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MARCH 2026

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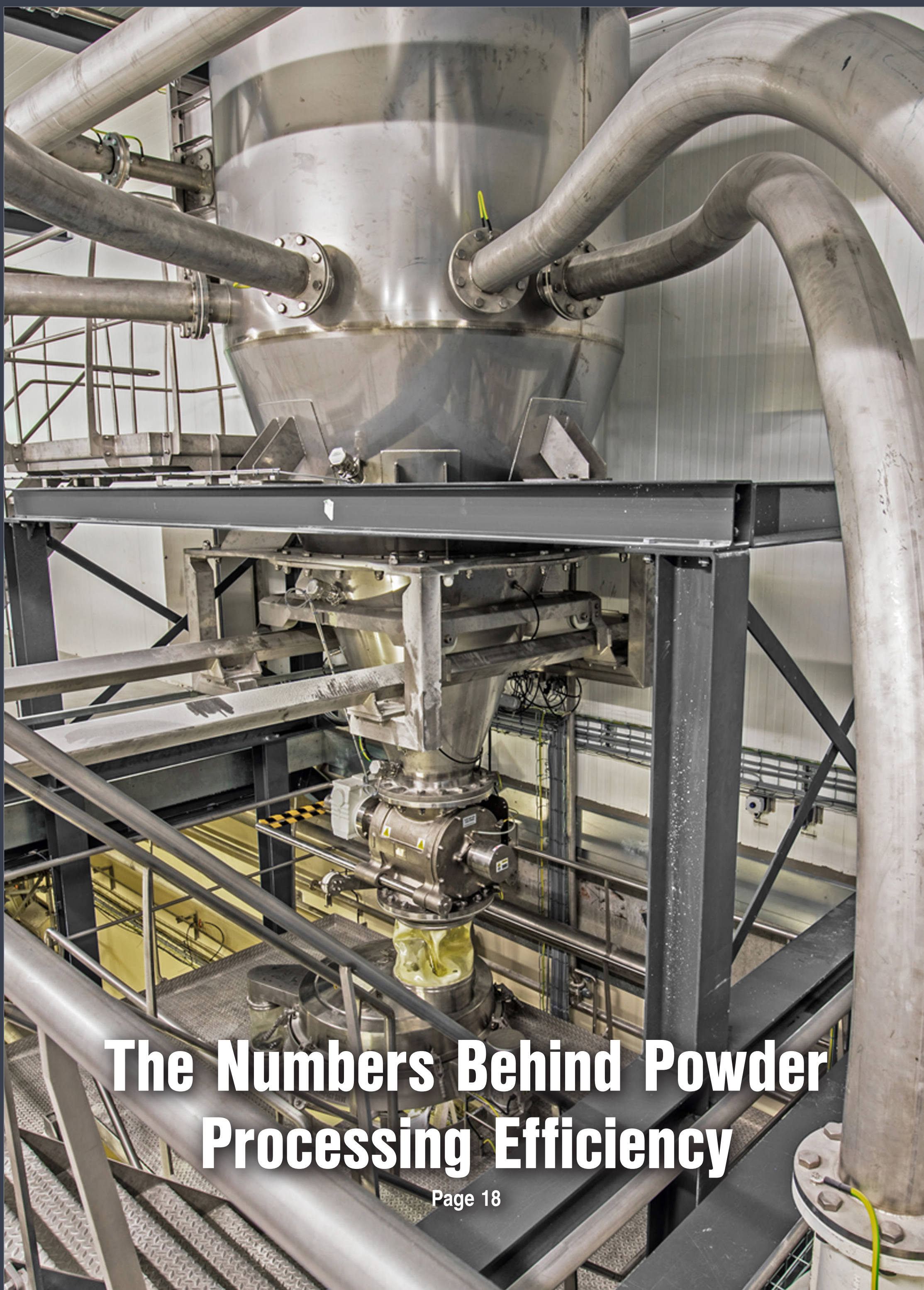

The Numbers Behind Powder Processing Efficiency

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Metering & Emptying Station

The new DULCODOS SAFE-IBC F&B by ProMinent is a metering and emptying station for intermediate bulk containers (IBCs) developed for the food and beverage industry. The system ensures maximum process reliability and the highest level of food safety — from storage to the precise metering of food ingredients and additives. Components that come into contact with media comply with Regulations EC 1935/2004 and EN 10/2011.

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Volkmann USA introduces the next generation PowTReX metal powder conveying system. The newest PowTReX is designed to help metal additive manufacturers produce large volumes of high-quality parts using multiple 3D printers at scale. PowTReX automatically transfers 3D printing powders from a container or supply hopper, extracts and sieves used powder after a completed build job to remove oversize particles, and collects the sieved powder for reuse and return into the printing process.

Volkmann Inc., Bristol, PA 609-265-0101
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Official Publication of
INTERNATIONAL POWDER & BULK SOLIDS CONFERENCE & EXHIBITION
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Mixing Impossible? Tackling High-Viscosity Formulations

By Erin Dillon, Charles Ross & Son Co.

The global supply chain for advanced materials has seen significant growth, particularly for manufacturers that support defense, space exploration, and infrastructure. This class of materials is broad and multidisciplinary, encompassing specialty composites, adhesives, sealants, coatings, lubricants, catalysts, battery slurries, and electronic pastes.

In a niche category of their own, energetic materials are produced by a relatively small number of manufacturers worldwide, a handful of which are operating at full production scale in the US. Rising geopolitical tensions have highlighted the need for reliable domestic sources, as government agencies and defense contractors look to local suppliers to quickly strengthen supply chain resilience and shorten lead times. As demand grows, so does the need to expand US manufacturing capability.

Increasing production, however, is not as simple as just mixing larger batches. Energetic formulations are not only mechanically demanding; they also need to be processed in an extremely cautious manner. How components are mixed can make all the difference between a perfectly uniform batch, poor product performance, or worst of all, a catastrophic safety incident. When viscosities exceed one million centipoise, mixing processes become much more challenging. The batch resists flow, creating challenges to agitator exposure, making them prone to entrapping air, and difficult to maintain controlled temperatures.

Double Planetary Mixers Ramp Up Energetics Production

Double planetary mixers (DPMs) are widely used in this sector as formulations scale from laboratory to production. These mixing systems are engineered to operate under extreme mechanical forces, manage uniform dispersion even with high solids loading, and maintain precise control over shear and energy input, all while meeting stringent safety requirements.

Operators who successfully process energetic formulations with a DPM rely on a set of best practices that prioritize controlled material movement, measured energy input, and risk reduction at every stage of mixing.

Best Practice 1: Focus on Torque to Deliver Power

As resistance increases due to rising viscosity, mixing requires more power, which is converted directly into heat within the batch. Unlike free-flowing formulations — which transition more readily to turbulent flow with simple agitation and little power

Ross mixer with high viscosity blades, designed with precisely angled helical contour consumption — viscous materials tend to stay in laminar flow and require significant torque for proper turnover. Inefficient mixing results in stagnant pockets that do not easily release heat energy, as well as hinder complete wet-out of dry ingredients.

DPMs are specifically suited for dense, sticky, and putty-like formulations. Unlike conventional mixers, they are engineered for high torque and consist of two identical blades that rotate on their own axis while rotating across the mix vessel on a central axis. This controlled, repeatable agitation moves material from the vessel sidewall into the center of the batch, regardless of the viscosity. It eliminates stagnant zones where heat or non-dispersed energetic powders could accumulate. The slow but thorough planetary mixing action of the DPM ensures that all raw materials and heat are distributed evenly throughout the batch.

Best Practice 2: Select Blade Geometry Based on Batch Behavior

While viscosity is a key factor, overall batch behavior must be considered in the process of blade selection. Traditional rectangular blades work well for most applications, but some formulations are prone to climbing up the blades and vessel sidewall.

For these types of formulations, high viscosity (HV) blades are the ideal choice. Designed with a precisely angled helical contour that generates both axial and radial flow, HV blades push product forward and down. This prevents material from climbing toward the shafts and out of the mix zone, reduces localized hot spots, and promotes more uniform flow patterns. The HV blades significantly outperform standard designs for very stiff and non-self-leveling materials.

Best Practice 3: Configure the Mixer to the Process

Not all energetic formulations have the same chemistry or the same physical characteristics, and as a result, no single mixer configuration can process every application. Slight differences in formulation, batch size, and even facility conditions can influence equipment requirements from blade choice to materials of construction. It is important for operators to take an educated and thoughtful approach to their environment and batch process parameters when deciding on mixer features.

For example, lock-wired fasteners prevent critical components from loosening under sustained vibration, raised mix cans compensate for uneven plant floors, and bronze bushings resist wear while eliminating the risk of spark generation between mating surfaces. Each of these details may seem small, but together they allow the mixer to perform reliably and operate safely through countless production cycles.

Mixers for energetic formulations must meet stringent safety standards, including explosion-proof motors, advanced controls for remote operations, torque monitoring to prevent mechanical overload, and additional safeguards that protect both operators and equipment.

Best Practice 4: Actively Control Heat in the Batch

Jacketed vessels allow operators to manage temperature precisely, using water, oil, or glycol to either add heat to thin out high viscosity prepolymers or remove heat generated in the batch. Real-time monitoring through thermocouples gives instant feedback, so the operator can correct any potential hotspots before they become a problem. Additionally, being able to accommodate heating or drying steps for components prior to mixing can increase efficiency, reduce contamination risk, and save time.

Best Practice 5: Use Vacuum Mixing to Control Air Entrapment

Mixers designed to operate under vacuum can be highly effective in removing trapped air from the batch, promoting rapid powder wet-out and thorough dispersion, while eliminating exposure to oxygen. This reduces risks that could compromise consistency, product performance, and safety in high-energy formulations.

DPMs are typically rated for up to around 29.5 in. Hg with a leakage rate of less than 1 in. Hg in 30 minutes. The actual vacuum level achieved is dictated by the vacuum pump and vapor pressure of the product. These mixers can also be designed to hold positive internal pressure for nitrogen purging and product discharging purposes.

While these design best practices define what is required to safely mix high-viscosity energetic formulations, their real value is demonstrated in application. Scaling from laboratory development to full production introduces new challenges in risk management, equipment reliability, and process control. The following case study illustrates how these considerations come together in practice as an emerging US manufacturer expands domestic energetics production.

Case Study: Safely Mixing Energetics From Lab to Production

Previously known as Estes Energetics prior to an acquisition by Voyager Technologies in 2025, the company was founded in 2021 to provide a domestic source for solid rocket motors, munitions, black powder, and specialty chemicals needed for defense and commercial industries. In just a few years, driven by increased demand for US-based energetics manufacturing, they ramped up their solid propellant operations and began preparing for high-volume production in 2026 and beyond.

Ross double planetary mixer

Scaling Safely

Instead of jumping directly to large-scale production, Estes approached the necessary growth with safety as the guiding principle. The team validated material behavior, mixing parameters, and equipment response at every stage of the scale-up process.

Development tests carried out on a Ross 2-gallon double planetary mixer provided observations including optimal order of addition, appropriate blade speeds, cycle time, power draw, temperature profile, and product behavior during discharge. Lessons learned from these small-scale trials were applied to a 10-gallon system, where repeatability and process consistency were evaluated again. Both mixers successfully mixed materials with viscosities more than 5 million centipoise.

The next step was a trial using a 40-gallon DPM at the Ross Test & Development Center in Hauppauge, NY. These tests were performed using a non-hazardous simulant formulation that mimicked the rheology and density of actual formulations made in their 2- and 10-gallon mixers. Estes engineers worked alongside the Ross technical service team in preparing the simulant batch, which came out thoroughly uniform after being mixed under deep vacuum in the Model DPM-40.

Customizing the System for Production Needs

All the above research and development work led to Voyager's fully customized Ross 150-gallon heavy-duty double planetary mixer. Many best practices were applied, with features such as HV blades that prevent material climb, reverse lift system, lock-wired hardware, and a completely flush (no dead zone) bottom discharge valve. The jacketed mix cans with custom thermocouple probes allow precise temperature monitoring and were internally machined to maintain special blade-to-vessel clearances.

Through this thoughtful approach, Estes was able to reduce the number of batches per shift, lower labor requirements, and maintain tight process control, all while ensuring operator safety. This not only enables reliable day-to-day production but also positions Estes to meet their goal of scaling future operations efficiently and reinforcing the US supply chain for energetics.

Ensuring Safety & Reliability Through Inspection

The completed mixer underwent a strict inspection process to ensure all aspects meet requirements dictated by the "DoD Contractors Safety Manual for Ammunition and Explosives" (4145.26). The heavy-duty HV blades were X-rayed to rule out internal defects that could lead to processing failures. Welds were subjected to dye penetration inspections to ensure long-term structural integrity. Additional tests were completed on the vacuum system, safety limit switches, jacket pressure holding, blade-to-bowl clearances, and hydraulic lifts. These rigorous inspections confirmed that the mixer could handle propellant formulations safely for many years to come.

Left to Right: David Almedia — ROSS VP Operations, Tom DiGiannurio — ROSS VP Engineering, Eric Wong — ROSS Mechanical Design Engineer, Rob Gonzales — Voyager Technician, Jami Hall — Voyager Technician, Kevin Alvarado — ROSS Mechanic, and David Hailey — Voyager Chief Engineer

Estes motors being static fired.

Supporting US Supply Chain Resilience

The lessons learned from the scale-up process demonstrate how diligent testing, thoughtful process adjustments, and robust equipment design work together to produce complex, high-viscosity formulations reliably and safely.

More than a technical accomplishment, Estes's increased production is a commitment to strengthening domestic energetic materials manufacturing. By combining operator-driven best practices with carefully customized mixing equipment, the company is ready to meet the growing demand across defense and commercial markets while maintaining consistent quality.

Disclaimer: Voyager Technologies does not guarantee any results or make any promises as to the performance of such process.

Erin Dillon is media and marketing coordinator at Charles Ross & Son Co. (Hauppauge, NY). With more than 15 years of experience in the marketing and operations industry, she has published numerous articles and whitepapers on the latest advancements in mixing and blending technology, providing valuable insights to industry professionals. For more information, call 800-243-7677 or visit www.mixers.com.