# *On-line particle size analyzer automates milling at DSM*

***Real-time control increases productivity.***

DSM was founded as Dutch State Mines in 1902 when the Dutch government nationalized its coal company. Today, the company focuses on three broad businesses: life science products, performance materials, and polymers and industrial chemicals. It operates 200 production sites and offices in 40 countries.

At its plant in Filago, Italy, DSM makes composite resins for the marine and automotive industries, including 15 varieties of powder resins from four intermediate products.

### The importance of particle size

The Filago plant produces the intermediate resins in 20-ton batches using polyesterification. Afterward, the resin flows onto a steel cooling belt that solidifies it into chunks. These are broken into flakes, and the flakes pass through a pin mill and classifier. Next, additives are dosed into the powder, and the mixture flows to a blending silo and a drum-filling station.

During milling, it's important to create a powder with a specific particle size distribution (PSD) because the PSD determines how well the resins perform for the customer, said Giorgio Mapelli, industrial engineer at the Filago plant. "The optimal properties are achieved at a certain particle size diameter," he said. "You have to fit a curve, especially at both ends of the curve where it is finer or coarser." In most of Filago's seven PSD specifications, no more than 5 percent of particles can fall below 45 microns, and no more than 8 percent of particles can exceed 250 microns.

***DSM's plant in Filago, Italy, uses a horizontal pin mill to reduce the size of resins destined for the marine and automotive industries. Until June 2000, the company relied on manual sampling and sieve tests to monitor its performance.***

### Controlling the mill

The Filago plant operates round the clock, seven days a week. Milling takes place in 5-ton batches and must be monitored to ensure the mill is creating the correct PSD. For several years, the only way to monitor the PSD was to take manual samples and pass them through test sieves.

Using this manual method, workers sampled and tested after the production of 400 kilograms of powder resin. This established the PSD specification for that batch. Then, after every 1,000 kilograms, the procedure was repeated. For every 2,500 kilograms of resin milled, workers took a sample from the blending silo. If necessary, they adjusted the mill speed, the classifier speed, the resin feed-rate, the airflow, and other parameters to change the PSD to meet the specification.

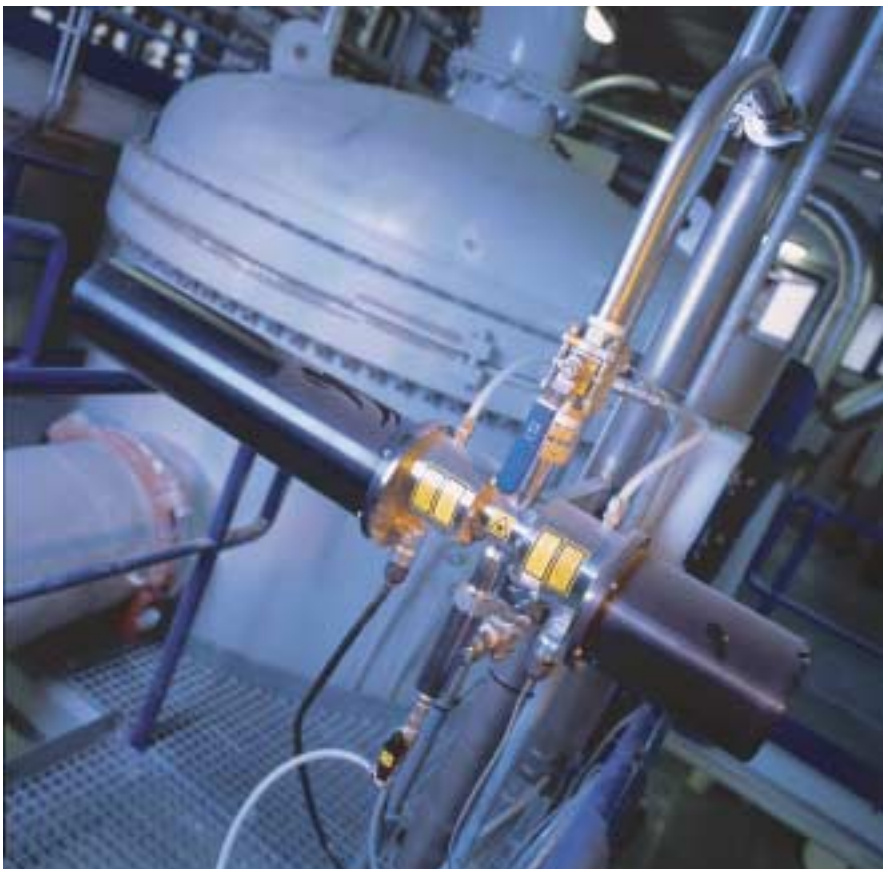
Manual testing and mill adjustment were usually effective in creating the correct PSD, Mapelli said, but not always. "We were never sure of taking a representative sample," he said. "It happened from time to time that the sample was not representative and the operator would make a wrong decision."

Workers also adjusted the milling parameters differently, sometimes in opposite directions. They would even stop the mill during a production run. "When they were not sure what they had milled, they really needed to stop, mix, and check the contents [of the blending silo]," Mapelli said. Furthermore, during shift changes, no one was available to monitor the milling system, so it sat idle several times a day. In short, the milling operation was not as simple, reliable, or productive as it could have been.

***The instrument pays for itself in six months thanks to labor savings.***

### On-line particle analysis

To reduce labor, make the process more reliable, and increase production capacity, Mapelli investigated on-line particle analysis. "I got in touch with some



***The on-line particle size analyzer, installed between the mill and a blending silo, constantly withdraws samples from the pneumatic conveying line for measurement. It then returns the sample to the flow of product.***

suppliers that I met at trade fairs or that I saw in technical magazines," he said. "Many suppliers had good machines to measure particle size, but their systems for taking and handling samples was not really handy or smooth."

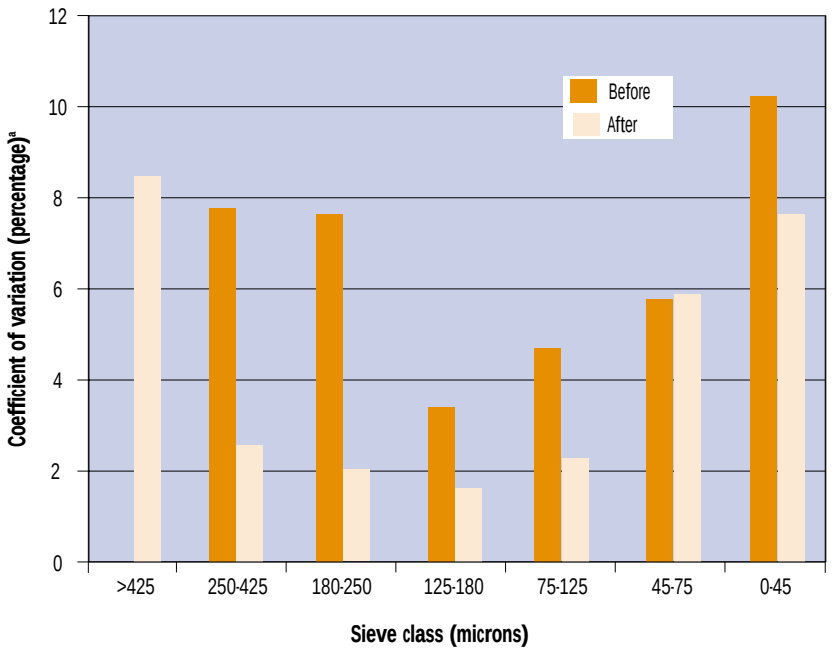
One exception was the Insitec on-line particle analyzer from Malvern Instruments of Malvern, UK. "We chose the Malvern device not on the basis of measurement accuracy or performance, but on the basis of the simplicity of installing it and managing it in a working plant," he said.

The sampling method was especially appealing. "We have just a venturi on the bypass of the main line that sucks out a portion of the flow," Mapelli said. "At the end, it replaces the sample flow into the line, so nothing is wasted. We don't need any robots to take a sample. It's very simple and robust. [Other suppliers] were suggesting automatic sampling or other stuff, which I didn't want to use."

The supplier's experience and its ready-to-use controls were also attractive, Mapelli said. "At the time, they could boast of many more industrial applications than the others," he said. "They had the software available for transferring data to our DCS (distributed control system)," he said. "Other suppliers were saying 'We can build the software,' but that was something I didn't like, because it is too risky."

**Figure 1**

**Coefficient of variation for DSM sieve classes before and after installation of the on-line particle size analyzer**




[a]*Note:* Coefficient of variation (CV) is the standard deviation (SD) expressed as a percentage of the mean: CV = SD ÷ the average SD × 100

## Operational basics

The on-line particle analyzer, installed in June 2000, determines particle size using laser diffraction and Mie light-scattering theory, the same basic technique that many laboratory analyzers use. But unlike bench-top analyzers, an on-line analyzer must take into account the high particle concentrations within the process line. To accommodate these high particle concentrations, the on-line analyzer at Filago uses multiple scattering algorithms.

Accurate results also depend on gathering representative samples that are properly conditioned. The sampling system at Filago achieves this by using a flute to collect the sample and a venturi to aspirate it at the same velocity as in the process line. Only then does the sample enter the measurement zone for analysis.

## Smoother operation

To ensure that the analyzer would work as expected, Mapelli first rented it for two months. During that time, he correlated the new data from the on-line analyzer with data from the sieves. "I realized that it was OK, working good," he said.

Then Mapelli studied the mill closely to learn how each operational variable changed milling performance. "I got to a certain point of optimization-the minimum and maximum of the [PSD] curve if you want. For some parameters, the feeding, flow-rate, classifier speed, I got to the optimum point. Then I could move the curve left or right just by using the mill speed, and I'm cutting the finer particles by using the secondary airflow at the bottom of the cyclone."

The next step was to install a computer card to track six analog values, each representing a sieve class, or cut size. Mapelli then wrote a computer program that linked the data signal from the analyzer to the plant's DCS.

Now, workers need only to choose the product to mill, the silo of origin, and the destination silo. "The system starts by itself," Mapelli said. "It uses the milling parameters saved from the previous batch of the same product. Then you have a start-up phase lasting 15 or 20 minutes while the milling system tries to enter a broad specification. Every 2 minutes, [the software] moves the mill rpm and airflow to enter this broad specification." Once the mill enters this specification, the analyzer continues to check the milled resin and adjusts the mill to make the specification as narrow as possible until reaching the end of the batch.

Now, no one needs to check the PSD during milling, and the plant halved the

***A close-up view of the particle size analyzer. A venturi, right, aspirates each sample before measurement to duplicate the velocity of particles in process flow.***

number of workers in the milling area to five. And those five have few duties related to the milling system. Mostly, they manage the drum-filling operation. In just six months, the reduction in labor alone justified the expense of the entire particle size analyzer installation, Mapelli said.

Furthermore, the analyzer and controls reduced the volume of fines by two-thirds and reduced the standard deviation between batches by 20 percent (See Figure 1). And the milling system no longer sits idle, so production capacity has increased 20 percent. The on-line analyzer also speeds detection of blockages, broken filters, or other process upsets.

"We installed the device in June 2000 and from November 2000, we are working automatically with no major problems," Mapelli said.

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