Q&A: Capsule Fill to Finish

OILS:

How are essential and other oils filled into capsules?

Extracted oils are filled into capsules by use of capsule filling machine of which there are many types. There are two methods of filling; via a positive piston pump or by pressure and time. STI manufactures or distributes the following machines for oil filling into capsules.

- Manual RoboCap (ML-1) filling system: Pressure and time; also fills powders and tincture:
- RoboCap filling system: Pressure and time; also fills powders and tinctures:
- LF 10: Positive piston pump; Oils only:
- Lab Cap 3000: Positive piston pump; also fills powders and beads:

What type of oils can be filled into capsules?

Any oil extracted from a plant, flower or seed for human consumption can be filled into a capsule. Some examples are THC (tetrohydro cannabinol) CBD (cannabidiol), coconut oil, flax seed oil, olive oil, garlic oil, (the following link is a list of many oils)


How do I know if the oil is compatible with the capsule?

All oils should be tested for compatibility with a capsule. Fill several capsules with the oil of interest and see if the capsule remains stable and does not dissolve.

How thick or thin does oil have to be?

The oil viscosity is measured by centipoise (cps). Water has the viscosity = 1 – 3 cps. Corn oil has the viscosity = 65 cps, honey = 2,000 to 3,000 cps. Most machines can fill a range of oils from 3 to 2,000 cps.

Can coconut oil too thick to flow be thinned?

Yes, there are two ways to make a highly viscous oil fluid enough to flow and fill. One is by formulating the oil with thinning excipient or heating the oil. STI machines all have heaters to keep the product at the proper temperature to ensure efficient flow.

Is it possible to control the amount of oil going into a capsule?

Yes. STI machinery have infinite variable fill controls to put as little or as much oil in the capsule as needed.

Is it possible for the oil to leak out of the capsule?

Yes. THC, CBD or any essential oils that are too thin at room temperature will eventually leak out of the capsule. The leaking will occur where the rim of the capsule cap meets the cap body. This is called the “cut-line”. Even oils that do not leak at room temperature may leak if the capsule is exposed to heat after market. For example, if a capsule is left in a car on a hot day the capsule could heat to a point where the oil in the capsule becomes thin enough to leak out.

How is leaking prevented?

There are several ways to prevent leaking. One solution is formulating the THC or CBD oil to remain in a solid state at room temperature. To fill the oil into a capsule the solid formulation can be heated in the machine to a fluid viscosity suitable for filing. When the oil is dosed into the capsule at room temperature it returns to a solid state and is unable to leak through the cut-line. However, the filled capsule must be tested under different conditions to ensure stability.
The second solution is to band the capsule with capsule banding machines. The banding solution is made of the same material as the capsule: either gelatin or vegetable based. The banding solution is applied to the capsule at the cutline thus sealing the oil inside. STI makes several different capsule banding machines.

Are there a capsules specifically designed for oil filling?
Yes. There are several capsule manufactures making capsules designed to delay oil from leaking out of the cut-line long enough to transport to a banding system. The advantage of these capsules is as follows:
1: They allow built up pressure of gas in the capsule to vent.
2: Prevent oil from leaking long enough to band.

How is capsule size determined?
Capsules come in standard sizes from size 00 to size 4. Once the amount (weight) of material is determined it is then easy to determine the size of the capsule.

How should I store capsules?
It is important to store capsules in a controlled environment at around ~35% relative humidity at ~72 degrees F. Gelatin capsules have a moisture content of 12% to 16%. This moisture allows the capsule to flex when opening and closing. If the capsule loses too much moisture the capsule becomes brittle and is difficult to run on a capsule filling machine.

POWERS:
Is it possible to put cannabis powder in oil?
Yes. This is called a suspension. There are many reasons to suspend a powder in oil but the primary reason is to use the oil, most often coconut oil, as media to reduce the THC or CBD concentration... To maintain proper integration of the powder in the oil the cannabis powder particle size should not exceed 50 microns. This size reduction will prevent powder segregation. When the suspension is ready for filling a hopper with an impeller should be used. This keep the powder particles properly integrated in the oil. This assures each capsule has the correct concentration of THC or CBD powder. STI can help can suggest different powder reduction systems. All STI capsule fillers have impellers in the hopper or available to install in the hopper.

How is cannabis powder filled into capsules?
Powders are filled into capsules by use of capsule filler. The type of filler required is dictated by the number of capsules to be manufactured in a given time period IE: the number of capsule per day, per month etc. Capsule filling machines can range from systems that fill 2,000 per hour (manual filling) up to 200,000 per hour (large fully automatic machine). STI has machines that fill capsules with powders and oils from 800 capsules per hour (cph), to 22,000 cph.
Some powders require additives to make the powder run smoothly on a capsule filling machine. STI can help with formulating powders to achieve consistent fill weights while maintaining optimum filling speeds.
STI can also assist with the selection of the right machine to meet the filling application and production requirements.
How do I get cannabis plants, leaves or flowers to a powder form for filling?
This process is called milling. Milling reduces the cannabis or hemp raw material to an acceptable particle size for capsule filling. The milling system should be capable of milling the cannabis raw material to a uniform particle size allowing for maximum flow on the capsule filling machine. There are many machines that mill powders for different batch sizes and applications.

Are additives required to fill cannabis powder?
There are many additives (excipients) that can be used to increase powder performance in the capsule filling process. These excipients are utilized to improve flow characteristics or as a filler to decrease the concentration of the cannabis or hemp to the desired level. STI offers formulation consultation to achieve maximum cannabis powder performance.

Can the volume or weight of powder going into capsules be controlled?
Yes. Capsule filling machines having weight control capability use a dosing disk or a dosing tube and piston to vary weights. STI Lab Cap 3000 uses the dosing disk method. The disk can be designed to hold the exact amount of powder going into the capsule. STI can help determine the correct disk size for the exact powder weight required.

What type of capsule should be used for powder filling?
There are many different types of capsules. However, they can be reduced to two general types. Gelatin based capsules (most common) and vegetable based capsules. Both types work well for cannabis powder filling. Vegetable based capsules are popular for capitalizing on the vegetarian market. They are also useful if the powder being filled absorbs surrounding moisture. This is called hygroscopicity. Vegetable or HPMC capsules maintain less moisture content than gelatin capsules. Therefore, veggie based capsules are impacted less by hygroscopicity than gelatin based capsules which must maintain a much higher moisture content.

How is the capsule size determined for powder filling?
Capsules are manufactured in many sizes. The common sizes are 00 to size 4. The size 00 capsule will hold the highest volume and size 4 the least of the sizes mentioned. To determine the correct capsule size the density of the powder must be ascertained. Once the weight required for each capsule is determined simply pick the capsule size that matches the weight. See the chart below for standard capsule sizes and volumes.
What is powder density and why is it important in capsule filling?

Powder density is the weight of powder in a given volume. In the chart above the powder density of .45 is the weight of powder filled to 1 ml in a graduated cylinder. As the number increases the powder is denser. Typically denser powders flow better than lighter powders. Lighter powders tend to be more airborne when handles therefore, there can be greater weight variance from capsule to capsule.

EQUIPMENT: CAPSULE FILLING

What equipment is used to fill coconut and other essential oils into capsules?

There are many capsule filling solutions for THC or CBD extracted oil that is infused into an oil carrier like coconut oil.

A small output system is usually a manual machine. It typically requires one operator and has a low cost. However, it has limited expandability. It can produce up to 800 caps per hour.

A medium output machine combines manual and automatic features. It has much greater expandability and can produce 1,400 cph to 10,000 cph.

A high output system can fill up to 22,000 cph.

Our systems include filling machines that are designed for low capsule output, medium output and high output volumes. STI also has manual filling systems, semi-automatic and fully automated systems.

Is there machinery that will fill both coconut oils and powders into capsules?

Yes. Many machines are capable of filling both oils and powders. STI has machines with a relatively low cost and low output that fill powders, liquids and tinctures. This is unique in the industry and is very popular in the cannabis industry.

Click here to view RoboCap series.

Our Lab Cap 3000 can fill oils and powders and is fully automatic. This machine has greater control over fill volumes for powders.
What utilities are required to run capsule filling machinery with oils or cannabis powders?

The smaller output machines require standard 115v electricity (standard to all buildings). The larger machines require a minimum of 220v, 3 phase, 60 Hz electricity. All machines require an air compressor. The compressor should be able to push 80 psi (pounds per square inch) at approximately 2 cfm (cubic feet per minute). The compressor should be oil free. If the compressor is to be utilized for one processing machine most big box stores will have a compressor adequate for one or two machines. However, if more machines will be running off a single compressor at the same time a larger system will be required.

STI can help determine the best compressor solution for any cannabis operation.

Does the capsule filling machine need to be placed in a separate space?

Yes. Powder capsule filling generates air borne particulate that should be contained within a closed space. This will prevent cross contamination, eliminate the possibility of powder contaminating other processes and surface and reduce exposure to operators. The closed space (filling suite) should have air exchange capability. There should be a vent to exhaust air and a vent for return air. The exhaust vent should be filtered to capture the powder being vented. This exchange of air should happen 6 times per hour for optimum powder control.

Cannabis processing may require containment within the machine. This will prevent the operator from any exposure to a highly concentrated THC powder. STI has simple or complex solutions to machine powder containment. We can review your specific powder and design a solution that will ensure operator safety and meet any regulatory mandates. Click here to see an example of our flex containment system.

THC or CBD infused oils should be filled in a suite as well. It is important to keep particulate that can be generated in the areas outside of the suite from contaminating the oil being filled. Also, vapors can escape from the oils and may need some containment for operator safety.

What other equipment is needed to run a capsule filling machine?

There are few additional tools that should be available to for filling capsules as follows:

- Laboratory scale for weight sampling
- Thermometer and Hygrometer for temp and humidity monitoring
- Vacuum to assist in particulate powder control
- A capsule polisher to eliminate powder on the outside of filled capsules

How do I control the amount of oil going into capsules?

There are two methods for controlling the amount of cannabis oil going into a capsule as follows:

- Pressure and Time: Pressure from a compressor is built up in a product tank above the oil level. When the filling chamber valve is opened the pressure pushes the oil through the fluid path to the dosing chamber. At a predetermined time the valve closes stopping the flow of oil. The time the valve is opened is manipulated by a controller on the system control box. More time the valve is opened = more oil in the dosing chamber. The back pressure in the hopper determines the speed of the flow. More pressure = faster flow; less pressure = slower flow. The amount of oil dosed in the capsule can be any amount up to the level fill of the capsule body.
- The Manual and RoboCap series capsule filler fills by this system.
• Positive Piston Pump: Liquid from the product hopper vessel is pulled through the fluid path by a piston retracting in a cylindrical chamber. Once the piston has reached a predetermined point the PLC tells a ball valve which is positioned below the hopper to turn 90 degrees. This shuts off the fluid path from the hopper to the cylindrical chamber and opens the fluid path from the chamber to the dosing nozzle into the capsule body. The longer the piston retracts the more oil fills the chamber. The piston action is controlled by the PLC controller and can be adjusted for any fill volume.

How do I control the amount of powder going into capsules?
There are four basic filling technologies: Manual, Augur, intermittent tamping and dosator or reciprocal.
• Manual filling is volumetric and can only fill to the level of the capsule body. To significantly change the volume of powder the capsule size must be changed to equal the volume required (see the chart above to view the capsule sizes and volumes).
• Augur filling (Model 10 capsule filler) is also volumetric. However, by manipulating the revolution of the augur and the ring fill volume can be altered within a limited range. To make a significant change in volume a different size capsule will be required.
• An intermittent system (Lab Cap 3000) controls the volume by a dosing disk. The dosing disk is milled to the volume required and the density of the powder.
• The dosator system utilizes a powder tube and piston to control the powder volume. The tube which houses the piston is plunged into a powder bed. The piston retracts to a preset position and the powder is pulled into the tube. The tube retracts from the powder bed and shifts over the capsule body and the piston pushes the powder down into the capsule body. The diameter of the tube and the distance of retraction control the volume going into the capsule.

How do I get material too thick to flow into capsules?
Some oils, particularly coconut oil can be solid in temperatures below 79 degrees. Heating the oil to make it thin enough to run a capsule filling machine will require heat or reformulation.
• Heating the oils to flow could be accomplished as easily as heating the room where the capsule filling machine is. However, the additional heat will make the room uncomfortable for the operators and could affect the stability of the capsules.
• The RoboCap, Lab Cap 3000 and LF10 all have heaters which can be utilized to heat the product so it will flow through the fluid path to the capsule body.
• Additives can be formulated into the oil to make it fluid at room temperature. This will eliminate the need to heat the oil while on the machine. STI can help determine the appropriate excipient.
Is it possible to combine a powder into coconut oil and fill the solution into capsules?
Yes, this is called suspension. In some cases milling the THC or Hemp to a fine powder and combing it with oil can be advantageous. If the THC concentration of the powder or hemp can be determined by assay the need for an oil extractor can be eliminated. However, the powder must be milled to a particle size of 50 microns or less. This size will allow the particle to remain suspended or floating in the oil. However, an impeller must be used to assure the powder is evenly integrated throughout the oil. Even a very fine powder will eventually succumb to gravity and float toward the bottom of the vessel. The Lab Cap 3000 and LF10 have impellers built into the hopper to keep the powder properly integrated in the oil preventing particle separation.

Are there capsule filling machines that will fill both oil and powder?
Yes. The RoboCap can fill powders or liquids separately. The Lab Cap 3000 can fill a liquid followed by a powder in the same capsule.

How does the machine run different size capsules?
Different size capsules are run on a capsule filling machine by acquiring change parts for the different capsule sizes. In other words, each capsule size requires a set of change parts to process an individual size.

What is required to clean a capsule filling machine after use?
Cleaning requirements are dictated by the level of cleanliness required. If cleaning at the end of a shift and the same powder will be run the next shift less cleaning is required. If cleaning is for changing to a different powder or liquid product a thorough cleaning is required to meet cGMP standards. This includes taking off powder contact parts and washing down separately, vacuuming gross product from the outside of the machine and washing down with an appropriate cleaning solution. The final wash down should be done in an area where air borne product can be vented. STI has cleaning protocols in all operation manuals and advance cleaning protocols can be purchased.

Is there training and support available?
Training is available for all STI equipment. Technical support is available 12/5 for all machines.

EQUIPMENT: BANDING MACHINES
Do I need to put a band on coconut oil filled capsules?
A band may be necessary to secure the coconut oil from leaking out of the capsule at the point where the cap meets the body. A simple test can be conducted to determine if a band is required as follows:

- Heat an oven to ~100 degrees
- Line a cookie sheet with brown Kraft paper. Kraft paper or butcher paper must be used.
- Using your current method of capsule filling fill the 100 capsules with oil.
- Put capsules on the Kraft paper.
- Place cookie sheet in the oven for ~30 minutes shaking the cookie sheet every 5 minutes.
- Even the smallest leaks will appear on the Kraft paper. If no leaks appear your product may not leak from the capsule.
Another test is a ship test. Fill capsules with oil and put the capsules into bottles used for packaging. Ship the bottle to someone in a distant city or state. Have them ship it back to you. Do not use active THC or CBD. Open the bottle and put capsules on Kraft paper lined cookie sheet. If spots do not show most likely a band is not needed.
If leaks appear in either test a band should be used to secure the oil in the capsule.

What happens if there is no band on the capsule?
After capsules are filled, packaged and sold. What happens to the product? Could it be left in a hot car, will the packaged be dropped or otherwise aggressively handled, where will it be stored? All of these environments could lead to oil finding its way through the seam of the capsule and onto other capsules in the bottle creating questions about quality. This why stability test like the ones described above should be executed to assure the product reflects high standards.

What can be done to avoid the putting a band on capsules?
Formulating the solution so the oil is solid at room temperature is the surest way to avoid using a band. STI can help with coconut oil infused with THC or CBD formulations for viscosity solutions. What other advantages are there to capsule banding? Banding can also be used for tamper evidence, odor masking and branding as the banding material can be colored.

What is the capsule banding material made of?
Capsules are made of two different raw materials: Gelatin and Hydroxy Propyl Methylcellulose (HPMC) better known as Veggie Caps. The banding material for these two capsules is made from the same raw material as the capsule. This allows for optimum binding to the capsule surface. After curing the banding solution becomes part of the capsule.

What type of capsule banding material should be used?
If gelatin capsules are being filled then gelatin banding solution is required. If HPMC or vegetable based capsules are being used then the same banding solution is required.

Where can the banding material be bought and how much is needed?
STI provides banding kits that have complete instructions for preparation and mixing.

Does the banding material come premixed or does it require preparation before banding?
Banding material does not come premixed. It is bought as a powder and is prepared and mixed prior to the banding process.

What capsule banding machines are available for banding capsules with essential and other oils?
STI manufactures two banding machines.
The Lab Top Bander is made for smaller batch sizes.
The CB15 is designed for larger batch sizes.

Should banding be done in a separate area?
Capsule banding should be done in separate environmentally controlled area. There are optimum temperature and humidity levels to assure high quality banded capsules. The environmental controls are best achieved in a separate banding suite.

Can the band be tested to make sure oil is not leaking?
Yes. A random sample should be taken from the banded capsules after they have cured. They are placed on Kraft paper to check for leaking. Kraft paper will show even the smallest oil leak.
What other equipment is needed to operate a bander?

The STI Lab Top Bander comes with 6 slats. These slats hold 15 capsules. If greater output is required more slats can be purchased to increase the output.

The STI CB15 Bander is an automatic machine and does not require any additional parts or tools.

How do I change the machine to run different size capsules?

To change capsule sizes from one to another change parts are required. Each capsule size requires a set of change parts to run on the banding equipment. STI typically inventories these change parts and are readily available.

Is it difficult to clean a banding machine?

All contact parts must be thoroughly cleaned according to the steps outlined in the operational manual and stored in a covered container or area. The non-contact surfaces must be cleaned according the steps outlined in the ops manual. Advanced cleaning protocols are available.

Is training and support available?

On-site technical support is available. STI maintains customer service and technical support staff available by email or phone 12/5.