

Make It Or Break It: How Tablet Design & Tooling Choice Can Help Or Hinder Nutraceutical Manufacture

Tableting can be a challenge for nutraceutical manufacturers, especially if the tooling used is not appropriately designed for the formulation. This article discusses tablet-design and tool steel considerations that can lengthen tooling service life and boost production.

The growing consumer interest in healthy living and natural products has led to an increase in nutraceutical production on a global scale, with market reports projecting that the global nutraceuticals market will grow at an 8.8 percent compound annual rate through 2025, reaching \$578.23 billion.

The demand for dietary supplements with vitamins and minerals is putting pressure on manufacturers to produce quality tablets efficiently and economically. This can be extremely challenging for manufacturers because the natural ingredients in dietary supplements are usually unrefined, abrasive, corrosive, and hard, making the formulations difficult to compress into quality tablets. If the wrong tablet press tooling is used, it can lead to sub-par tablets, production problems and downtime, and premature tooling wear or damage, all of which increase production costs.

A proactive approach is needed to combat the problems faced during nutraceutical production. During the earliest stage of product development, manufacturers must carefully examine the tablet design and the properties of the steel used to produce the punches and dies to ensure that the tooling will be up to the task of tableting aggressive nutraceutical formulations.

Get In Shape

Tablet design is key to producing quality nutraceutical tablets. Tablets comprising vitamins and minerals, on average, tend to be larger than pharmaceutical tablets, as

nutraceutical formulations can have as many as 50 active ingredients and two to eight excipients; whereas pharmaceutical tablet formulations generally contain one to four APIs and around five or six excipients. Moreover, nutraceutical ingredients tend to be coarser, and as a result more damaging to tooling, than pharmaceutical ingredients. These factors, among others, will affect the design of the tablet shape and profile.

Tablet shape can vary from simple round and oval shapes to uniquely shaped and branded products. More elaborate shapes can be used to promote identification and branding. For example, an orange slice shape could be used for tablets containing vitamin C, and character or animal shapes can be used to make a nutraceutical tablet more appealing to children (Photos 1a and b). For designer shapes, dietary supplement manufacturers should consult a professional tablet tooling designer, because complex shapes tend to have vulnerable, high-stress areas that can wear or break during compression.

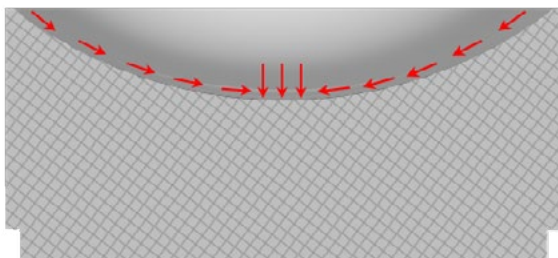
Choosing a robust tablet shape and design can help reduce tooling wear and impregnation, common issues when working with abrasive nutraceutical ingredients. If a tablet face requires a punch with a deep concave cup, the punch tip will wear quickly around the steepest areas of the cup, as the granules will tend to move laterally and create friction during compression, as shown in Figure 1a.

This type of wear can lead to various production problems, such as the removal of details or break lines embossed into the punch cup,

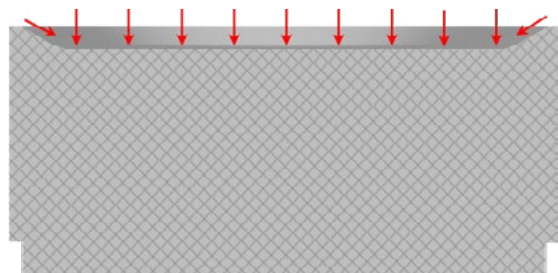
resulting in poor tablet definition and potential functional tablet failure. Another common issue is capping and delamination, which is when the top of the tablet separates from the tablet body after compression during ejection from the die or take-off from the lower punch. When compressing abrasive materials, consider using a flatter, shallower tablet profile such as the one shown in Figure 1b or a profile specially designed to reduce potential friction and wear.

Figure 1

An exaggerated example of granule movement across punch tips during compression



a. Concave punch cup



b. Flat punch cup

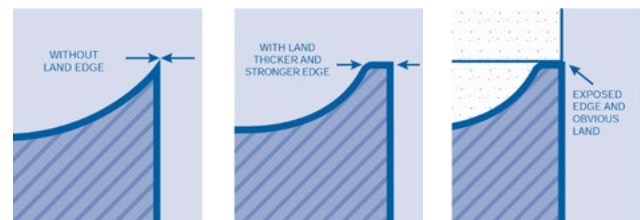
Additionally, when working with rough nutraceutical formulations, the gap or clearance between the punch-tip edge and the die bore is critical. If abrasive particles become trapped between the punch tip and the die, they'll accelerate wear of both tools. Trapped particles can create wear rings in the die bore and cause claws or j-hooks to form on the concave face of the upper punch, resulting in flashing or possible decapitation of the tablet. The correct tablet and tooling design can mitigate or even eliminate these potential problems.

An expert tooling designer will be able to add appropriate strengthening features to the tablet design such as blended lands and profile changes, resulting in a strong tablet

that can be quickly and cost-effectively produced. The land on a tablet is the flat lip or ridge around the perimeter of the tablet face perpendicular to the tablet's edge. Figure 2 shows examples of punches with and without lands. Often, tablet manufacturers elect not to apply a land because it is perceived to be aesthetically undesirable on the finished product. However, skillfully blending the land can minimize its visual impact on the final tablet while increasing the tooling strength and performance, resulting in higher production volumes. Incorrectly blending the land, on the other hand, can result in a range of problems during compression, including chipping of the land during tablet take-off, or issues during coating, such as coating build-up on the tablet edge, which will eventually chip off. To correctly blend the land, ensure that the flat area on the tip edge is maintained while applying a radius to the intersection between the flat perimeter of the punch tip and the concave cup that forms the tablet profile.

Figure 2

Punch tips with and without land



Also consider the tablet profile, especially if the tablet will be coated. Successful tablet coating is dependent on the tablet profile. A tablet is softer at its core than at its perimeter, so the core can erode during coating from contact with the coating pan and other tablets (Photo 2). You can prevent this weakness by avoiding tablet designs with very round profiles.



Photo 2: Core erosion is a common defect for tablets with very round profiles, especially when put under strain during coating. The tooling should be redesigned with a less concave profile to help the tablets withstand the coating process.

Is Your Tool Steel Up To The Job?

In addition to good tablet design, it's important to make sure your tooling is made from the correct tool steel. The punches and dies are the main contact parts with your nutraceutical tablet formulation. Proper material selection during the initial design stage will ensure tooling productivity and durability during tablet production. Choosing a steel that is not metallurgically capable of handling the repetitive compression of abrasive formulations can lead to numerous problems. Proper steel selection will achieve the best possible balance of abrasion and corrosion resistance, compressive strength, hardness and resistance to chipping and cracking, a clean structure, and good machinability and formability.

Special tooling steel can be used to counteract the aggressive nature of hard and abrasive granules commonly found in dietary supplement formulations. Although tungsten carbide is a popular steel choice for nutraceutical production due to its excellent wear resistance and high compressive strength, it is brittle and can lead to premature punch-tip fractures. Furthermore, dies made from tungsten carbide can react with certain formulations, leaving black spots on the tablet walls. When tableting abrasive formulations, powder-metallurgy-grade steels may be better for punches and dies than standard tooling steels, because they have superior hardness and durability.

Improve Design And Enhanced Production Will Follow

Tablet tooling durability and longevity are key to achieving high productivity and profitability. Nutraceutical manufacturers should not overlook tablet design because it is critical to avoiding production problems, preventing premature tooling failures, and manufacturing a quality end product. Nutraceutical manufacturers should invest in tooling made from the most suitable tool steel for the product, especially for difficult-to-compress formulations. With careful consideration and input from a tablet and tooling design expert, a company can optimize its nutraceutical tableting process and increase its bottom line.

Reference:

1. www.grandviewresearch.com/press-release/global-nutraceuticals-market.



Steve Osborn is product design manager at I Holland. A key member of the customer support group, Osborn is responsible for the production areas related to the manufacture and forming of the punch tip profile. He has experience

in all manufacturing operation and leads the interactive tablet design service at I Holland.