INVESTING IN POWDER TESTING EQUIPMENT

In this article, we consider how powder testing can deliver value focusing on the features of off-line and at-line testers. The goal is to support sound decision-making based on rigorous economic assessment.

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The concepts of return on investment (ROI) and payback time in relation to processing equipment are second nature to practicing engineers. That doesn't mean that the calculations associated with computing ROI are always straightforward. When assessing analytical equipment, the upfront costs can be relatively easy to determine, but the potential return is significantly more difficult. Powder testing equipment can provide a particularly interesting example for the consideration of this issue.

Weighing powder testing's benefits

Powder testers are used to assess powder flowability at each stage of the manufacturing process, from early research and development through quality control. Maximizing a powder tester's ROI first involves realistically establishing the benefits — and their value — that an appropriately specified tester might deliver. Some of those benefits include:

- ***Product development and formulation.*** In research and development, powder testing can accelerate a program to a more successful conclusion. The most substantial economic prize is a shorter time-to-market, which can dwarf other returns. There's also potential for savings on pilot-scale studies, which can be both time-consuming and expensive, along with increasing potential gains in experimental productivity.
- ***Equipment design and selection.*** Powder testing that identifies optimal processing equipment for a given powder can help maximize the likelihood of trouble-free operation over the long term, delivering economic returns by enhancing manufacturing efficiency, potentially resulting in fewer unplanned shutdowns — for example faster commissioning and less material re-work — or both. For companies that specialize in designing and providing powder processing solutions, the ability to efficiently specify an optimal solution directly boosts productivity.
- ***Process operation and troubleshooting.*** When powder processes fail to perform consistently, powder testing can elucidate the cause of the operational problem and provide a secure foundation on which to develop a solution. Solving these operational problems — particularly long-standing ones — can deliver significant economic dividends by reducing production costs or increasing throughput.
- ***Quality control.*** Using a powder tester for quality control can help detect substandard raw material before it enters the plant or a substandard final product before it's released. The reliable detection of poor-quality raw materials avoids operational issues ranging from out-of-specification production to an unplanned shutdown, while detecting a compromised-quality end product safeguards profit margins and company reputation.

Factors that matter

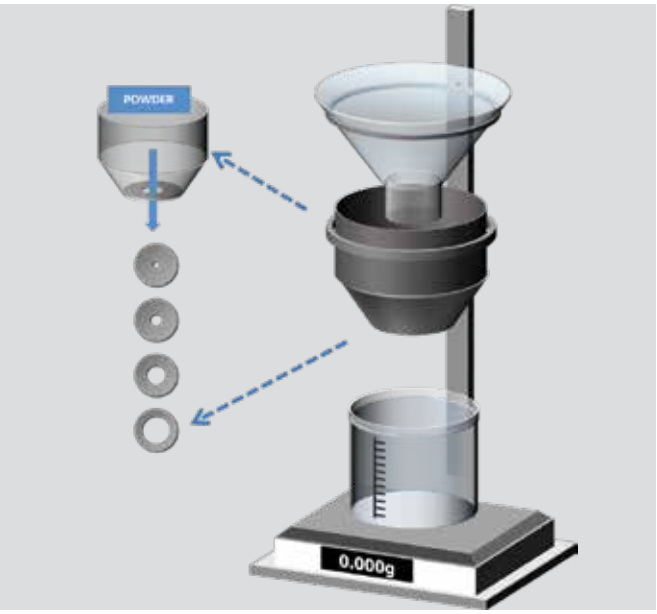
Commercially available powder testers that measure flowability vary considerably both in terms of price — from around $2,000 to more than $45,000 — but also in terms of ability to deliver economic benefits due to substantial differences in test result relevance; repeatability, reproducibility, and sensitivity; and instrument automation levels and data quality.

Relevance. Many testers measure just a single number, while some generate multiple parameters, providing comprehensive insight into powder behavior. Techniques and testers also differ with respect to the extent the conditions applied during testing can be varied. Some instruments allow control of the test environment to simulate process conditions to a greater extent than others. The net result of these differences is that the data generated by a tester may or may not be relevant to the process in question. The tester may detect sample differences that show no correlation with powder performance in the process or application. This issue, which is unique to powders, can significantly erode a tester's value — particularly for more demanding applications.

Repeatability, reproducibility, and sensitivity. These three parameters define a tester's ability to detect difference and differentiate one sample from another. A frequently encountered problem in powder processing is that materials classified as being the same end up performing differently because the tester is unable to measure and provide adequate differentiation.

FIGURE 1

Simple manual testers, such as those that measure flow through an orifice, are low-cost but often lack the ability to directly address some powder processing issues.



Repeatability is a measure of instrument precision — the variability associated with repeat measurements of the same sample by the same operator. *Reproducibility* additionally involves operator-to-operator variability and errors associated with sampling and sample preparation. *Sensitivity* is an inherent characteristic of a technique but can also be affected by both repeatability and reproducibility, so two instruments that use the same technique may differ in terms of sensitivity because of their design. A tester that uses an inherently sensitive technique and is engineered to deliver high repeatability and reproducibility will be the most discriminating tool for testing similar powders.

Automation. The simplest powder testers are manually operated with minimal automation, as seen in Figure 1. Upfront equipment costs are correspondingly low with the downside that each measurement's labor costs can be relatively high. An automated tester, as seen in Figure 2, tends to be associated with more sophisticated techniques, but it keeps cost-per-measurement to a minimum and productivity high. Initial equipment costs for an automated instrument will be higher, reflecting the equipment's complexity, but considering lifetime costs and factoring in labor based on typical usage may more fairly reflect the economic merits of choosing automation over the long term.

Automation also helps ensure that a rigorously specified method is consistently applied, boosting repeatability and reproducibility of a testing technique and providing the foundation for achieving the sensitivity required for more difficult powder testing challenges.

Examples of estimating ROI

The following examples help illustrate how the relative importance of these features vary from application to application and demonstrate, in principle, how to estimate an ROI to justify investing in a suitably specified tester.

***Example one*:** An equipment supplier specifies turnkey powder processing solutions based on customer powder sample analysis. The requirement is for a powder tester that supports the efficient identification of optimal processing equipment for a given powder and minimizes the need for pilot-scale trials.

This application calls for a tester with broad relevance, one that's suitable for powders across the cohesivity spectrum and that generates data that can be correlated with a range of different unit operations. A tester that measures multiple powder properties would enable the detailed characterization of each new material and the development of a robust specification for powders that perform well in individual pieces of processing equipment.

In terms of economic return, accurate and relevant powder testing has the potential to accelerate the company's workflow, boosting productivity at the specification stage, reducing the need for at-site modifications, and supporting trouble-free commissioning. If the average time taken to develop and deliver each solution is reduced, then serving an increased number of customers annually could deliver an associated annualized economic gain. which can be calculated from average profit per customer. For example, if the time taken to develop a solution is reduced by just under 7 percent from 150 hours, on average, to 140 hours, and the company currently delivers 45 solutions per year, each with an average profit of $20,000, then the annualized return on the powder tester is more than $60,000 assuming a market for increased sales.

***Example two*:** A powder supplier can potentially access a market that pays a premium price, higher than that obtained for the current product, but only if its quality is consistently high.

This application calls for a tester with high repeatability and reproducibility but may be met by a relatively simple technique depending on the end use of the powder. Testing will be routine and relatively frequent to safeguard product quality, so automation would likely provide an advantage.

Calculating the ROI in this example is straightforward since success will mean a premium price for every ton of material. For a plant with a throughput of 10,000 tons per annum, making an additional $60 per ton in profit equates to a gain of $600,000 per year, a significant gain that highlights the potential benefit of being able to access higher-value markets.

(**Editor's note**: Please contact the author for the equations or more information on these calculations.)

FIGURE 2

A powder tester that offers dynamic, shear, and bulk property measurement provides powder characterization for more complex processing.

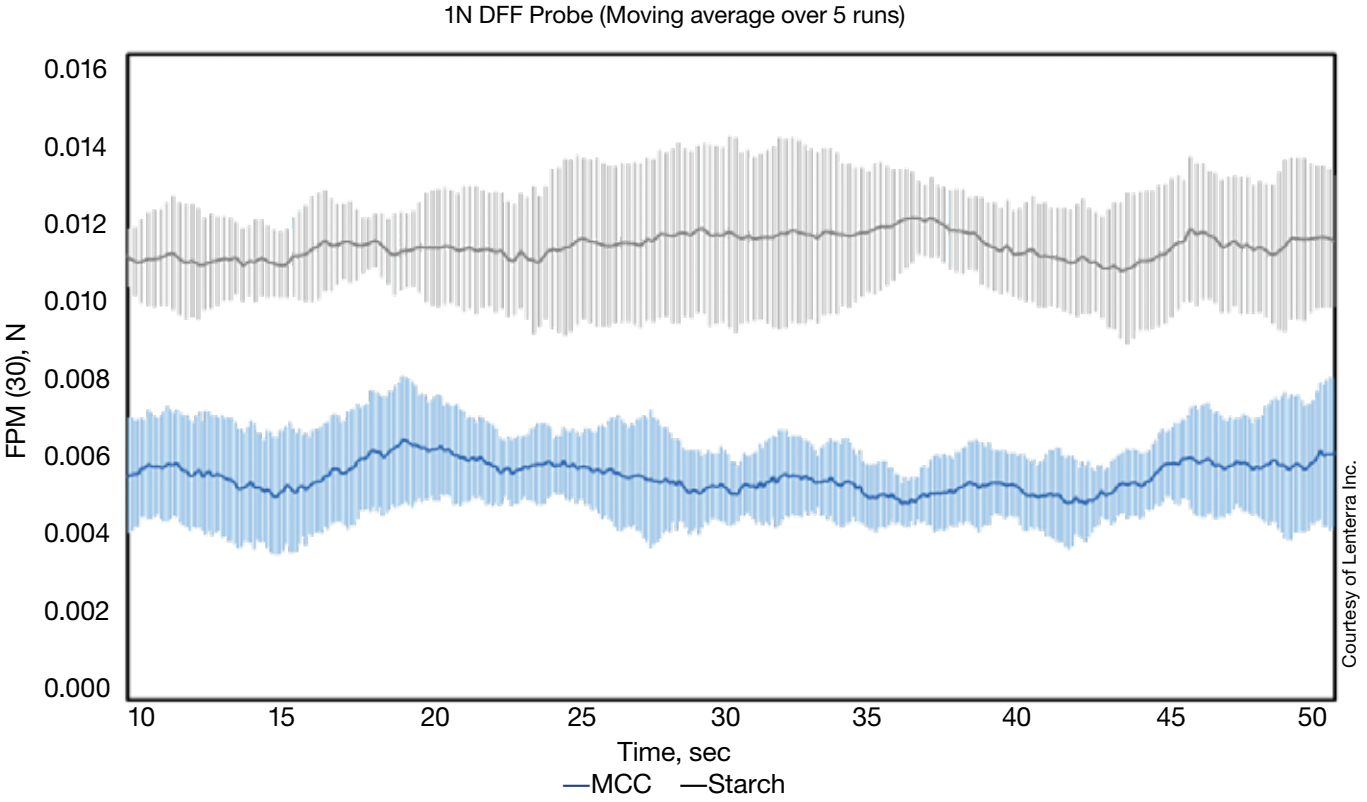
Looking ahead

The focus of this article is on off-line and at-line testers, but in-line powder flow measurement is becoming increasingly well-established as new commercial solutions are introduced to the market. By providing real-time process monitoring, as shown in Figure 3, these systems offer complementary opportunities to enhance manufacturing efficiency and the potential to further boost powder processing profitability.

A powder tester selected on the basis of realistically evaluating likely financial return and the performance required for success can offer an extremely attractive ROI. Generating such a return typically relies on choosing a tester that reliably measures powders that perform differently, provides data that are relevant to the process in question, and offers an appropriate level of automation. Opting for a powder tester that robustly fulfills, rather than unnecessarily exceeds, requirements is critical for an optimal return. **PBE**

FIGURE 3

In-line technology that characterizes powder flow in real time – here showing force pulse magnitude data tracking microcrystalline cellulose and starch through a chute – will open up new opportunities to enhance the profitability of powder processes.



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