Interest in multi-tip tablet tooling has grown in tandem with the drive to increase tablet productivity and efficiency. This article outlines the factors that influence the success of multi-tip conversions, including press compatibility, formulation characteristics, and tablet properties.

Multi-tip tooling increases productivity and shortens production run times, thereby decreasing maintenance and reducing the amount of time spent on press setup per batch. In fact, the increase in production can eliminate the need to install another tablet press, conserving time, capital, and floor space.

Multi-tip tooling boosts production because it compresses more tablets per turret rotation than single-tip tooling can. How much it raises output depends primarily on how many tips it has. It could be as few as two and as many as two dozen or more. The exact number depends on the tablet's size and shape, the granulation's characteristics, and the type of tablet press used.

The chemical and food industries were among the first to adopt multi-tip tooling, which has been available for more than 30 years. Manufacturing artificial sweeteners was an early application. In the pharmaceutical industry, manufacturers of oral contraceptives were one of the first to use multi-tip tooling, but others soon understood the benefits, and multi-tip tooling is now transforming the way tablets are made.

Not only can multi-tip tooling boost production while eliminating the need for additional tablet presses, it can...
also reduce the number of tool setups required per batch. Fewer setups translate into more time spent making products and faster batch times. These advantages lead to other benefits: Less energy usage and fewer hours to complete a campaign, which makes the press available for other products. Because run times are shorter, the cost of operating the tablet press also decreases.

A less obvious benefit is the ability to quickly manufacture time-sensitive granulations. These are formulations that—to prevent defects—must be compressed into tablets very shortly after they're made. Presses equipped with multi-tips are better suited to the task than conventional presses because they work faster. Plus, if the formulation requires a special environment, using fewer presses means less need for dedicated suites.

One press, more production

While those benefits are significant, most of the inquiries our company receives are driven by a desire to increase production, preferably using an existing tablet press. One customer's inquiry concerned upgrading a Korsch PH800 that had 77 stations equipped with single-tip tooling.

The machine's theoretical maximum output was approximately 831,000 tablets per hour but, in reality, it ran at 80 percent of maximum speed, which is typical, and produced around 665,000 tablets per hour. To increase output, the press was equipped with double-tip punches and corresponding dies. During trials, tablet output increased to 1 million tablets per hour—approximately a 50 percent increase—while operating at 60 percent of its maximum speed. Next, the press was fitted with triple-tip tooling, and output reached nearly 1.5 million tablets per hour, a 125 percent improvement. As a result, the press could complete a batch in 8.5 hours instead of 14.5 hours.

Another project involved a high-speed Fette tablet press equipped with a segmented die table. With single-tip tooling, it ran at 900 rpm and produced 900,000 tablets per hour. With the addition of double-tip punches and corresponding dies, the machine reached 1,200 rpm and output soared to 2.4 million tablets per hour.

Tablet press compatibility

Although most presses can accommodate multi-tip tooling, there are some factors to take into account.

- Confirm that the upper turret has a keyway in its punch guides to align the tooling. It is not necessary to have a keyway in the lower guides because, as with standard tooling, the tips remain in the die. But it is advantageous to have a keyway there; it speeds setup and reduces the chance of damaging the lower tips.
- Examine the feeder paddles. They may require modification to ensure they deliver enough formulation to fill the dies.
- Assess the tablet ejection system. It must be capable of receiving a larger volume of product.
- Consider the press monitoring system and associated equipment. Everything must work in concert to provide information efficiently, and some systems cannot accommodate multi-tablet output.
- Check the condition of the press. There should not be significant wear in the turret area. Pay particular attention to the punch guides, keyways, and die pockets. Also inspect the cams and replace them if they show signs of excessive wear or degradation. Failure to do so will lead to damaged punch heads.

Formulation considerations

It's also important to assess the formulation's characteristics before you commit to multi-tip tooling. How well the granulation flows is key. If it doesn't flow into the die quickly enough, you're sure to have problems.

There are a few ways to increase flow on the press without having to reformulate. One approach is to modify the feeder mechanism. The appropriate feeder will allow the press to maintain its turret speed. In other cases, running the turret more slowly is the better approach because that gives the formulation more time to fill the dies.

The formulation's particle size distribution is another important factor. If, for example, the percentage of fines is high, the same problems typical of presses running single-tip tooling can multiply. This includes fines passing through the clearance between the tip and die, which allows buildup and causes tightness and friction in the lower punch, possibly leading to premature headwear and damaged cam tracks. If the percentage of fines cannot be reduced, modifying the working tolerances may be a solution. It may also help to shorten the tip length and/or change the tip undercut on the lower punch. Reducing the tip length decreases the amount of contact and thus friction, while a sharp undercut to the tip (sometimes called a Bakelite or die-scraper relief) can help keep the die bore clean.

Tablet shape and size

When considering multi-tip tooling, evaluate the shape and size of the tablet to ensure it is compatible. Round tablets allow an efficient arrangement of the tips; but capsule shapes, ovals, and polygons are more challenging. They may require more time to devise an arrangement that preserves tooling robustness and optimizes die filling and tablet take off.
As for size, any tip 4 millimeters or less in diameter is at risk of distortion or breakage and preventing that can be quite a design challenge. One solution is to reinforce the punch tips, as shown in Figure 1. In this case, the small-diameter tips required equipping the press with a restricted fill cam, which limits the movement of the lower punch and restricts the depth of fill. That prevents the punch tips from dropping too low in the die bore. This design also includes recessed dies to accommodate the reinforced tips and to prevent them from contacting the die bore.

**Figure 1**

Reinforced small-diameter tip with recessed die to prevent it from contacting the bore

As with single-tip tooling, the tablet profile, embossing, and break-line details are critical design elements. Seek the expertise of a professional tooling designer to account for these and the many other variables that come into play when developing a multi-tip configuration. Most tablet designs are compatible, but the type of press and the type of multi-tip tooling must be considered.

**Types of multi-tip punches**

There are four main types of multi-tip punches: internal cap fixing, external cap fixing, pin fixing, and monoblock (Figure 2). The cap and pin fixing designs, all of which combine several components, have been around for many years. Monoblock multi-tip punches—so named because they are made from a single piece of steel—are the most recent type and became available because of advances in CNC machining. Each type has benefits and drawbacks.

**Internal cap fixing.** This design offers a clean method of fixing the tips, which are easy to replace if damaged. Its seamless joints don’t interfere with the punch guides or oil/dust seals, minimizing contamination. The internal cap is secured with self-locking screws that prevent it from coming loose. Because the design comprises several components, it’s easy to combine different materials and coatings.

**External cap fixing.** This design resembles internal cap fixing, but because the cap is fitted to the outside of the punch body, more space is available and it can accommodate more tips per punch.

**Pin fixing.** If the application calls for punch tips that are easy to replace, pin fixing is the best choice because it is a simpler design with fewer components.

**Monoblock.** This design requires no disassembly before cleaning or reassembly thereafter and is preferred for WIP and other applications that require the tooling to be easy to clean while it is mounted on the press. Because it has no joints, the monoblock design will not damage the punch guides or seals. It also reduces the risk of cross-contamination. The one drawback of monoblocks: A damaged tip requires replacing the entire punch.

**Figure 2**

The main types of multi-tip punches

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To ensure your multi-tip tooling remains in good working order, follow this standard operating procedure.

1. **Clean.** It’s essential to remove all contamination. The easiest multi-tip tooling to clean is the monoblock.
2. **Assess.** Inspect the punches and dies to determine their general condition.
3. **Repair.** Rectify any damage to the tooling, including any light corrosion and/or minor damage by manual polishing. Only make repairs when absolutely necessary.
4. **Measure.** Ensure the tooling’s critical dimensions are within tolerance. For multi-tips, focus on measuring the working lengths of each tip on the punch and the working lengths of the punches across the set. Keeping them within tolerance will help you control tablet weight, hardness, and thickness.
5. **Polish.** Use an automated polisher to ensure a consistent, uniform finish.
6. **Lubricate.** Apply a light oil to the tooling to protect and preserve it and to help ensure the tablet press operates smoothly.
7. **Store.** Eliminate or minimize damage by using dedicated storage cabinets. Keep accurate records about the tooling.

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—S.O. and S.D.
Incidentally, the most common means of preventing contamination—equipping the upper punches with drip cups and/or bellows—requires additional consideration when used with multi-tip tooling. With multi-tips, the groove in the punch that holds the cup/bellows in place can reduce the space available for multiple tips, limiting how many tips the punch can accommodate. An expert tool designer can limit this impact. See Figure 3.

**Setup and care**

Once the tablet design is final, the prototypes tested, and the final set of tooling ready, be careful during installation. First, use a die alignment tool to check die-pocket wear and turret alignment. That’s important because if the dies aren’t set correctly, both the upper and lower punches can misalign and become tight in the guide. If that happens, the punch tips will contact the die wall, leading to friction and heat buildup. Furthermore, the punches will not move freely during compression and that will damage the fill and ejection cams.

The size of the die pockets is also important. Depending on their condition and that of the die table, they may need replacing or you may need to revise the tolerance of the die specification. Of course, the die pockets must be free of foreign objects and burrs. Also be sure that the die-fixing screws are in good condition so that the multi-tips can work to their full capacity.

While all tablet press tooling should be handled carefully, multi-tip tooling is even more delicate than standard tooling, and proper maintenance is critical to maximize service life. The sidebar on the opposite page lists seven maintenance steps to follow to avoid tooling problems, many of which stem from poor handling and maintenance. Don’t try to save time by skipping a step or doing a less-than-thorough job. If you do, you’ll pay for it in lost production time due to unplanned maintenance and tooling replacements.

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