

Steel Yourself



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Cost efficiencies and improved quality can be achieved by making simple changes to the tablet manufacturing process. By collaborating with a specialist vendor and taking into account the appropriate steel type, companies can overcome any tooling issues they may face

Material quality is one of the most important factors to consider when it comes to the manufacture of tablet compression tooling. The majority is produced from tool steel, and it not only plays a vital role in the life of the tooling, but also in the tableting process itself. In addition to premature wear and tear, improper material selection can cause quality concerns during production – slowing down processes and causing costly

delays, wasted product and inefficient use of personnel. As a result, choosing a proper grade of high-quality, long-lasting material for punches and dies will help to reduce expenditure and gain process efficiencies.

Defining Steel Quality

Steel quality is quantified by how well it meets its specified chemistry, its cleanliness (the degree to which it is free of impurities or inclusion), homogeneity of the microstructure, grain/carbide size and, in some instances, if it meets the mechanical requirements for that particular grade.

Many steps are required to manufacture the steel that makes punch and dies. Starting from its raw form, it is melted, poured, refined and rolled. All of these phases affect how well the end product will perform, and there are multiple process variations that can have an influence. The cleaner the tool steel, or how ideally formed the structures are, the better it will perform.

Figure 1 (above): Choosing the most appropriate steel for tablet tooling is a more complex decision than manufacturers might first imagine

Cleanliness can also refer to how closely the chemical make-up matches the specification for that grade, as impurities in the tool steel can affect its performance. The manufacturer can also implement treatments using heat or cryogenics on punches and dies to make small improvements to performance.

Steel chemistry can also play a part in reducing issues that are encountered during manufacturing. Certain elemental compositions can provide advantages such as improved product release, wear and/or durability.

Keywords

- Steel chemistry
- Cleanliness issues
- Tool grade
- Speciality coating
- Punch cup finish

Choosing the Right Grade

It is important to choose the proper steel grade to complement the powder chemistry. Selecting a tool steel that demonstrates the necessary characteristics to eliminate the product's manufacturing challenges will provide many benefits, including increased production, reduced downtime and lower operating costs. Sticking and picking are among the most common tablet manufacturing problems that can be improved simply by choosing a complementary steel type. Sticking occurs when powder formulation sticks to the punch cup surface, while picking occurs when formulation is pulled from the tablet surface because a portion has become trapped in the engraving or embossing characters.

Steel grade is commonly overlooked, but should be carefully considered as there may be trade-offs involved. For example, although steels with a higher chromium content can improve product release, they may be less durable. Other characteristics can also be improved by proper steel selection; if a powder is highly abrasive, steel with a greater concentration of vanadium can impart wear-resistant properties, thus improving tool life.

Speciality Coatings

Another option to improve performance involves applying a speciality coating to punches. Coatings can, in limited cases, supply certain qualities that are useful when encountering difficult powders to compress; for example, coating punch tips with chrome or chromium nitride can reduce sticking problems. With a proper polishing technique, a chrome surface can have an average



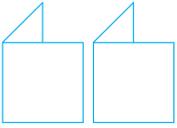
surface roughness of less than 0.5 microns. Various coatings – such as titanium nitride or diamond-like carbon – can bring positive results for tablet manufacturers experiencing abrasion problems.

However, because coatings can be an unnecessary expense on top of tooling costs, choosing an appropriate steel type is still recommended. In many cases, simply choosing steel that is complementary to the product's requirements will bring the same positive results as adding a coating.

Some tooling manufacturers subscribe to a one-size-fits-all approach and suggest customers use a coating without fully understanding their needs. In general, coatings do not wear evenly, which can cause manufacturing issues as powders naturally abrade the more vertical cup surface, losing the effectiveness of the coating. In contrast, tools without coatings can be less complicated to refurbish and polish, offering significant cost savings and resulting in a more efficient process. Adding a coating should be a last resort.



Figure 2: Applying speciality coatings to punches can offer improved performance, but should be a last resort once other avenues have been explored



Steel should be tested by an independent laboratory for cleanliness to guarantee it meets the specifications for the grade purchased. A manufacturer should be able to supply certified quality reports listing the chemical composition of punches and dies, as well as the cleanliness of the batch

There is likely to be a great deal about a coating that tablet manufacturers are unaware of – thickness, wear, adherence to the cup face and, often, the actual chemistry. The use of designer names for common coatings is also sometimes used as a marketing strategy and to justify higher prices.

Certified Composition

Steel should be tested by an independent laboratory for cleanliness to guarantee it meets the specifications for the grade purchased. A manufacturer should be able to supply certified quality reports listing the chemical composition of punches and dies, as well as the cleanliness of the batch. This ensures transparency and can greatly aid in troubleshooting compression issues when they arise. Some tooling suppliers hide the American Society for Testing and Materials and German Industry Standard tool steel designation behind 'branded' steel grades.

Even if a customised solution is offered, firms should be able to provide reports that specify the steel's exact composition.

It is helpful for tablet manufacturers to partner with their tooling vendor to communicate any powder characteristics like the potential for sticking, abrasive wear and tendency for high compression forces. Armed with this information, the manufacturer can more accurately suggest a proper solution to meet the needs of the powder.

Alternative Finishes

There are other options, beyond coatings, to reduce issues related to tablet quality. The Natoli Institute for Industrial Research and Development recently conducted tests with different tool steel types, coatings and specially finished punches to determine which would best produce tablets from particularly sticky powder. The tableting industry generally believes that the smoother the metal punch cup is, the less sticking will occur. This is because a smoother surface minimises adhesion forces by reducing the opportunity for powder molecules to interact with asperities on the cup surface.

In one case study, when faced with a complex formulation that was prone to excessive sticking, tools were manufactured with a punch cup that had a lightly abraded surface. This could be described as a matte

finish, as opposed to the usual mirror-like surface that is generally preferred. The effectiveness of this finish was then tested against other possible solutions, including punches manufactured with chrome, chromium nitride, diamond-like carbon and speciality nickel polymer-based coatings. All of the test tools were run at the same time in the same tablet press with virtually no other variables. Micro indentations were etched into the punch cup to identify tablets from each compression station of origin and, after the experiment, the tablets were separated so any tablet defects could be attributed to each specific coating.

Results of the experiment were definitive – the matte finish yielded a reduction in tablet defects that was double that of any other coating tested. It has also been instrumental in eliminating sticking problems with Nuprin, one of the first ibuprofen products on the over-the-counter market.

Making the Choice

Choosing the appropriate steel type for applications can bring economic benefits, along with improved tablet quality. Remember to communicate with your tooling vendor so they can help with proper steel selection to meet your powder's needs. Your tooling manufacturer should be able to assist you with virtually any tablet production problems you may encounter.



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