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WHITE PAPER

PREVENTING STICKING AND PICKING THROUGH TABLET DESIGN

Prevent unanticipated problems during scale up and full-scale production by considering tablet compression issues before tablet designs are finalized.

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PREVENTING STICKING AND PICKING THROUGH TABLET DESIGN

Sticking is one of the most common problems of tablet manufacturers. It occurs when granules or particles from the formulation attach and stick to the face of a punch cup, resulting in defective tablets. Picking is a specific type of sticking that refers to material becoming stuck on the faces of the compression tooling due to embossed designs, such as the letter or numerals of the tablet logo or identifier. Sticking or picking issues are often not detected until transferring the product from research and development to production. Although sticking and picking are frequently related to deficiencies in tablet design, remediation does not always require changing the design (and thus the tools used for tablet manufacturing).

When powder sticks in the punch cup or embossed characters, one of the first things to check is the moisture level of the formulation. Excess formulation moisture or excessive humidity in the compression suite

can initiate sticking or picking.

Insufficient compression force is also a potential source of sticking/picking because the compaction of the powder is not complete. When this occurs, the adhesive forces of the punch are stronger than the cohesive forces of the inadequately compressed tablet.

Another potential cause of sticking and picking is a deficiency in the amount of lubricant within the formulation. An increase of lubricant will impart greater release of the compressed tablet from the punch cup surface.

Careful inspection of the punch cups is also essential to ensure there are no surface scratches to capture small particles of formulation. Scratches will lead to filming, which is an initial slow form of sticking, often due to fines and excess moisture in the granulation. If surface scratches are identified, punches should be polished. Additionally, a specialized

polishing compound can be used to impart greater lubricity and better product release properties.

When simple or environmental fixes are not enough, a full tablet design review may be necessary. Tablet design plays a pivotal role in oral solid dosage manufacturing, although it's often overlooked. Typically, a pharmaceutical company's marketing department pushes for certain tablet shapes and logos with the end goal of promoting brand recognition. However, those designs may not be optimal for manufacturing requirements and demands. Compression tooling suppliers, who are often highly-experienced tablet design experts, can identify potential sticking and picking issues before tablet designs have been finalized, thus reducing production challenges.



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Font selection: serif vs. sans serif.

Font selection is often a battle of form versus function. As illustrated in **Figure 1**, an ornate or decorative serif font will be more prone to picking problems compared to a more simplistic, sans serif font. The same embossing using a practical, simplified sans-serif font uses increased engraving and corner radii. This font modification minimizes picking opportunities, increases the likelihood for consistent powder

compaction, and yields the best over all possible cohesive forces for the tablet.

Figure 1. Decorative or serif fonts are more prone to picking problems than simple, sans serif fonts.

Picking problems can best be addressed during the tablet design process by making modifications to the embossed letters or using compound cup configurations to improve compression in the deepest areas of the punch cup. The

compound cup configuration allows for greater control over the curvature of the cup surface, thus allowing for optimization of the surfaces directly around the logo.

Adjusting the engraving cut.

Although it is important to first consider the font or typeface for the design, attention should also be given to the design of the engraving cut. Pre-picking letter or numeral islands as well as tapering the peninsulas for some letters will often alleviate picking problems.

FIGURE 1



SERIF
DECORATIVE



SANS SERIF
SIMPLISTIC



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Figure 2 highlights where a peninsula (i.e., a partially enclosed area) and an island (i.e., a fully enclosed area) are formed within a typeface on a typical round tablet. The variation in engraving width, as well as the isolated peninsulas of the serif font letters, are impediments to even powder compaction. This variation often leads to powder picking away from the compressed tablet core

and remaining in the punch cup. The engraving of the "93" cut into the tablet is shown in Figure 2A with typical engraving width, depth, and an angle of 35 degrees. Most product formulations can readily be compressed into tablets using tools with this style of engraving design. However, many formulations are not typical, and problems can still occur.

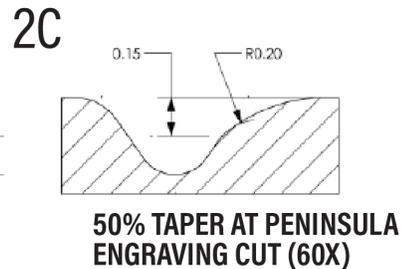
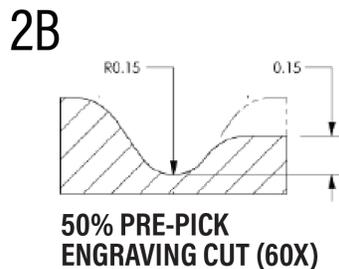
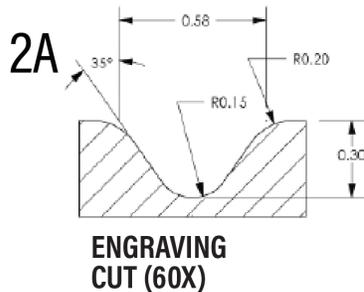
Figure 2. The risk of picking in an island or peninsula in a typical engraving cut (shown in 2A) can be reduced by decreasing the island depth using a pre-pick cut (2B) or by tapering (2C).

FIGURE 2

- ISLAND
- PENINSULA



NOTE: ISLAND WITH ■ IS PRE-PICKED 50%. PENINSULAS WITH ■ ARE TAPERED 50% OF THE ENGRAVING DEPTH.



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To reduce or eliminate problems with material picking in the center island of the “9,” pre-picking can be incorporated in the design. Pre-picking decreases the height of the resulting island or pad on the tablet by intentionally adjusting the depth of the engraving cut on the cup face. For example, as shown in **Figure 2B**, the depth for the island is reduced from 0.30 mm to 0.15 mm.

This reduction is defined as a 50% pre-pick. The amount of reduction can range between 10 and 100%, depending on the extent of the picking problem. For branding or

aesthetic purposes, consideration must be given to tablets that will be coated post-compression, as excessive pre-pick will significantly reduce the clarity of the logo.

The partial pre-pick concept is applicable to any letter or numeral with fully enclosed areas (i.e., islands or pads).

Many other somewhat complex characters that do not have fully enclosed areas are also prone to picking. Letters like E, S, K, and M and numerals such as 2, 3, and 5 all contain these partially enclosed areas (i.e., peninsulas).

For these areas, a feature called “tapering” or “ramping” is employed to reduce the likelihood of picking. Starting on the tablet surface at the open end of the peninsula, this feature tapers downward toward the enclosed end of the peninsula by a percentage of the engraving depth. Peninsulas usually are tapered between 10 and 50% of engraving depth, with 30% as the most common. An example of a 50% taper is illustrated in **Figure 2C**.

Logo/identifier placement. Although font selection and design of the engraving cut are two crucial aspects of tablet design, attention should also be paid to the placement of the identifier. The size and spacing of the characters can be modified to reduce the occurrence of picking. Additionally, moving the placement of the characters out of center can also be an effective option as illustrated in **Figure 3**.

Figure 3. Out-of-center placement of text can reduce picking.



Figure: 3



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Exploring tooling material

If sticking and picking have been discovered during the research and development stage, or if it is time to order the next set of punches for a product with known sticking and picking challenges, another consideration is to have the punches made from a specialty steel. The steel type used will vary based on the product's formulation.

It is widely accepted that punch steel with a high concentration of chromium in the alloy, usually between 16 and 18%, enhances release of the compressed product. For example, M340 or 440C are beneficial for sticky products because the high chrome content yields improved product-release characteristics. Steels with higher levels of carbon (D2) and vanadium (PM-3V, 9V, 10V) provide better wear resistance for abrasive formulations common in nutraceuticals, as sticking can occasionally be caused by a degradation in cup surface finish caused by these types of abrasive products. Other specialty steels are available to enhance the performance and the service life of the punches and dies for compression strength, wear resistance, and corrosion resistance. A reputable tool vendor will have multiple grades of high-chrome steel available and should help their tablet manufacturing customers to make the best selection for a particular formulation. The finish of the tooling, whether it be mirror or matte, is an additional aspect that should be discussed with the tooling vendor when working with a difficult product.

As an alternative to using a specialty steel, a specialized coating can enhance the release characteristics of the punch faces and reduce or eliminate sticking and picking. The most common coatings are hard chrome (Cr) and chromium nitride (CrN). Several other coatings are available as well, depending on the unique characteristics of the formulation to be compressed. It should be noted that due to the abrasion of some formulations and polishing, coating layers can wear off over time, reducing their effectiveness. A tooling vendor should be able to explain the unique properties and advantages of the tool steels and coatings available for a formulation.

A proactive approach

Consulting with a qualified tooling vendor and discussing sticking and picking issues early in the development process will help reduce potential production issues and costs associated with purchasing redesigned tooling. There are several remedies that can help eliminate sticking and picking, ranging from slight formulation changes to tablet design and tooling modifications. It is important to discuss all product properties with the tool vendor during the tablet design phase to help eliminate sticking and picking issues before they occur.

About the authors

Bill Turner is the technical service manager and Kevin Queensen is a mechanical engineer who works in Technical Service Support, both in Tooling and Tablets at Natoli Engineering Company, Inc.