Flashing is a common problem for manufacturers of pharmaceutical and nutraceutical tablets. This article explains what causes flashing and provides measures you can take to prevent it.

A tablet press forms pharmaceutical or nutraceutical tablets by compressing a powder or granular formulation between two steel punches within a hole bored into a steel die. A typical tablet consists of convex upper and lower faces formed by the concave tip (called the cup) at the end of each punch and a band between the two faces formed by the wall of the die bore.

Protrusions that form along the tablet band during compression are called flashing. Flashing can occur...
regardless of the tablet shape and is most common when compressing materials that undergo plastic deformation under high pressure. The particle size of the formulation and the amount of pressure applied during compaction are also factors. In this article, I’ll discuss the impacts and causes of flashing and suggest some preventive measures to help minimize it.

**Impacts of flashing**

Flashing occurs in the production of every tablet to some extent, due to the clearance between the punch tip and the wall of the die bore. When a punch tip’s outside edge becomes worn, the clearance increases, which increases the propensity for flashing to occur during compression. Flashing is one way some tablet manufacturers determine that their tooling is nearing the end of its useful life. I would not recommend this method, however, because of flashing’s impacts on product quality, customer experience, and process efficiency, including:

- Excess dust in bottles;
- Raised sharp edges around the tablet band, inhibiting swallowability;
- Aesthetically unappealing tablets;
- Reduced yield, which increases manufacturing costs; and
- More downstream processing to remove the flashing, which also increases manufacturing costs.

**Causes of flashing**

**Tablet press.** The tablet press can introduce variations in the compression process that may contribute to increased flashing. For example:

- Worn guideways can cause excessive punch deflection and nonuniform clearances.
- Turret misalignment can cause uneven wear on punch tips and nonuniform clearances.
- Die-table runout can affect fill depth and cause tablet weight variations.
- Wear on the flight-control cam or punch-holding plug or improper setup can increase tablet weight variations.
- Scraper-blade wear can increase weight variations.
- Tail-over-die wear can increase weight variations.
- The feeder platform’s height and wear on the feeder’s bottom surface can increase weight variations.

Tablet weight variation is directly proportional to force variation as is the pressure applied during compaction. Tablets compressed under higher than average pressure can exhibit more flashing. Generally speaking, batch runs with higher weight variations require a higher average compression force to help the low-weight tablets meet the targeted hardness values. Flashing is worse when you run the tablet press at high compression forces.

All of the above issues can impact the tablet compression process, potentially causing non-uniform or excessive wear to punch tips and die bores. In contrast, a well-maintained press can reduce the number of variances, minimizing flashing and tool wear as well as the need for extra downstream processing.

**Tool loading.** If your tablet press is well maintained and in good working order, the next factor to consider is how you are loading the tools into the tablet press. The clearance between an upper, shaped (not round) punch tip and die bore when made to TSM standards can be as much as 0.003 inch (0.076 millimeter), providing room for manual manipulation.

The manual manipulation occurs when the setup operator inserts the upper punch of a shaped tool into the die. Best practice includes manually turning the punch in the direction that the press rotates, clockwise or counterclockwise, to align the die before locking it down. This human involvement in alignment has some inherent error associated with it, such as the lack of consistent torque from one punch to the next.

![Photo 1: Flashing occurs in the production of every tablet to some extent, due to the clearance between the punch tip and the wall of the die bore, but it can become more pronounced and problematic when a punch tip’s outside edge becomes worn.](image1)

![Photo 2: Stoning the punch tip with a 600-grit polishing stone is a quick way to restore a land that has become too thin, remove J-hooks, and maintain a sharp outside edge.](image2)
I recommend investing in a setting tool that's designed to reduce setup time and achieve more consistent alignment. This tool can add a little to upfront costs, but over time, it can save thousands more by reducing tooling wear and preventing critical fracture from tools being repeatedly misaligned and developing excessive cross-edge wear. Make time to discuss this issue with your tooling vendor and see what setting tools the company has to offer.

**Tablet and tooling design**

Making subtle tablet design changes can optimize production and increase tooling life. These changes can be so slight as to be unnoticeable to the eye, preserving a tablet's look and marketability and maintaining proper weight and thickness.

**Clearance values.** The clearance between the upper punch tip and the die bore affects both air release and the amount of flashing. The Tableting Specification Manual (TSM) [1] specifies clearance values that are optimized for air release, which can increase tablet integrity during high-speed production but may allow more flashing than desirable. In most cases, the TSM clearance values also prevent tip binding.

On the other hand, the European Union (EU) standard—International Organization for Standardization (ISO) 18084:2011 [2]—uses the tighter ISO F7 clearance values, which are based on the tablet's length for oblong tablets and diameter for round tablets. If your tablet isn’t prone to capping and the formulation doesn’t cause film-forming problems on the die bore, then selecting an EU-style tip clearance can reduce flashing and provide better tool alignment, which can reduce excessive edge wear and extend the life of the punch tips.

**Cup depth and land.** As previously mentioned, the punch cup is the cavity at the end of the punch tip that forms the shape of the tablet face. Land is the flat surface around the perimeter of the punch tip between the cup and the tip’s outside diameter. The dimensions of the punch cup and land not only determine the tablet shape but can also greatly influence tooling performance and tablet quality. Often, simply increasing the land can increase tool life and decrease flashing.

**Nutraceuticals.** Nutraceuticals are typically more difficult to compress than pharmaceuticals. A pharmaceutical product may have only 3 to 4 active ingredients and 4 to 5 excipients and/or fillers to aid in compression. Nutraceutical formulas, such as multivitamins, on the other hand, may have 25 or more active ingredients or contain more natural ingredients that don't respond well to compression. These formulas may have particle variations as well as flow issues that then dispose the tablets to capping or lamination. This, combined with pressure from the nutrition industry for more natural products, limits the amount and number of excipients or fillers added to the formulas to aid in compression.

Before choosing an alternative tool steel or coating to protect against flashing from excessive tooling wear, nutraceutical manufacturers should first consider decreasing the cup depth and increasing the land width. A shallower cup can reduce the amount of compression force required to make a suitable tablet, and a wider land makes for a stronger tool.

**Excessive compression force.** Some machine operators may apply more force than needed to compress a good tablet. This practice increases the pressure in the punch cup, which can lead to increased wear or even fractures to the punch tips. This additional wear increases the clearance between the punch tip and the die, causing more flashing.

Using an overload setting that's no more than 20 percent higher than the average compression force required to make a suitable tablet is acceptable as long as the coefficient of variation (CV) is not wildly high. Typically, a CV value of less than 5 is considered good. The overload settings will alert the operator when compression-force variations are higher than expected, providing the opportunity to correct the variation and reducing the likelihood of increased wear.

**Tablet shape.** Shaped punches don't wear evenly around the perimeter of the tip. Since the roller applies torque to the punch head during compression, the punch tip naturally rotates in the direction of turret rotation and becomes snug against opposing corners of the die wall. As a result, flashing is typically uneven on shaped tablets. As previously mentioned, using an interchangeable setting tool to pre-torque the punches in the direction of turret rotation when aligning the dies can help reduce uneven flashing.

**Tooling support.** Discuss your options with a tooling company when initially designing a tablet and take advantage of their many years of experience as well as the large cross-section of customer experiences upon which they draw. A tablet design that looks perfect from a marketing perspective may not lend itself to ease of production in a rotary tablet press, and an experienced tooling engineer can help you achieve the tablet design you want while minimizing flashing and maximizing productivity and safety.

**Tool handling and maintenance**

Tool maintenance is just as important as other aspects of tableting but is sometimes overlooked, with companies varying greatly in their maintenance practices. Working with your tooling supplier to create good tool-handling and maintenance practices can help reduce flashing. Be sure to include periodic preventive maintenance (PM) schedules in your standard operating procedures (SOPs), optimized for the product or products you’re manufacturing. To start, review your tool maintenance SOPs with a tooling supplier. Tooling suppliers are the best source for tips to extend tool life. I would also recommend involving your alternate tooling supplier in this process to gain a different perspective.

Dents or dings are major contributors to premature punch-tip wear and failure, and improper handling is their most common cause. Tablet tooling is made from
hardened steel, but punch tips are very delicate and easy to damage if they impact another punch or fall on an unprotected floor. The area of highest concern is the land around the perimeter of the punch cup, which is the part of the tool that tends to wear out first and that tends to take the most abuse during handling.

Good handling is crucial not only to the life of the tool but also to the proper functioning of the tablet press. A damaged tool can damage the press during operation, which can then impact the next set of tooling, causing a quickly increasing cycle of damage.

**Tool handling.** Companies often blame tool damage during handling on clumsiness or inattention, but proper tool handling procedures can go a long way toward preventing damage from occurring. Minimizing handling steps will protect your tools. Examine a tool’s life-cycle and write down each step that requires handling:

- Decide which tasks you can complete together. For example, do you remove a tool from a tote to perform a visual inspection, put it back in the tote, and then repeat the process to measure working length? Could you remove a handling step by staging these tasks together?
- Determine if you can eliminate tasks. For example, do you transfer tools from a cart to a cleaning rack? Could the cleaning rack be a part of the cart that lifts off?
- Establish how often you really need to polish, measure, and inspect tools. Formulations can vary regarding abrasiveness and stickiness. Consider optimizing your schedules based on your product’s needs.

Evaluate your methods of storage and transport in trays, bins, totes, tables, carts, and racks and redesign them to reduce damage to tools:

- Decide if damage to tools occurs during transport and storage. Can you change your methods so that tools don’t come into contact with one another during those processes?
- Determine if movement during transport causes damage. Do you secure your tools during transport?
- Evaluate the weight of the tools during transport. Is the transport weight excessive?
- Determine if tools are easy to reach for a given task. Are you attempting to save floor space by making drawers or shelving too low or too high? Doing so can increase risk to operators, slow process times, and raise the chance of a tool mishap.
- Determine if tools placed loosely on tables or carts are free to roll off an edge. Does the table or cart have an edge barrier? Does the workspace have a floor mat to cushion a tool’s fall in high-risk areas?

Assess your methods of cleaning, measurement, repair, and press setup to decrease damage to tools:

- Determine if personnel remove multiple tools at a time from storage or transfer totes. If so, does the employee hold more than one tool in his or her hand simultaneously? Best practice is to handle just one punch at a time.

- Ascertain whether multiple tools have the opportunity to touch one another during cleaning. Do you place a handful of tools loose in a bucket?
Tool maintenance. You must maintain the sharpness of the land’s outside edge to minimize flashing. Buffing the punch tip can round the land outside edge, as shown in Figure 1. While buffers are very common in tool rooms and are quick to use, they can affect tablet quality when used to polish a punch cup. Instead, consider using a hand-held, variable-speed rotary tool with a small brush. Also, tool manufacturers typically use a stereo zoom microscope to efficiently inspect tools, and I recommend investing in one for your tool room as well. This microscope allows maintenance personnel to quickly identify uneven wear, cracks, and excess material left in an engraving after cleaning as well as hard-to-see changes that may be occurring in the land or other parts of the punch tip. A loop can do this as well but isn’t as efficient or as effective at spotting small details that can lead to big problems later.

After cleaning, repair and polish the punches if needed. If you find that the punch land has become too thin or see a J-hook pattern, rolled edges, dents, or uneven edges, you can fix them with a 600-grit polishing stone, also known as an Arkansas stone. Stoning is a quick and simple way to restore land to its proper size with a sharp outside edge to minimize flashing.

References

Mike Beyl is Western tablet tooling specialist at Wilson Tool International (866 752 6531, www.wilsontool.com). Wilson Tool’s tableting division provides compression tooling, including standard punches and dies, accessories, and custom-designed tool solutions, to the pharmaceutical, nutraceutical, industrial compression, confectionary, and other industries.