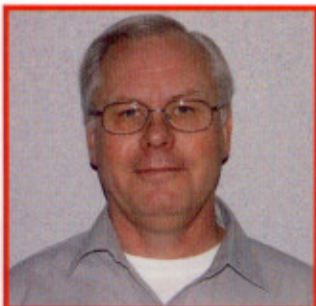


Wire & Cable Technology

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Compounding Cable Insulation in a Miniature Rotary Batch Mixer

by:

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Gentle blending, heating and cooling in a rotary mixer promote the efficient absorption of additives.

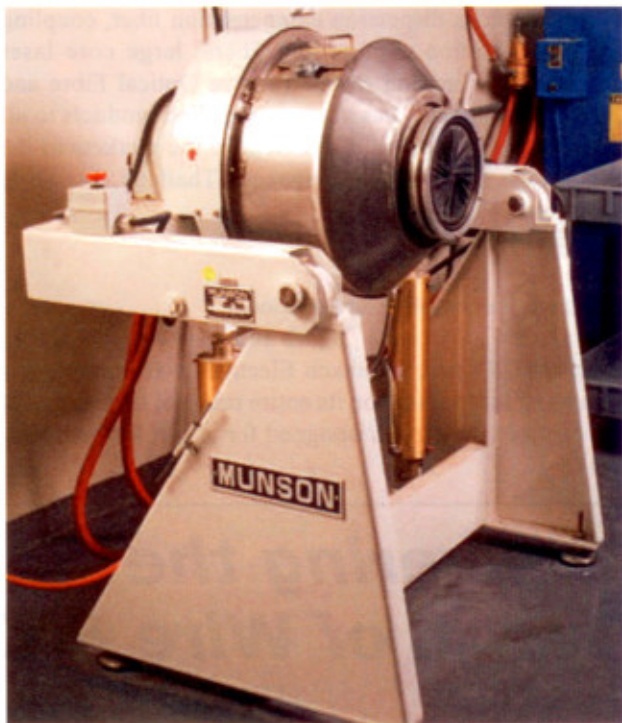
In the R&D department at **General Cable**, Indianapolis, IN, USA, a team of physicists, chemists, polymer scientists and mechanical engineers develop insulation and jacket materials for the company's wiring products to satisfy tightening regulations and customer demands.

The group relies on its **Indianapolis Technology Center** to develop materials used for wire insulation and jacketing of power cables used in utility, petrochemical, gas, mining, nuclear and military applications.

According to Technical Services Manager **Bruce Johnston**, the blending of thermoplastic resin pellets with solid and liquid additives for wire insulation compounds is a critical part of the development process, and one which presented the technical services department with several challenges.

"We use a variety of thermoplastic resins including LDPE, LLDPE, EVA, PP, CPE and Silicone, which we mix with peroxides to produce thermosetting (or crosslinkable) compounds," Johnston explained. "The insulating compounds are crosslinked to allow the cables produced with them to operate at higher temperatures than thermoplastic insulations."

To prevent high shear forces from degrading temperature-sensitive thermoplastics and/or melting the resin pellets, the team previously needed to start and stop its existing high-speed mixer repeatedly. The team now utilizes an MX-1-SSJ rotary batch mixer from **Munson Machinery** that gently tumbles the material in a rotating drum. The unit has a volume capacity of 1 ft³ (0.03 m³) and weight capacity of 50 lb (22.7 kg), and can blend at anywhere from 100% to 10% of capacity with equal effectiveness, enabling the team to vary its testing protocols. The mixer is also jacketed, allowing operation at various temperatures as required by different materials.



Compounding Tailors Properties of Thermoset Wire Covering

The basic mixing process stimulates the absorption of peroxides by pelletized, thermoplastic polymers 1/8" (3.175 mm) in size. The peroxides act as curatives that give the polymers the ability to crosslink and become thermosetting.

"As the polymers, we use elastomers, polyolefins and silicones, but mainly polyolefin-based materials," explained Johnston. "Generally, the resin must absorb from 1% to about 3% of its weight in peroxide, which sometimes requires pre-heating of the pellets. In addition, the R&D department is looking at antioxidants that are liquid at room temperature."

Antioxidants can extend the lifetimes of the final materials and improve their electrical properties.

Johnston's group had no first-hand experience with a rotary batch-type of mixer, but the staff of General Cable's Indianapolis compounds plant uses a 300 lb (136 kg) capacity model 700-TS-17.

"Much of the decision came from the compounding plant's familiarity with the mixer," recalled Johnston. "And Munson



Munson MX-1-SSJ miniature rotary batch mixer with mixing vessel jacket plumbed to a water-heating unit (above); Loading port of the miniature rotary batch mixer (right).

helped us determine the size we needed."

At 1 ft³ (0.03m³) batch capacity, the MX-1-SSJ is among the smallest in a line of miniature rotary batch mixers ranging in capacity from 0.25 to 15 ft³ (0.01 to 0.42 m³), all being scaled-down versions of production-scale units ranging from 10 to 600 ft³ (0.28 to 17 m³) in capacity.

Designed for applications in laboratories, pilot plants and small production operations, it tumbles, turns, cuts and folds its contents, minimizing degradation of materials that are friable or sensitive to pressure and/or temperature.

"Sometimes we're looking at adding new curatives," Johnston said. "We want as much flexibility as possible to add different compounds that require different temperatures."

The team specified the mixer with a water jacket allowing operation at temperatures to 200°F (93°C).

"The constant exchange of material against the heated drum wall with no dead spots provides uniform heat distribution and eliminates the need for remixing," Johnston explained. "We benefited from the unit's low shear mixing, which minimizes frictional heat and the generation of fines, and from hydraulic tipping and an easy-to-clean interior."

Establishing Mixing Protocols

The mixing process begins with pellets received from suppliers or formulated by the researchers.

"Then the choice of procedure depends on which peroxide is being added to which polymer," Johnston explained. "Some peroxides are liquid at room temperature and others are solid and must be melted. Going into the mixer though, they're always in liquid form."

Each mixing protocol depends on the properties of the batch ingredients. The typical dwell time is two hours, but General Cable has some materials that will absorb the peroxide in just 20 minutes.

The mixer is actually capable of blending all components uniformly in less than three minutes. Mixing temperature is also a factor. Copolymers such as EVA and EEA are relatively soft, enabling pellets to absorb the peroxide at room temperature. Other materials will absorb only when they are heated, which can cause its own problems.

"If the temperature of the mixer must be increased to promote absorption of the peroxide, the pellets can become tacky and adhere to the drum," Johnston continued. "In this case, it is necessary to reduce the temperature of the drum and continue mixing to cool the pellets."

For each procedure, technical service personnel load the mixer with the required weight of the material, pour in the peroxide and start the mixer. Johnston pointed out that for a new material, the team checks it every 15 minutes, and that it can take a lot of cleaning if you get the temperature wrong. To complete the process, the team might add extra curatives, which stabilize the polymer-peroxide mix. This process often takes place in a second mixing step.

To determine the optimum batch sizes, the team experimented with 50 lb (22.6 kg) batches, close to the mixer's maximum capacity. But with materials whose specific gravity exceeded 1.0, the team quickly found that 25 lb (11.3 kg) batches provided the amount of material that the R&D department needed.

"Twenty-five pounds (11.3 kg) of compound can make 3000' to 4000' (915 to 1220 m) of 14 gauge wire," Johnston said. "That's enough for initial evaluation."

The 25 lb (11.3 kg) batch size also works most of the time for materials with specific gravity below 1.0, although those sometimes require 50 lb (22.6 kg) batches.

Johnston concluded by saying, "The particular value of the device stems from its ability to adapt to various batch sizes and temperatures, while minimizing unwanted shear, heat generation or material degradation."

To learn more about this technology, visit the Munson Machinery and General Cable websites listed below.

www.munsonmachinery.com

www.generalcable.com



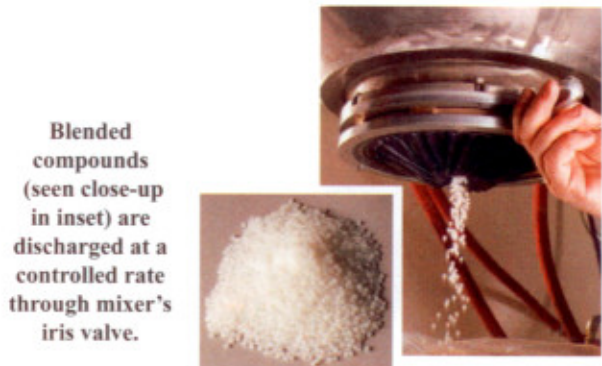
General Cable technician loads pelletized resin into miniature rotary batch mixer.



Miniature rotary batch mixer with loading port and iris valve closed, ready for a mixing cycle.



Technician tilts the mixer to vertical for discharging.



Blended compounds (seen close-up in inset) are discharged at a controlled rate through mixer's iris valve.



EPDM-insulated 25 kV power cable.

Company Profile: Munson Machinery is a world leader in mixers, blenders and size reduction equipment for bulk solid materials. Since 1823, Munson has set the industry standard for durability, evidenced by numerous machines from the early 1900s operating at customer locations to this day. As important as reliability is Munson's pace-setting technology that enables you to cut energy costs, increase capacity, minimize maintenance and boost efficiency while producing higher quality products. Whether your application is small, large, straightforward or problematic, Munson can satisfy it with unequalled cost effectiveness. www.munsonmachinery.com

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