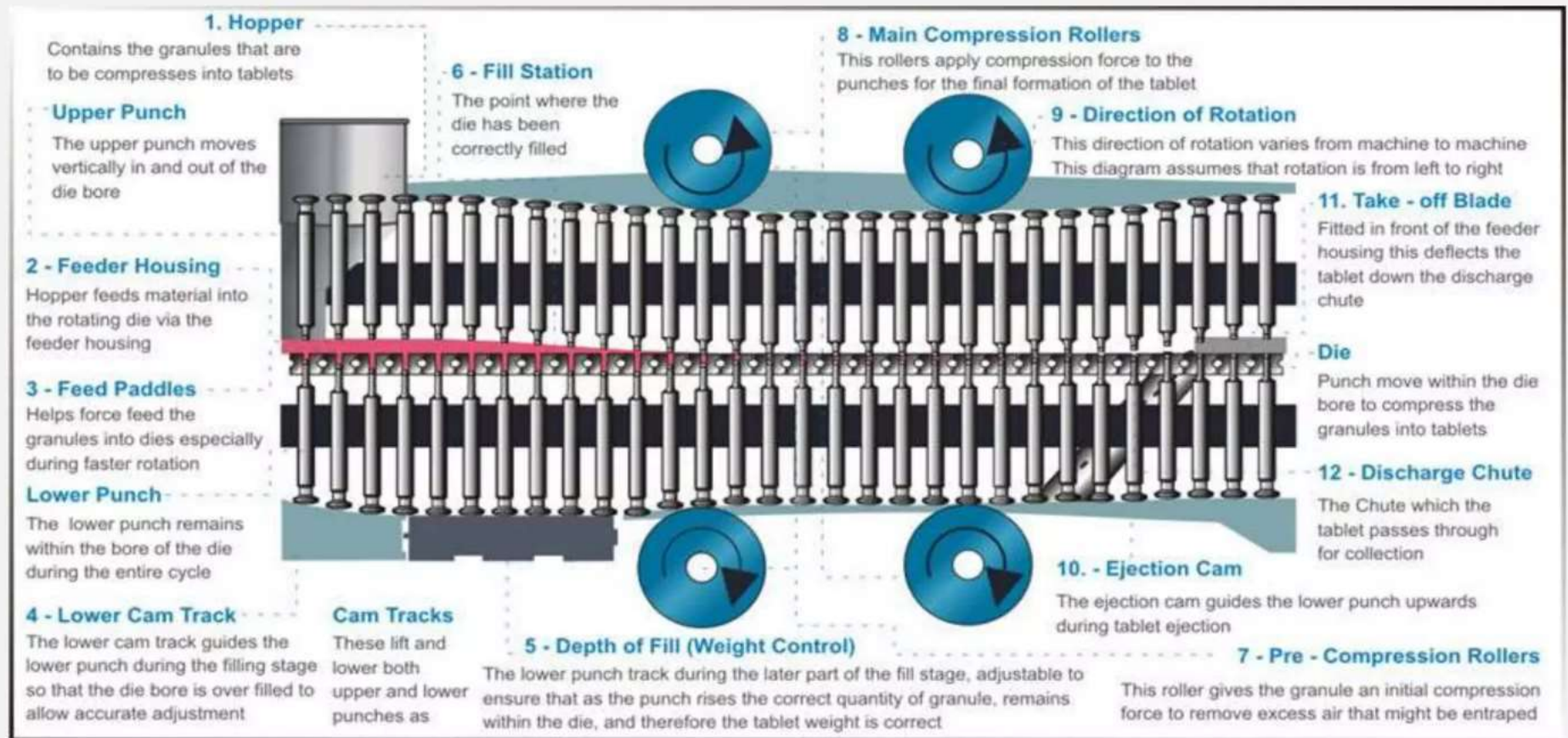
- ✓ Ejection cam is located just after the main compression rollers.
- ✓ After compression, the tablet is always fixed within the die systems (space between lower and upper punches).
- ✓ The ejection cams steadily and slowly push the bottom punch upwards. At the same time, the top cams move up and so are the top punches. As a result, the fully compressed tablets leave the die cavity i.e. the compressed tablet remains just at the top of the die.

TAKE –OFF BLADE AND DISCHARGE CHUTE

- ✓ The take –off blades are fitted just above the feeder housing.
- ✓ Their main role is to deflect the fully compressed tablets into the discharge chute and then are collected in containers.



PARTS OF A ROTARY PRESS



PARTS OF A ROTARY PRESS

TOUCH SCREEN CONTROL PANEL

- ✓ HMI system control every aspect of the tablet making process.
- ✓ HMI can either be attached to the main machine or exist separately.

SEALING SYSTEM

- ✓ The sealing system provides advanced dust handling capability. This isolation reduces need to clean the machine regularly and possible cross contamination.

ELECTRIC MOTORS, GEARS AND BELTS

- ✓ The compression rollers, punches, dies, turret, etc. are all moving parts. This means that the machine uses a prime mover.
- ✓ We can use a servo motor or an induction motor. For example, a servo motor is a perfect choice for the filing system. This is because it is easy to control servo-motors to meet the highest degree of precisions such as 0.01mm.
- ✓ However, for the pre-compression and compression stages, synchronous motors offer a better speed and control. Servo motor for tableting machine Furthermore, to transmit this motion to other sections, we may use a combination of both gears and belts. Even the motor can accurately start this machine, whether under maximum load or with no load. In short, to achieve a desired motion, we need to incorporate mechanical, hydraulic and electrical systems.

PARTS OF A ROTARY PRESS

LUBRICATIONS SYSTEMS

- ✓ Moving parts form integral sections of tablet compression machine parts, therefore, to avoid wear and tear due to friction, we need to lubricate moving parts.
- ✓ A number of tablet press machines feature a central lubrication system. The machines automatically lubricate moving components.

HYDRAULIC PUMP UNIT

- ✓ An efficient hydraulic pump unit will help maintain consistent pre-pressure and main pressure.
- ✓ This guarantees smooth and accurate tableting process.
- ✓ Internal section of a tablet press machine part again, to avoid possible damage that may occur on the tablet press tooling system, these machines are equipped with an overloading protective unit.
- ✓ This automatically stops the machine in case of overload.

Other parts of the machine include,

- ✓ Rubber wheels (depending on the size of a machine), switches, LED light indicators, lockable polycarbonate cabinet and cooling system.

ADVANTAGES OF ROTARY PRESS

- ✓ High productivity can be gained with a minimal amount of labor while saving money.
- ✓ Rotary press has an output of between 9000 – 234000 tab/hour or more thus saves time and meets up with the high demand of tablet dosage form.
- ✓ The powder filled cavity can be automatically managed by a moving feeder.
- ✓ Rotary press decreases waste of valuable formulation in non-specific tablets.
- ✓ The machine allows independent control of both weight and hardness.

STAGES OF TABLET COMPRESSION PROCESS

- i. FILLING
- ii. METERING/WEIGHT ADJUSTMENT
- iii. COMPRESSION
- iv. EJECTION

FILLING

- ✓ The filling stage of tablet compression process involves transfer of granules to the compressing machine punch-die cavity.
- ✓ The punch die cavity is composed of upper punch, die and lower punch. The position of lower punch within the die determines the volume of the punch-die cavity.
- ✓ This volume must be appropriately sized for the weight of granulation to be compressed into tablets.
- ✓ The granulation is overfilled on the die table (turret) to ensure complete filling of the punch-die cavity volume.

STAGES OF TABLET COMPRESSION PROCESS

METERING/WEIGHT ADJUSTMENT

- ✓ The metering stage of the tablet compressing process involves removal of excess granulation from the compressing machine.
- ✓ This stage enables the exact weight (volume) of granulation to be compressed into tablets.
- ✓ The exact weight of granulation is controlled by the height of the lower punch in the die. The height of the lower punch is controlled by the metering cam (also called the dosage cam).
- ✓ The lower punch is raised to the appropriate level in the die to provide the exact weight of granulation in the punch-die cavity. The excess granulation is scraped from the surface of the die table.

COMPRESSION

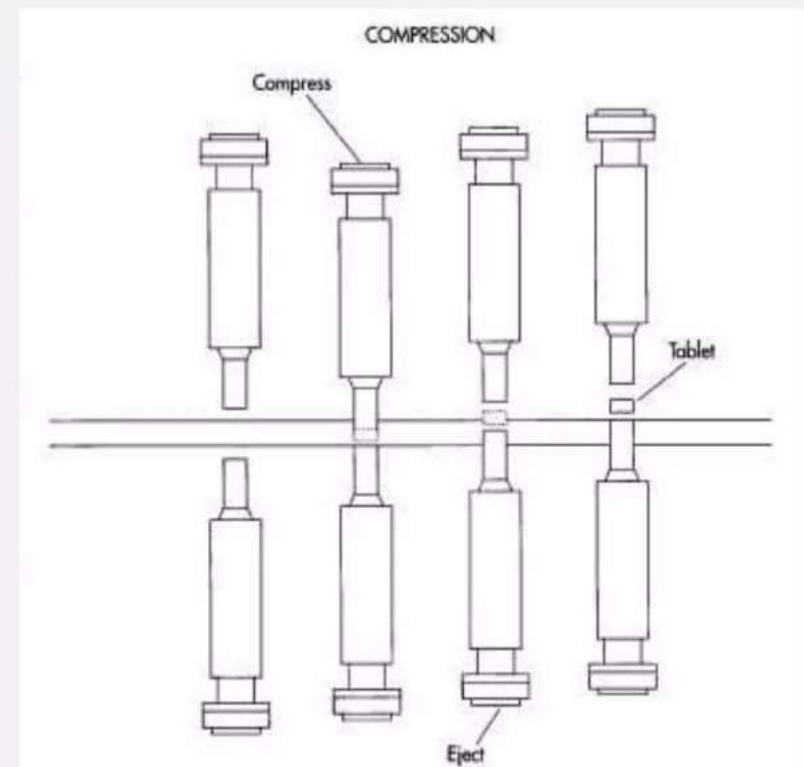
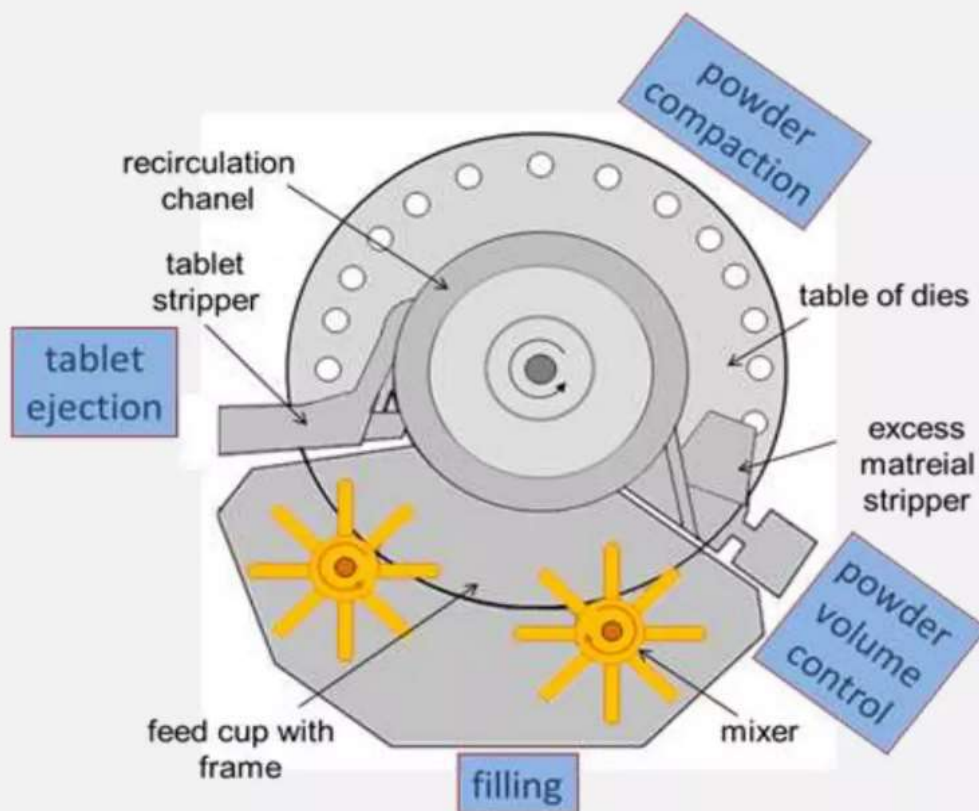
- ✓ The compression stage of the tablet forms the tablet.
- ✓ This stage involves bringing together the upper and lower punches under pressure within the die to form the tablet.
- ✓ As the punches enter the compression stage, the upper and lower punches move between two large wheels called pressure rolls. These pressure rolls push the punches together to form the tablet.
- ✓ The distance between the upper and lower punches determines the thickness and the hardness of the tablet. When the punches are close together, a thin and hard tablet is created. When the punches are farther apart, the tablet made is softer and thicker.
- ✓ The proper balance of thickness and hardness determines the optimum roll distance for any specific product. These adjustments are made while keeping the tablet weight constant.

STAGES OF TABLET COMPRESSION PROCESS

EJECTION

- ✓ The ejection stage of the tablet compressing process involves removal of the tablet from the lower punch-die station.
- ✓ In this stage, the upper punch retracts from the die cavity and rises above the turret table. Then the lower punch rises in the die, which in turn pushes the tablet upward to the top surface of the die table and out of the die cavity.
- ✓ A scraper (also called takeoff scraper or tablet rake-off) then pushes the tablet off the die table away from the compressing machine into the collection container through discharging chute.

STAGES OF TABLET COMPRESSION PROCESS



STAGES OF TABLET COMPRESSION PROCESS

