
Case history

Making a batch without breaking your back

An automated batching system eliminates dust, waste, and bag disposal costs while increasing a refractory plant's productivity.

Uni-Ref, the manufacturing division of United Refractories, produces high-temperature refractories, which are used in the steel, aluminum, iron, and chemical industries. The company began operating in Detroit in 1973. As refractory demand increased, the company moved in 1984 to a 110,000 square-foot facility in Sharonville, Ohio. The company's headquarters are in Pittsburgh.

The refractories Uni-Ref produces are used primarily as protective liners in vessels that transport molten or corrosive materials. Fred Daniels, plant manager, said each refractory is unique in its chemical and physical properties. To make refractories at the Ohio plant, Uni-Ref receives a large variety of dry granular and powder ingredients, mostly aluminas.

In the past, the plant received truckloads of 100-pound paper bags of raw ingredients that varied in particle size and bulk density. The bags were stored in a warehouse until needed.

"When we were ready to make a batch [formula], the pallets of bags would be moved into production and staged on any given production line," Daniels said. "Basically a guy would have a recipe and he would hand batch the ingredients into a stationary hopper. Production was continuous, all day long, and someone would stand and manually batch ingredients using the 100-pound bags."

The ingredient and amount batched in the hopper varied according to the refractory being made. "There may be different types of alumina ingredients [needed for a recipe]," Daniels said, "where we would add two bags of this, maybe four bags of this, and a bag of this until [the batch] was complete in the hopper."

Once the ingredients for a batch were emptied into the hopper, a belt conveyor transported the batch from the hopper to a mixer and the hand-batching process would start again. Each production line, four at the time, had a batching station with an operator emptying ingredients from 100-pound paper bags to the hopper.

After the various ingredients are mixed, the finished refractories are packaged in 50- to 100-pound bags. Water is added to some batched mixtures to produce wet refractories, which are extruded and then packaged in 50- to 100-pound bags, cartons or pails.

Hand batching is often messy, occasionally inaccurate, and always strenuous

Daniels said the entire batching operation relied on operators adding ingredients accurately and efficiently. Manual bag handling often created a dusty environment and caused some ingredient loss from spills near the hopper. Daniels said spilled ingredient as well as any residue left in emptied bags resulted in waste and, potentially, inaccurate batches. Operators had to manually lift, open, and unload the 100-pound bags of ingredients.

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The batching system allows the refractory producer to receive and handle many different ingredients and automate the batching process.



An operator discharges an ingredient from a bulk bag through an airtight flexible sleeve and slide-gate valve into the dispensing bin.

By manually producing batches, Uni-Ref found it difficult to ensure batch accuracy and consistency in making refractories. Batches that didn't contain the correct amounts of required ingredients had to be reworked. Product spills also occurred when the paper bags were torn open by forklifts that transported the bags throughout the plant. Spills required extra cleanup time and could slow production.

For the process to be successful, Daniels said operators were asked to maintain product accuracy and control workplace dust by engineering dust collecting equipment for each product line and cleaning the facility at the end of each day. In spite of these controls, operators created piles of empty bags near each manual batching station.

"We would accumulate the empty bags at each production line," Daniels said. "Then we had people assigned to compact the bags for disposal. We had to deal with all those empty bags throughout the day."

Refractory producer searches for batching system upgrade

To improve the plant's batching system, and as part of an effort toward ISO 9001 certification, the refractory producer began to search for batching alternatives. The company wanted a system that would conserve raw materials, reduce the waste from empty paper bags, and provide employees with a cleaner, safer environment.

Uni-Ref received a mailing from an equipment manufacturer that made a batching system including multiple bulk bag dispensing stations. The mailing prompted the plant to begin a search. Daniels said the company decided to try one of the equipment manufacturer's stations, and the manufacturer agreed to an in-house 6-month test.

"That also gave us time to look at other equipment and other types of systems," Daniels said. "We set up one station for handling raw materials and then we tested all of the various particle sizes and bulk densities of ingredients that we handled over a period of 6 months. We ran all of the different ingredients through the system."

The dispensing station's test results were very positive, Daniels said, while the alternative systems considered were not as promising. Other systems either were too large or too expensive, or required a complicated discharging operation.

"We looked at four other systems and considered two of them," Daniels said. "The others included machines that would require special parts when they wore. They would be very expensive to replace. These were things that we didn't see with the system we tried. This [system] was very user and maintenance friendly."

Once the material is in the dispensing bin, an operator uses the PC to control how much material is dispensed to a belt conveyor. Each dispensing bin contains a fully automated shut-off valve and a load cell that measures the weight of material to be discharged.

Besides the anticipated maintenance costs, the purchase cost of the various systems was a consideration. Daniels said Uni-Ref representatives visited plants and another equipment manufacturer's facility, but never performed additional tests. The company was pleased with the tested station's ability to be custom designed and expanded. Company officials were also pleased with the relationship they developed with the manufacturer.

"I think we looked at initial cost and the ability to work with the manufacturer," Daniels said. "This system is pretty simple, easy to understand, and easy to maintain. The manufacturer knew our business. They definitely have a good knowledge of the refractory industry."

Bulk bag batching

In early 1998, Uni-Ref replaced the stationary batching hoppers with a Mini-Bulk System made by Ingredient Masters. The system's components include 12 bulk bag dispensing stations that each support a frame for a bulk bag. Each bulk bag frame is independent of the station, is transportable by forklift, and has an airtight flexible sleeve and slide-gate valve for unloading material to the station.

Each station's components include a 42-cubic-foot polyethylene dispensing bin with a PC-controlled, positive shut-off dispensing mechanism and a load cell. Product flow is controlled by a PC and a PLC at each station to discharge ingredients to the belt conveyor.



Prior to installing the batching system, paper bags were manually lifted, opened, and unloaded into a hopper, creating dust, bag clutter, and muscle strain.



Using a PC and PLC, a Uni-Ref operator can automatically discharge materials at each batching station along the belt conveyor

Rather than receive the refractory ingredients in 100-pound paper bags, the plant now receives them in bulk bags between 3,000 and 4,000 pounds. Some minor ingredients are still received in paper bags. When needed for a particular batch, a bulk bag is brought from the warehouse by forklift and placed in the support frame above a dispensing station. An operator opens the bulk bag to unload material to the dispensing bin, which is connected to the control valve with a dust-tight sleeve.

Once the material is in the bin, an operator uses the PC to control how much material is dispensed to the conveyor. The load cell measures the weight of material to be discharged. Ingredients from other dispensing stations sequentially discharge material onto the conveyor, so as not to overload the transfer rate.

"So if you called for 200 pounds of an ingredient," Daniels said, "[the valve] would open up and discharge its ingredients as stations two, three, and four also discharge their ingredients for the batch [onto the conveyor]. Each station is working independently, and they will all run until they have discharged the material and the amount that you've asked for onto the belt."

The belt conveyor transports the different ingredients for each batch to a large bulk bag that's taken to a production line for mixing.

"If one mixer needs 20 batches of a product, this system will [discharge the ingredients needed] for 20 batches and put them into 20 individual large bulk bags," he said. "So we are actually combining the ingredients before they are put into the mixer."

Daniels said the installation process and transition to the new batching and dispensing system went well, with only a few minor "bugs" to work out.

"When we had any problems, we knew [the manufacturer] would be there to help us through them," he said. "We felt very confident. You can have a supplier come in and sell you something and then you never hear from them again. And you have all these problems and you try to work through them and you can't. [This supplier] does a very good job on the service end."

Automated batching system saves money, improves plant efficiency

Since the batching system has been installed, plant production is more efficient. Product spills have been almost completely eliminated. And operators no longer need to expend the time and effort to remove empty bags from the work area. "That was a big problem and a headache," Daniels said.

Daniels estimated labor costs have been reduced by 30 percent and bag disposal costs by more than 55 percent. He also estimated that product loss due to spillage and residue left in empty bags has been reduced by nearly 80 percent after switching to the batching system.

"We haven't really put a dollar figure on the savings," Daniels said. "We know that the number of mistakes or human error that we had in the past greatly outweighs the minor mistakes we have made learning this system. So that's a big plus."

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Production throughput has increased 15 percent, and the plant now operates at near 90 percent capacity. Aside from the cost savings and production gains, Daniels said the greatest benefit has been achieved in quality control.

"The biggest advantage [the automated batching system] gives us over manual batching is we have a chance to review the batch prior to it being discharged to a mixer," Daniels said. "Before, a guy would just prepare the batch. If an ingredient amount was off, you couldn't tell until the batch was discharged into the mixer. Your quality control was done at the time the refractory was made. Now, we have a chance to inspect a batch prior to it going to production. That's a big advantage. I'd say [the system] has lived up to what we expected." PBE

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