capsule filling

Strategies for improving capsule filling efficiency

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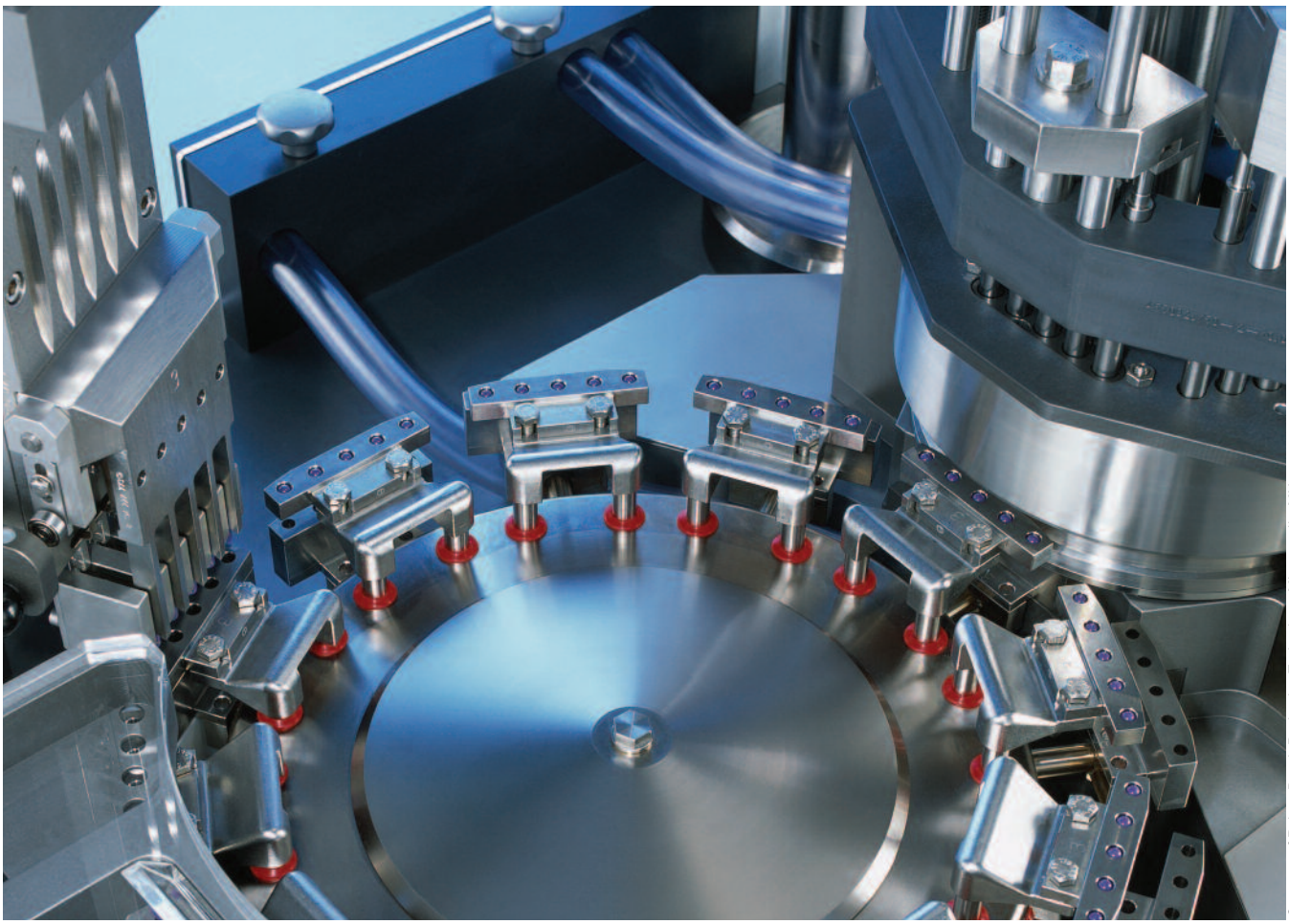

Courtesy of Robert Bosch Packaging Technology, Minneapolis, MN

Finding the right balance of equipment, capsule, and formulation can boost yields, increase filling speed, and reduce downtime, allowing you to deliver products more quickly and increase profits.

The ground rules have changed for product development and production in the health and nutrition industries, as well as in the pharmaceutical business. Today, manufacturers must meet demands for better products while making them faster and at less cost. In addition, companies that fill their products into capsules must meet the needs of new and emerging consumer populations, contend with competitors, and stretch ever-tightening budgets.

Because of this new environment, "cost leadership" has become the mantra. And while companies have always scrutinized the costs of raw of materials, there are limits to how much savings this can provide over the long term. This is particularly true when lower-cost materials lead to compromises in manufacturing efficiency or product performance.

Consequently, evaluating total "cost-in-use" is the paradigm to follow when seeking to improve the productivity and performance of your capsule filling operation. Total cost-in-use will speed up filling, increase yields, and cut downtime. These improvements will reduce manufacturing costs and time, thereby increasing your company's profits. In fact, the combined savings generated by higher yields and faster machines often exceeds what you spend on empty capsules.

Implementing Quality by Design

Pioneered by Joseph M. Juran and based on the foundation of Six Sigma methodologies, Quality by Design asserts that quality can be planned and that any problems that arise during manufacture are related to how you made and followed the plan.

When applying this concept to encapsulation productivity, the first and perhaps most important consideration is matching the dosing method of the capsule filler to the characteristics of your product. The same can be said about formulating the product: Match it to the dosing style of the machine you intend to use in commercial production.

Consider, for example, the difficulty of achieving consistent weight control when you attempt to fill a difficult-to-compress powder into capsules using a tamping-style machine. Only by accounting for the bulk density, lubricity, and other product characteristics during formulation can you maximize your success across the range of dosing styles.

An early focus on manufacturing efficiency leads to better profitability, which reaches its maximum potential only when you recognize how the formulation, equipment, and capsule interact. By employing this kind of thinking during development, you're better positioned to avert pitfalls and cost inefficiencies.

Capsule filling efficiency: Speed, yield, downtime

Identifying the right combination of formulation, equipment, and capsule can cut costs by maximizing production speed and improving yield while minimizing downtime. These three cost drivers—speed, yield, and downtime—are often intertwined, and an improvement in one area usually leads to an improvement in the others.

Speed. Time is money, and all things being equal, the faster your machine operates, the less products cost to make. Manufacturing costs also decrease as the number of different products that you make using the same equipment and staff increases. These include the costs of amortization, utilities, rent, and insurance.

Yield. The fill material, not the empty capsule, accounts for most of a product's cost. Thus, you can generate big savings by improving yields, which means reducing the loss of starting materials. Better yields also reduce the time and energy your staff wastes filling capsules that cannot be sold. Even a small improvement in yield can have a significant financial impact, and that explains why boosting yields has been the most common target when companies seek to improve their capsule filling operation.

Downtime. The longer production is halted—be it due to mechanical issues, cleaning, or troubleshooting—the more it costs to produce. You can reduce downtime dramatically by adopting a "fit-for-formulation" approach in the early stages of the project. That means, again, matching the formulation to the capsule and the capsule filler. Also, preventive maintenance is a must. Don't wait for trouble.

All three areas of potential improvement can generate savings. In a recent review of more than 30 case studies, we quantified the efficiency improvements that my company's technical service engineers were able to perform by focusing on these three areas:

- Increased speed. The average increase was 14,000 capsules per hour, and changes in this area contributed 61 percent to overall savings.
- Higher yield. The average increase was 6.7 percent, and changes in this area accounted for 17 percent of overall savings.
- Less downtime. The average reduction was 58 minutes per 8-hour shift, and improvements in this area accounted for 22 percent of overall savings.

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The combined savings of the 30 case studies was about $2.747 million, which averages $91,560 per company. Figure 1 illustrates how speed, yield, and downtime contributed to these savings.

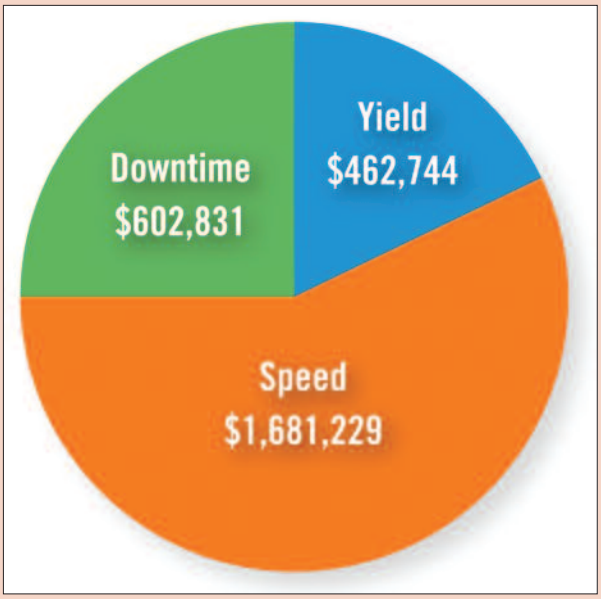
Snapshots of improvements and savings

Below are examples of how our technical service engineers identified and resolved customers' problems.

Increased speed for $365,000 in annual savings. An inspection determined that Company A was running its capsule filling machine below the rated speed. The limiting factor was the non-separation of capsules at higher speeds, a problem that stemmed from a vacuum pump that was not adequately sized. Once that was replaced,

FIGURE 1

Contributions of speed, yield, and downtime to savings of $2.7 million for 30 capsule filling operations



speed increased by 83 percent, a savings of $365,000 annually. In other words, the costs associated with producing the same number of capsules was greatly reduced because they were produced with less labor, machine time, and associated overhead costs.

Improved yield for $94,000 in annual savings. Company B discovered that an excessive number of capsules made using its intermittent-motion capsule filler were poorly joined. The company's inspections required to address the problem caused it to lose production time and lowered yield. During our assessment, we discovered that the setup of the closing station needed improvement: With adjustments to the height of the counter bearing and the timing of the movement, the capsules joined better, resolving the problem. As a result, the inspections became unnecessary, which reduced production downtime, and yields improved by more than 8 percent. In this case, the company saved $94,000 annually on the production of a single product.

The loss from defective products far exceeded the cost of replacing the worn segments.

Reduced downtime for $32,000 in annual savings. Company C was plagued with excessive downtime on one particular product, which had a sticky nature. Because of this product's characteristics, the machine's segments had to be cleaned frequently. Otherwise, the capsules fitting into those segments wouldn't separate. This frequent need to stop and clean resulted in significant delays. After an inspection, we designed and implemented an ejection-brush cleaning system that removed buildup while the machine was running. It greatly reduced the frequency of cleaning and thus downtime, which saved the company $32,000 annually.

Increased speed, improved yield, and reduced downtime for nearly $1 million in annual savings. Manufacturer D was receiving a growing number of consumer complaints about bitter-tasting capsules. We discovered that the capsules joined poorly during manufacturing, and the bitter powder was coating segments of the tamping machine, resulting in low yields. A root-cause analysis showed that the sticky and gritty powder used in this product was not being adequately compacted for dosing into the capsule. Thus, to achieve the desired fill weight, operators had set the machine to fill the capsules beyond their capacity. The poorly formed slugs and undersized capsules, however, simply led to greater powder loss, usually into the segment. This interfered with closing the capsules and left residual powder on their exterior, causing the bitter taste.

To address this problem, we improved compaction by modifying the equipment to form a better slug and thereby drastically reduced powder losses. As a result, the yield improved by 10 percent; downtime for cleaning decreased; and the speed of the equipment increased by 25 percent without sacrificing weight control. Over the course of a year, savings totaled nearly $1 million and patient complaints dropped drastically.

Tracking capsule filling efficiency

The goal of our technical service engineers is to unblock customers' paths toward greater efficiency by consulting with them on equipment purchases, product flow, operator training, and equipment adjustments. We're happy to work on whatever areas of capsule filling are holding back the customer from operating better.

Still, once improvements are made, it's important to accurately measure the financial gains that follow. Too often, the metrics of performance in the capsule filling room point only to the negative impacts that stem from not following established standards, such as poor yields and frequent downtime. But those metrics don't quantify the business impact, so it's important to calculate the value of improvements. The calculator we use accounts for the sum of all cost drivers, including labor and overhead, to more accurately calculate financial savings. Measuring these cost drivers is a powerful tool for maximizing profits. Table 1 lists the operational factors considered and the results of improvement for the case study that follows.

The reports generated by these calculations enable you to justify needed maintenance and to avoid unnecessary costs. They also bring into focus the steps to take to improve the productivity of a capsule filling operation, as the case study illustrates.

TABLE 1

Efficiency report: Operational data for analysis and results of improvements

a. Operational data

Unit volume	280,000,000
Target fill weight (mg)	315
Fill material cost (kg)	€75.00
Target/rated capsule filling speed	203,000
Hourly overhead	€150.00
Hourly labor cost	€15.00
Average selling price of finished capsule	0.00
Estimated markup of finished capsule	0.0%

b. Results of improvement

	Opening issue	Resolved issue	Difference
Actual capsule filling speed	158,981	171,355	12,374
Yield	96.1%	98.5%	2.4%
Downtime per 8-hour shift (min)	29	13	-16
Empty capsule cost (per thousand)	€2.60	€2.60	€0.00
Cost of yield losses	€301,527	€117,996	€183,531
Cost of slow capsule filling	€63,015	€42,030	€20,985
Cost of downtime	€17,557	€7,302	€10,255
Total	€382,099	€167,327	€214,772

Return on investment based on an efficiency report. Company E encountered various defects in its encapsulated product and asked for help. An inspection quickly revealed that the capsule-holding segments of the machine were excessively worn and needed replacement. A technical service engineer worked with the company's production team to create an efficiency report that showed that replacing the worn segments made financial sense. It was pretty straightforward: The financial impact of losses from defective products far exceeded the cost of replacing the segments. Once the team made the business case, managers could justify the cost and the parts were replaced.

Conclusion

No single piece of equipment suits every situation, and finding what will work best for your application requires you to consider the entire capsule filling undertaking, from formulation to production. It's the only way to ensure the efficient production of a high-quality product.

Understand the different types of capsule filling systems and what type of fill each handles best. This ties into the FDA's Quality by Design initiative and is the best way to optimize the capsule filler to handle your formulas. Next, determine the optimal setup. During early development, figure out how to combine the machine and each formula. That way you reduce future costs because your understanding of key operational factors will enable you to increase production, improve yields, and avoid downtime. As shown above, those improvements can give your company a significant financial boost. *T&C*

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