capsule filling

Making cap tucks a thing of the past

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The cap tuck is one of the most common and challenging defects experienced by capsule filling machine operators. This article discusses the most common causes for cap tucks, along with actions to take when you encounter them.

Poorly joined hard-shell capsules are both visually unappealing and have the potential to leak. A leaking capsule will not have the appropriate fill weight, and its contents may spill onto other capsules, making them unpleasant for patients to ingest. One of the most common types of poorly joined capsules is a defect called the cap tuck.

Cap tucks occur during the closing step of the capsule-filling process when the filled capsule body is pushed up into the cap. Instead of the smaller-diameter body sliding smoothly into the larger-diameter cap, the open (cut) edges of the body and cap collide, and a portion of the cut edge of the cap folds up under itself. In some cases, fill material may become lodged between the cap and the body, causing the cap tuck.

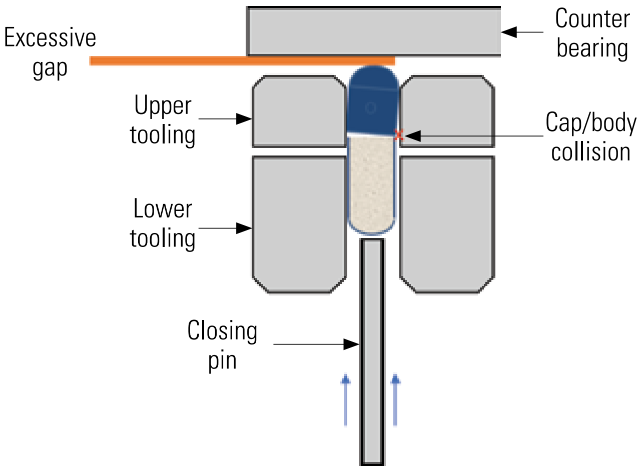
A cap tuck problem can result in hours of additional inspection time and a poor yield for the batch, so it's critical that machine operators quickly identify the cause and resolve the issue. Cap tucks are generally caused by one or more of the following factors: the filling-machine settings, the fill material, the quality of the powder slug, the condition of the filling-machine components, and the quality and design of the empty capsules.

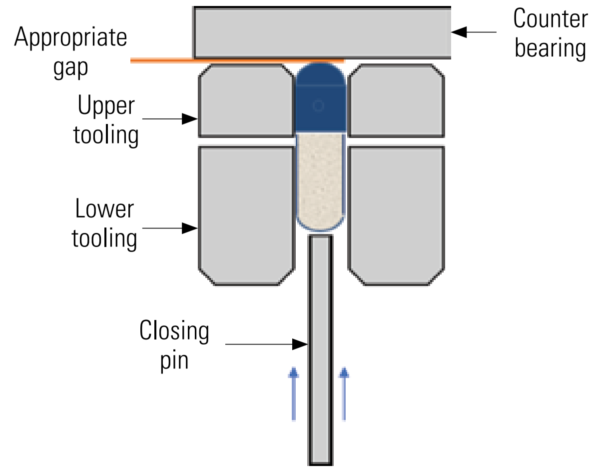
Filling-machine settings

A capsule-filling machine closes the capsules by pushing the filled capsule body into the empty cap, while holding the cap in a fixed position. The machine component that holds the cap in position is commonly called the counter bearing. When setting up the machine for a product, an important machine adjustment is to establish a small gap between the bottom surface of the counter bearing and the

Figure 1

Adjusting the counter-bearing gap





top of the cap dome. An excessive gap allows the cap to travel up and out of the stabilizing walls of the tooling, which can cause the cap to rock from side to side and collide with the capsule body during closing, as shown in Figure 1a. A small gap allows the cap to move very slightly, for self-centering as the body enters the cap, but keeps the cap from rocking laterally (Figure 1b).

You establish this gap by placing a feeler gauge between the top of the cap dome and the bottom surface of the counter bearing. The appropriate gap for most products is between .13 and .50 millimeter. A good practice is to start with a gap of .33 millimeter and then, if cap tucks occur, make small adjustments to determine the best gap for your product. If you're experiencing cap tucks, use the following adjustment pattern to fine-tune your counter-bearing gap to your product. Your completed notes may look similar to Table 1.

1. Measure and write down the current gap setting.
2. Quantify the current defect level by running the turret one revolution and then inspecting the capsules produced. Write down the number of defects next to your note of the gap setting.
3. Adjust the gap setting higher or lower in increments of .05 millimeter and then run one turret revolution at a time, counting the defects at each setting.
4. Perform these steps until you identify the ideal setting for your formulation.

Please note that you should reestablish this gap when switching from one lot of capsules to another. All capsule suppliers have an acceptable range for the cap length. For example, a size 0 capsule may have a cap length specification of 10.85 millimeters ±.35 millimeter. If you switch from one lot of capsules with lengths at the lower end of this acceptable range to a different lot of capsules with lengths at the higher end of the range, you may need to adjust the counter bearing. You

Table 1

Fine tuning the counter-bearing gap

Gap setting (millimeter)	Sample size	Number of defects
.33	1,000	7
.38	1,000	9
.28	1,000	3
.23	1,000	0

Photo 1: This photo shows caps from two different capsule suppliers seated in tooling (IMA Zanasi 40). Note the difference in cap length. Switching between these two capsules would require adjustment to the counter bearing to prevent cap tucks.

Photo 2: Coarse granules in the fill material can distort the capsule body, preventing smooth closing and causing cap tucks.

TABLE 2

Approximate recommended capsule fill weights at various powder bulk densities (in milligrams)

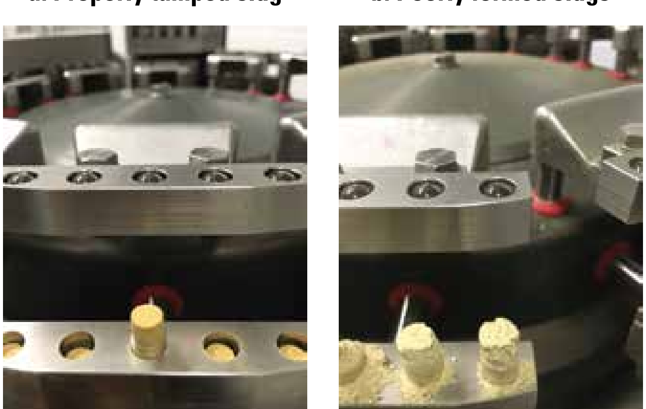
Capsule size	Recommended fill weight			
	At 0.6 g/ml	At 0.8 g/ml	At 1.0 g/ml	At 1.2 g/ml
000	822	1,096	1,370	1,644
00E	612	816	1,020	1,224
00	570	760	950	1,140
0E	462	616	770	924
0	408	544	680	816
1	288	384	480	576
2	216	288	360	432
3	162	216	270	324
4	120	160	200	240

Source: CapsCanada gelatin capsules technical data sheet 2018

FIGURE 2

Powder slug quality

a. Properly tamped slug **b. Poorly formed slugs**



will also need to re-establish the gap when switching between capsule suppliers, as each supplier's capsules have slightly different characteristics.

Fill material

The characteristics of the fill material can also cause cap tuck defects. Coarse granules with hard and sharp edges can distort and cut into the capsule body, preventing smooth closing. Many capsule suppliers specify the maximum particle size for encapsulated powder to be 30 mesh (600 microns), but in a blend, you would not want more than a small percentage of particles to be that large.

Filling capsule shells beyond their recommended capacity can also result in cap tucks. In some cases, slightly lowering the capsule fill weight will eliminate this problem. Take advantage of the elongated capsule sizes if overfilling is resulting in cap tucks. Approximate fill weights for various capsules sizes and powder bulk densities are shown in Table 2.

Quality of powder slug

During capsule filling, the empty capsule body receives the powder in the form of a tamped slug, which often extends above the cut edge of the body, as shown in Figure 2a. This slug of powder must remain in a compacted cylindrical form during capsule closing. Poorly formed slugs (Figure 2b) will cause the weight of the filled capsules to vary and can also contribute to cap tucks. On tamping-style filling machines, ensure that the dosing disc you are using is the appropriate thickness. On dosator-type filling equipment, proper compression will help with slug formation. In some cases, using smaller dosing tooling (size 1 tooling for a size 0 capsule, for example) can create a narrower slug, which may eliminate defects.

Condition of filling machine and components

Cap tucks can occur through misalignment of filling machine components. For proper joining, capsule-filling tooling must be precisely positioned and locked into place. If the alignment is off by a few thousandths of an inch (the thickness of a human hair), or if there is shifting of the tooling or capsule halves because of worn machine

Photo 3: Be sure to check the alignment of the turret in relation to the closing station during machine setup to prevent damaged capsules. (Unit pictured is a Bosch 3005.)

parts, the machine can produce damaged capsules. You must also ensure that the dosing station, closing station, and machine turret are properly centered to one another.

Quality and design of empty capsules

Capsule quality and design play a critical role in the smooth operation of a capsule-filling machine. The cap must fit securely into the tooling bore. The fit should not be too tight, causing poor seating and non-separation, or too loose, causing lateral movement and tilting during closing. Also, the side walls and cut edges of both the cap and body must be sturdy enough to withstand difficult fill materials and the rapid movement of the mechanical closing process.

Capsule roundness is also an important factor in proper closing. An out-of-round cap or body is more likely to collide with the cut end of its counterpart rather than joining smoothly. Larger capsule sizes such as 00, 00-elongated, and 000 are less likely to maintain a perfectly round shape at the cut end than smaller capsule sizes.

Storing unfilled capsules in the recommended environmental conditions will also help prevent cap tucks. Temperature swings can irreversibly alter the capsule shape and may also reduce the capsules' moisture content, making them less flexible during closing.

Working with a reputable capsule supplier will help to ensure that poor-quality capsules don't contribute to cap tucks or other defects. Look for a supplier that offers technical support to help you navigate the factors that cause defects such as cap tucks as well as other challenges that arise during the capsule-filling process. *T&C*

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