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Case history

Rubber cable producer finds the cure for batching ills

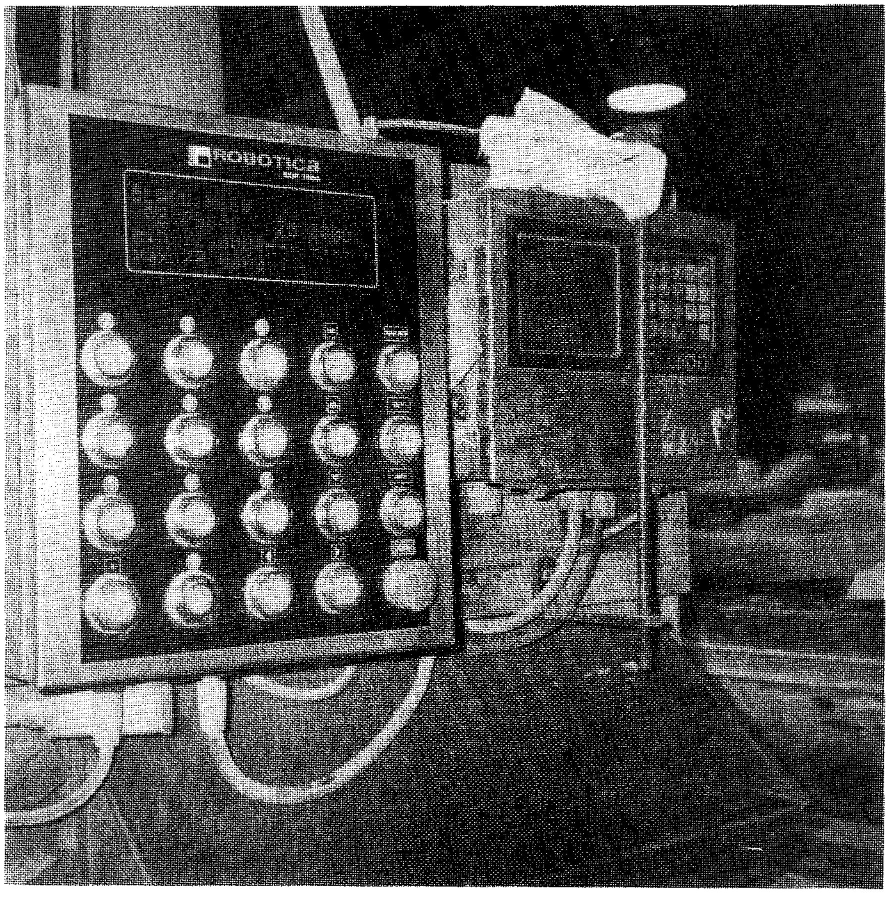
A producer installs a system to semiautomate batching, improving accuracy.

While manually adding multiple ingredients for batching, even a well-seasoned worker can lose track of the steps and inadvertently omit or duplicate an ingredient. This can result in a scrapped product batch. The larger the batch, the more a producer wants to reduce this possibility and the greater the reward.

For multi-ingredient batching, fully automating the process can often be cost-prohibitive. But there is an alternative: semiautomated batching.

General Cable, Highland Heights, Ky., operates manufacturing plants in various states to produce electrical cable. The products range from fiber optic cable to industrial power cord to automobile ignition wire. General Cable's Lincoln, R.I., plant produces rubber for cable insulation and coats copper wire.

The producer makes the rubber from several dry ingredients and a few oils. Dry ingredients include chlorinated polyethylenes (CPEs), ethylene propylene copolymer rubbers (EPDMs or EPRs), neoprenes, and clays. "We make nearly any kind of rubber there is," says Banbury mixer foreman Bob Robert. "It's batched in Banbury mixers and cured in continuous vulcanizers."



At each batchman station, a PLC prompts an operator to add major ingredients to a holding bin on a scale before the bin moves to a leadman station.

The rubber producer uses powders with particle diameters as small as 0.2 microns and as large as 20 microns, but most of the powders are in the 1- to 10-micron range. Bulk density ranges from 15 to 20 lb/ft³, and moisture content is typically below 0.5 percent.

For rubber batching, a worker assembles a pallet load of the 50-pound ingredient bags necessary for each batch. A typical formula includes 8 to 15 dry ingredients and a few oils. Some formulas include large blocks of soft EPDM rubber.

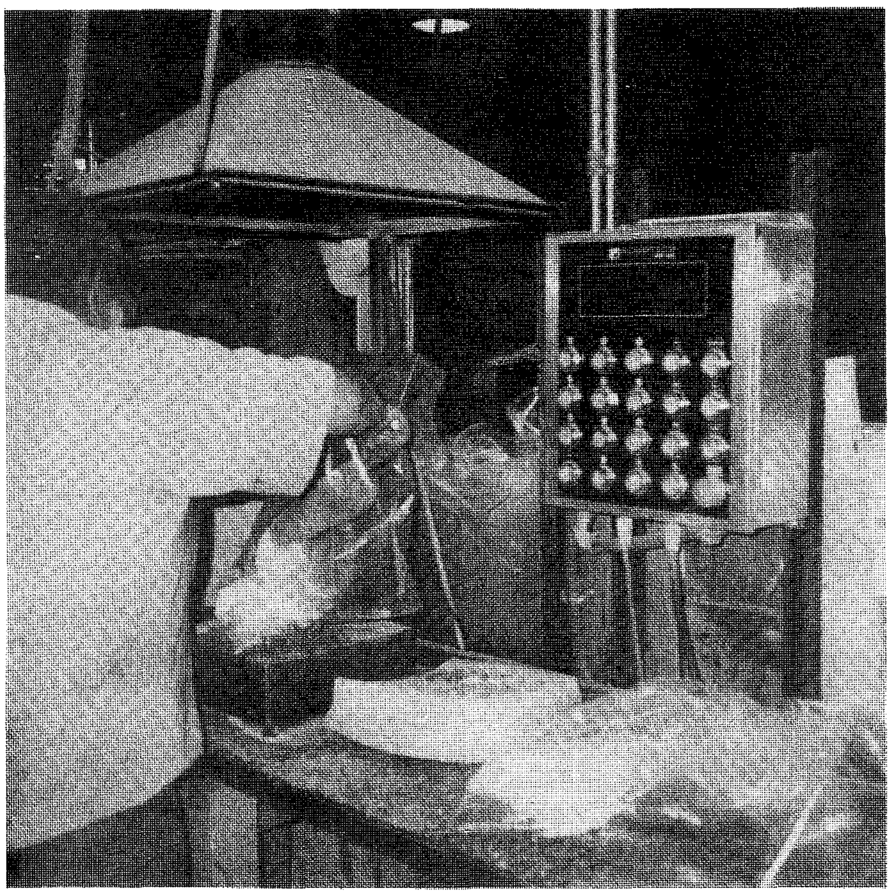
The major dry ingredients are delivered to a "batchman" station and the minor dry ones (such as pigments and accelerators) to a "leadman" station where they're premixed in small plastic bags.

The batchman manually dispenses ingredients to a floor scale by the bag or scoop and loads them into a steel holding bin. The bins are moved by a roller conveyor to the leadman station. The leadman adds the premixed minor ingredients into the bin and empties it into the Banbury mixer. In the past, the oils were also manually added at the leadman station. General Cable operates three such production lines.

Ingredients could be omitted or added twice

Until last year, the batching workers used specification sheets to guide them in adding each ingredient. Workers had to stay focused to ensure they added every ingredient — and in the right quantity. Although that sounds easy enough, it was possible to lose track of ingredient additions,

While adding ingredients, a batching worker could forget where he left off. "If you don't add all the curing agents, the rubber can soft cure."



At the leadman station, minor ingredients such as pigments and accelerators are weighed, premixed, and added to the major ingredients.

especially when repeating the same steps for each new batch.

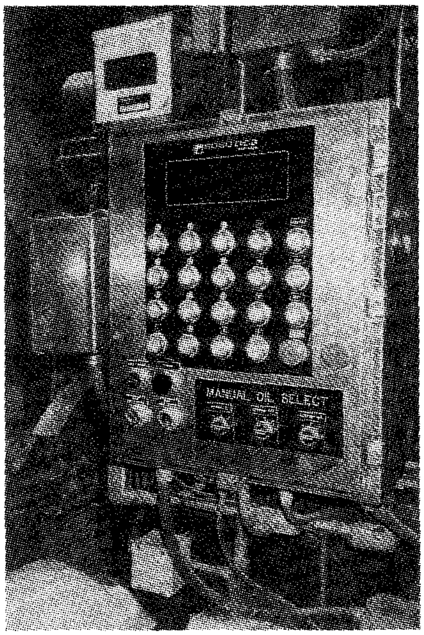
"If I talked to a batching worker while he was adding ingredients, or if he was interrupted for some other reason, he could forget where he left off," Robert says. Another problem was that the worker could over- or undershoot the ingredient amount during weighing. "They did a good job in general, but there was potential for error. Our Banbury batch workers have a lot of time in the business — probably 20 years on average. They're good employees and want to make good product." But inevitably, with this method, a batch occasionally had to be scrapped.

A bad batch usually meant the rubber cured to a soft or gummy texture rather than the specified firmness. "If you don't have all the curing agents in there, the rubber can soft cure — it stays very soft," Robert says. Another problem stemming from improper ingredient addition was that "the batch could have lumps; it wasn't as homogeneous as it should have been."

Sometimes a bad batch was evident merely by looking at it, but sometimes it was revealed only through lab testing. In either case, the batch had to be scrapped. "With 600-pound batches, there were always costs involved because you're mixing the same thing over again," Robert says. "There's material cost, there's time — the whole nine yards. Depending on the type of rubber we were making, it could get into quite an expense." Some scrapped batches could be reprocessed, but it depended on which ingredient was improperly omitted or added.

Producer seeks batching control

General Cable wanted to find a way to control batching to ensure ingredients were added to specification. In addition, they wanted a way to store batch data so they could generate reports and audit operations. This would allow them to trace a problem to its



This controller fully automates oil addition.

source and stop mistakes from being repeated.

A local equipment distributor, Central Scale in Warwick, R.I., had done various scale updates and service work for General Cable over the years and was very familiar with their operations. The two parties had discussed automated batching for some time. When General Cable finally decided to go forward with semiautomation, they approached the equipment distributor for a proposal. The producer also approached another party for a competitive quote.

The initial quotes were cost-prohibitive, so Central Scale went back to the drawing board to come up with another proposal. The distributor then proposed a semiautomated batching system by a manufacturer that was new to them. The system would electronically guide the batching worker through ingredient additions and require confirmations at each step. General Cable was interested, so the distributor set up part of the system in their shop for demonstration. This way the cable producer could observe the system and request modifications before ordering it.

General Cable sent a team of batching workers and engineers to the demonstration to offer input on the system's configuration. The team asked for a number of minor changes and some major ones, so the distributor and the equipment manufacturer customized the system accordingly.

"With scrapped 600-pound batches, there was always expense involved," says Robert, "because you're mixing the same thing over again — the whole nine yards."

During the demonstration, the team realized it would be difficult to add the oils with the new system, so they decided to fully automate oil addition.

Batching systems are semiautomated

After the system was customized, it was shipped to General Cable in summer 1996. The automation equipment manufacturer and the distributor sent technicians to the plant to install the semiautomated batching system.

The model KDP-FM batch control system was designed to govern manual dry ingredient addition and control automatic oil addition. The system includes 2 PCs and 17 PLCs with digital displays. One PC was installed in the Banbury mixer foreman's office, where the formulas are entered, and the second sits in the quality control lab, where chemists use the PC to generate and modify batch formulas. A PLC was wired to each scale at the operator stations.

Some system customization done at General Cable's request included replacing small switches with larger ones for easier triggering, reconfiguring PLC consoles to meet ergonomic needs, adding voltage-draw and batch-temperature level sensors to the mixer, and programming each leadman station PLC to use these levels to dictate when various ingredients should be added.

The system was also configured to receive batch formulas from, and send material-use levels (for inventory) to, General Cable's mainframe computer in another city.

For batching, each operator station receives the ingredients for a batch formula. The operator keys a password into the PLC to see the formula and number of batches needed for a given rubber. The PLC prompts the operator by displaying the first ingredient name, target weight, and tolerance.

"If we went back to the old way, it would be like going back to the Dark Ages."

As the operator pours the ingredient onto the scale pan, the PLC displays a bar graph with a rising bar that indicates the climbing weight. In addition to the bar display, the actual weight and the target weight are numerically displayed. When the weight is within tolerance, the bar's light intensity changes, prompting the operator to stop. If the weight exceeds the tolerance level, the PLC won't prompt the operator to add the next ingredient until the weight has been reduced to within tolerance or a supervisor keys in a password to authorize the weight value. After acceptance, the PLC prompts the operator for the next ingredient until the batch is complete.

Each time an ingredient weight is accepted, a data record — including the date, time, formula code, ingredient code, target weight, and actual weight — is saved in nonvolatile memory. This information is later retrieved for process auditing.

Besides semiautomating the dry material batching process, the system fully automates oil addition by controlling its injection from tanks to the mixer.

"After installing the system on one production line, we ran it for a few months," says Robert. "We liked what we saw so we installed similar systems on the other two lines." The later installations went smoother than the first, he says. "With the first system, like any startup operation, we had our bugs here and there to work out. But I wouldn't say they were unusual. The distributor and equipment manufacturer helped us get through them. We learned a lot during the first installation, so the next two went much smoother."

The automation equipment manufacturer has installed similar automation and semiautomation systems at plastic, pigment, chemical, food, pharmaceutical, and other plants.

Batching problems are cured

Robert says the batching system "has virtually eliminated soft-cure rubber" — a problem he cited as the number one concern in the past. And with 600-pound batches, it didn't take long for the system to pay dividends. "When we eliminated soft-cure batch costs, we eliminated a big number," he says.

Now if a soft-cure batch occurs, it can be traced back to bad materials or a cause other than operator error. "The system tracks the material used, how it's mixed, and mixture temperature as the ingredients are loaded into the mixer," says Robert. "If we run into a bad batch, we can look back and see whether all the ingredients went in, whether proper temperatures were reached, and whether cycle times were met. We can check the whole process with this system. It's a tool."

The operators have adapted to the new system quite easily, according to Robert. "They really like it now," he says. "Like anything new, when the system was first installed, the workers were a little apprehensive. But now if we went back to the old way, it would be like going back to the Dark Ages. Believe me, nobody wants to do that. It's one of the best tools I've been given to do my job. It's also a good training tool for new employees, because the PLC prompts them for everything. It saves training time."

"When we eliminated soft-cure batch costs, we eliminated a big number."

Robert says the system even helps plant morale. "Workers don't have to guess at anything anymore. It takes the worry out of the job for them," he says. "And if there is a problem, the auditing capability means we're no longer chasing ghosts. We're below our scrap goal, so we're doing quite well.

"And overall output has gone up because scrap has gone down. I'd estimate that we've seen roughly a 15 percent rise in output."

Since the installation, according to General Cable chemist Howard Barton, the lab has tracked a 20 percent productivity increase, a 70 percent scrap reduction, and virtually 100 percent consistency from batch to batch. **PBE**