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Poor man's NASCAR?

RACING TECHNOLOGY COMES to the BACKYARD,
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Low-shear mixing for high-performance cable

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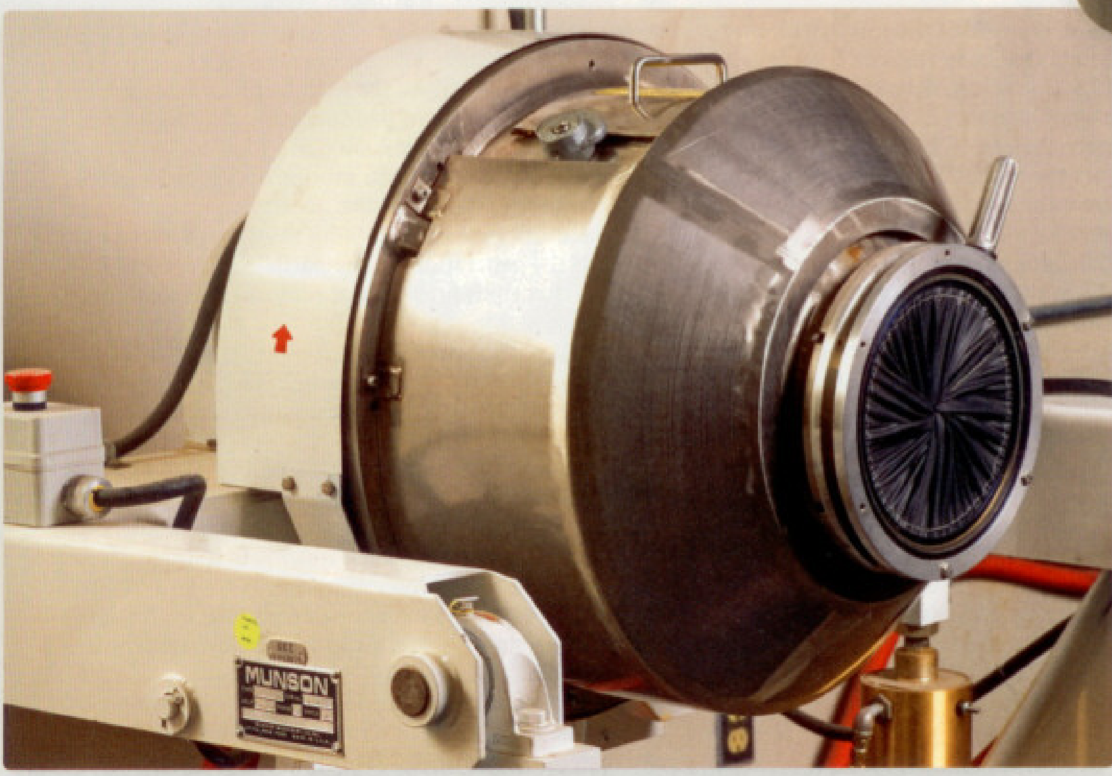
A wire company's R&D group switched to a low-shear mixer for cross-linking wire insulation.

Physicists, chemists, polymer scientists, and mechanical engineers in the research and development department at **General Cable**'s Indianapolis Technology Center develop wire insulation and jacketing materials for the company's power cables used in utility, petrochemical, mining, nuclear, and military applications. By adding peroxides to thermoplastics, they create thermosetting, or cross-linkable, polymers that withstand higher temperatures than unaltered thermoplastic insulations can.

According to Technical Services Manager Bruce Johnston, "the resin, in 0.125-in.-long pellets, must absorb about 1 to 3% of its weight in peroxide." The team

General Cable's thermosetting plastics form jackets and insulators like the one on this EPDM-insulated 25-kV power cable.



General Cable switched to a Munson MX-1-SSJ miniature rotary batch mixer with a water jacket to create thermosets out of thermoplastic pellets and peroxides.

A funnel fits to the mixer's loading port to accept thermoplastic pellets and additives. An iris valve lets operators control the discharge of blended pellets.

may also add antioxidants to extend material lifetime and improve electrical properties.

For each procedure, crews load the mixer with thermoplastic resin pellets that may include low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), ethylene-vinyl acetate (EVA), polypropylene (PP), chlorinated polyethylene (CPE), or silicone, pour in peroxide, and start the mixer. Team members might also add extra curatives in a second step to stabilize the polymer-peroxide mix.

"For new materials," Johnston points out, "we check the mixture every 15 minutes because getting the temperature wrong means a lot of cleanup."

The typical mixing time is 2 hr, but Johnston says some materials absorb peroxide in 20 min. Copolymers such as EVA and ethylene acrylate (EEA) are relatively soft and absorb peroxide at room temperature. Other materials will absorb only when they are heated.

If the mixer has to be heated to promote peroxide absorption, pellets can get tacky and stick to the drum. Then workers have to lower the drum temperature and keep mixing to cool the pellets. Thermoplastics can also degrade or melt completely if mixing temperatures get too high.

High shear forces and poor temperature control in their original equipment meant the team repeatedly needed to start and stop its high-speed mixer to keep temperatures low.

General Cable's Indianapolis Compounds plant already had a mixer from **Munson Machinery**, Utica, N.Y., so Johnston's group worked with Munson in selecting the best machine for their application.

The companies chose the MX-1-SSJ, a rotary-batch mixer downsized from production-scale units. The 1-cu-ft mixer gently turns, cuts, and folds material in a rotating drum. The motion minimizes degradation of friable or temperature-sensitive materials.

"The unit's low-shear mixing minimizes frictional heat and the generation of fine particles. It also has hydraulics that tip it for material removal and cleaning," Johnston says.

The team also specified a water jacket which let the mixer operate at temperatures up to 200°F. The jacket and mixing motion combine for uniform heat and eliminate remixing steps.

To determine optimum batch size, the team experimented with 50-lb batches, close to the mixer's maximum capacity. However, with materials whose specific gravity exceeded 1.0, the team quickly found that 25-lb batches provided enough material to cover 3,000 to 4,000 ft of 14-gauge wire, enough for initial evaluation. Some materials with specific gravity below 1.0 require 50-lb batches.

"The mixer adapts to various batch sizes and temperatures while minimizing unwanted shear, heat generation, and material degradation," Johnston says. **MD**