

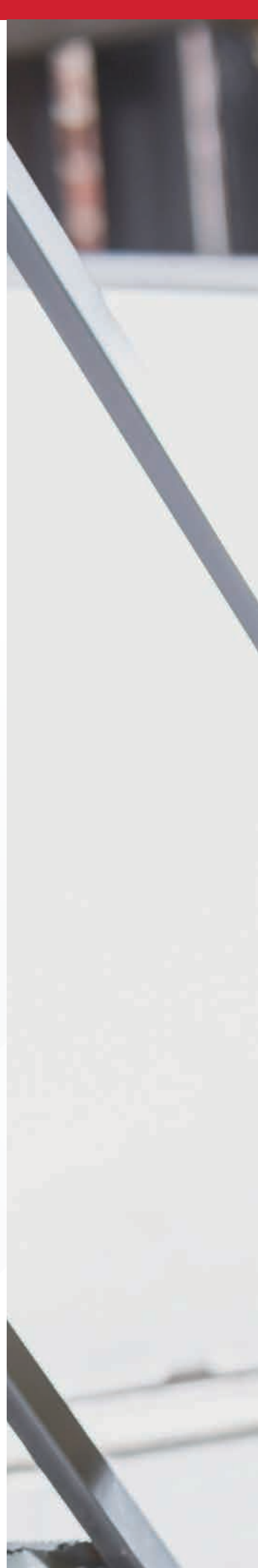
Lubricant Mixing & Processing Guide

Meeting the Unique Processing Challenges of Food-Grade, Specialty and High-Performance Lubricant Production.



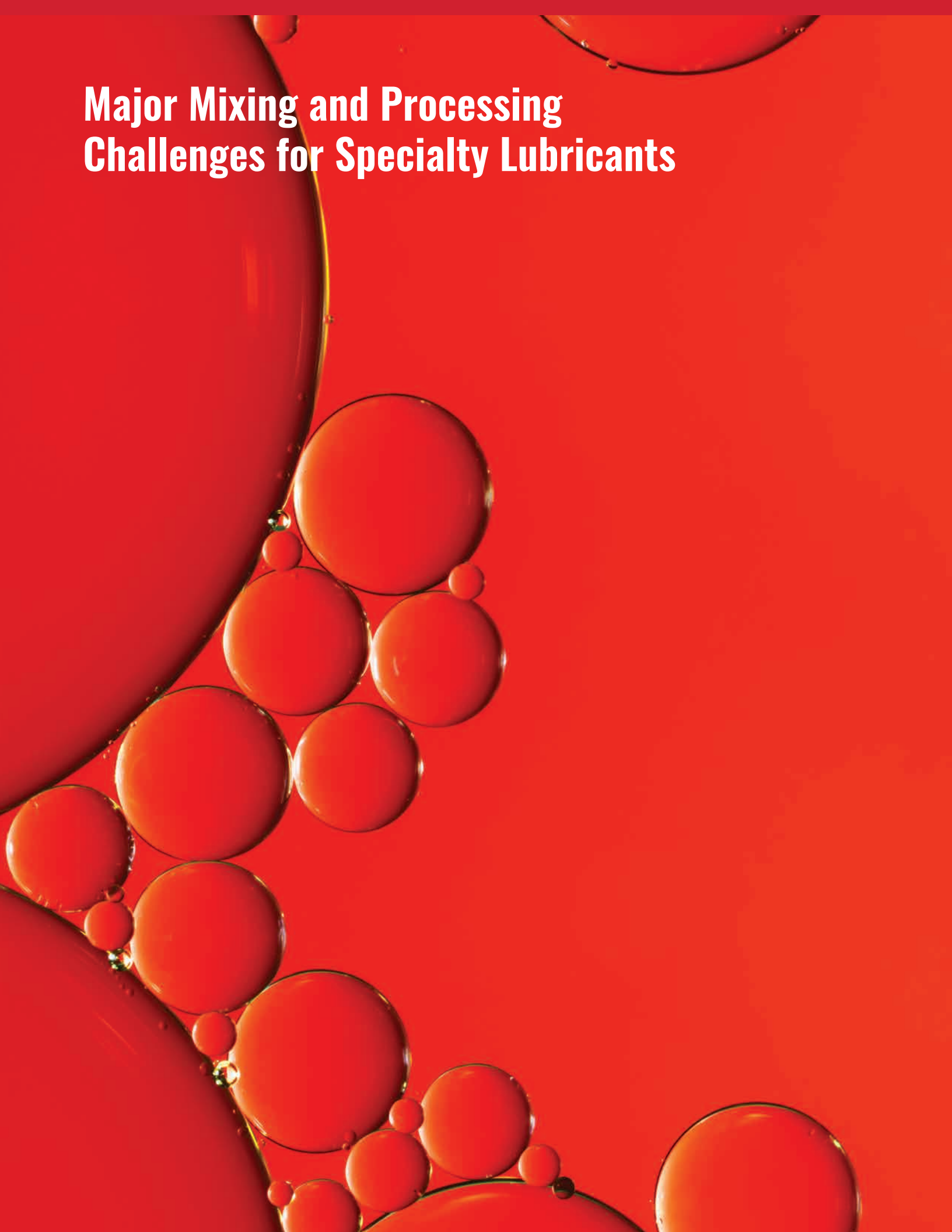
Lubricant manufacturing covers a large and diverse range of products, with a wide variety of processing requirements. For some products—like general purpose lubricants—traditional, widely available processing equipment can meet all their manufacturing needs, while other lubricant products present challenging mixing, temperature and safety demands that require specialized processing vessel features and performance:

- **Food-Grade Lubricants:** Due to more stringent USDA food safety regulations under the Food Safety Modernization Act (FSMA), NSF H-1 registered food-grade lubricants are widely used by food manufacturers in processing equipment to minimize food contamination risk. Additionally, use of food-grade lubricants is expanding, as processors replace conventional lubricants with food-grade lubricants to provide an extra margin of safety in their operations.
- **Specialty Process Lubricants:** A wide range of specialized lubricants, each with their own specific formulations and performance characteristics, are used for machinery and equipment in manufacturing, aviation, oil field extraction, mining, construction and other industries.
- **High-Performance Lubricants:** Formulated for greater lubricity, higher heat tolerance, longer service life, extended replacement intervals or other needs, high-performance lubricants deliver superior performance.





Major Mixing and Processing Challenges for Specialty Lubricants



While food grade, specialty and high-performance lubricants are used across a range of industries and applications, they all present demanding processing challenges to manufacturers:

High-Viscosity Mixing

Lubricant grease products of all types share viscosities as high as 2,000,000 cps. These high viscosities require mixing vessels and agitator assemblies with sufficient power to mix these batch ingredients.

High Temperature Processing

Lubricants used in equipment that runs at high speeds and generates high internal temperatures must be formulated and processed for high temperature operation.

Consistent Ingredient Addition & Blending

Specialty and high-performance lubricants often use costly ingredients and additives, or dry ingredients which may be difficult or dangerous to manually load into the open top of a tank or kettle. In their dry state, these ingredients may also be difficult to mix with liquid petroleum base ingredients, creating fisheyes or lumps of unmixed ingredients in the vessel.

Efficient Deaeration

When processing costlier high-performance lubricants, it is especially important to eliminate air bubble formation, which normally occurs during the mixing process. The presence of entrained air affects how precisely these expensive products are dispensed into packaging shipped to the end user.

Sanitary & Safe Operation

For manufacturers of food-grade lubricants, it is mission-critical to ensure their products are sanitary and free of contaminants. Other specialty or high-performance lubricant products—which may use additives or high temperatures in their processing—must give extra consideration to protecting operator safety.

Processing Vessel Requirements for Optimal Production

To meet the processing challenges of their specific products, food-grade, specialty and high-performance manufacturers may be wise to emphasize certain characteristics in their vessel and mixing equipment:

Robust Design & Construction to Efficiently Mix & Blend High-Viscosity Products

Mixing high-viscosity greases requires drive units and agitator assemblies robust enough to continuously move thick, heavy batch ingredients. To provide long-term service with low ownership costs, all components of the drive system—gearbox, driveshaft, bearings, agitator assembly and other moving parts—must be ruggedly designed and precisely fabricated to withstand the stress of constant operation.

Vacuum Operation for Trouble-Free Ingredient Addition & Thorough Deaeration

Adding vacuum operation and a secondary valve to the processing vessel enables dry powder ingredients to be consistently drawn into the unit and dispersed directly into the liquid batch, without the risk of fisheyes or lumps of unmixed material collecting on the sides of the vessel. Pulling vacuum while mixing can help remove trapped air bubbles in the product.

Special Vessel & Jacket Design for High Temperature Operation

Lubricants often require processing at temperatures beyond the limits for steam heating in conventional processing vessels. Vessels engineered to circulate special heat transfer fluids in the vessel jacket can boost processing temperatures close to 500 degrees. Be aware that the higher heat operation requires a jacket design that is both highly

efficient, to consistently transfer heat energy to the vessel sidewalls, and robust enough to withstand continuous long-term operation at these higher temperatures.

Vessel & Mixer Design to Maximize Product Yield

When costly ingredients are used in high-performance or specialty lubricant products, the vessel and its agitator must be designed to efficiently clear the product from the vessel sidewalls and discharge it from the vessel to maximize batch yields. Less efficient designs will leave excess material at the bottom of the vessel, which is either wasted, or must be manually cleared or recovered at extra cost.

Sanitary Design for Food-Grade Lubricant Production

Vessels designed to manufacture food-grade lubricants must be fabricated in stainless steel for sanitary, contaminant-free operation, and designed for fast, efficient cleanability to minimize contamination risk.



Important Safety Features for Vessels Used in Lubricant Processing

Safety, quality and production are all important considerations in lubricant processing, but the most important of these is safety. Without safety—both for your plant’s production team and for the products you produce—there is little point to achieving quality and production goals, when compared to the downside consequences of unsafe equipment operations or the even greater liability risk of defective products. This is why lubricant manufacturers must carefully consider the range of safety features available when specifying and configuring a new lubricant processing vessel.



Operator Safety Features

Operator Safety During Operation

Your first safety consideration is for your production team. Consider the ergonomics of your production process and its impact on operator safety during every batch process:

Power assist for ingredient loading and filling: If ingredients are loaded manually into an open-top vessel, how heavy are the loads for the individual ingredients in your batch? How high must they be lifted by operators? Often, power-assisted loaders and automatic fillers are used to prevent fatigue and injury to operators when loading batch ingredients.

Hinge cover lift assists, cover limit switches, vessel cover grates and motor cutoff safety switches: Consider the number of times your plant operators must open and close the vessel lid during a typical batch process and what operations they need to perform during these steps. Important equipment features are available to prevent accidents and injuries when operators must open the vessel lid during a batch process while the vessel's mixer or agitator is in motion:

- **A spring- (or air-) operated cover lift assist** allows for easy opening and closing of heavy vessel lids so operators can access the batch before, during or after processing. This feature also prevents operator injuries from the vessel lid falling back down unexpectedly onto the top of the vessel.
- **A grate positioned under the cover with a grate motor cutoff switch** allows for visual inspection of the batch during the mixing and heating process, and also allows operators to safely add ingredients to the batch while the agitator is operating. Grate openings can be custom-sized to allow only ingredients to pass through the grate, but prevent hands and arms from entering the vessel. Additionally, a grate motor cutoff switch, which automatically turns the agitator motor off if the grate is lifted from the top of the vessel, can be added to the vessel specification to prevent injuries during operation.
- **A variable frequency drive (VFD)** can be specified for use with the vessel motor, featuring overload protection that is activated when obstructions or heavy motor loads cause amperage spikes in the motor.

Operator Safety Features (continued)

Vacuum ingredient addition: Many lubricant products utilize ingredients and additives that can be hazardous to operators once airborne. For example, airborne dust from dry ingredients loaded into the top of a conventional open-top vessel can be dangerous if inhaled by plant personnel. Using closed-top vessels equipped with vacuum ingredient addition minimizes the risk of airborne ingredients escaping into the processing area.

Vessel jacket insulation: During the high temperature heating process used in many lubricant processing applications, the vessel jacket can become dangerously hot for operators working around the vessel. Specially configured high temperature processing vessels can feature jacket insulation, which reduces the temperature of the vessel to a safe level, and significantly reduces burn risk to operators. By reducing heat loss, jacket insulation also improves heating efficiency and reduces the ambient room temperature on the plant floor.

Discharge handle extension or pneumatic actuation operation: Extension handles can be installed on sanitary ball valve outlets to prevent operators from having to bend down or move underneath the vessel to discharge the vessel at the end of the process. Pneumatically actuated valves can also be used for remote operation and even greater safety.

Additional Safety Features

Food-Grade Lubricant Production

For food-grade lubricant production, assuring a product which is always sanitary and free of contaminants is another critically important safety goal. These safety features can be considered in the design and configuration stages of your next vessel purchase for food-grade lubricant production:

Sanitary features for optimizing clean-in-place (CIP) systems: Important design features and fabrication techniques can be integrated into new food-grade lubricant production vessels to optimize the use of CIP systems. For example, higher-grade surface finishes can be used on the internal areas and all other product contact surfaces of the vessel to increase CIP cleaning efficiency. Also, weld joints, seams and other product contact surfaces that are welded, ground and polished will create smooth, sanitary and easily cleanable surfaces.

Design features to eliminate the potential for standing water or fluid collection: Several design features can eliminate the risk of water collection on the outside of the vessel. For example, channel risers can be used to slope the channel bridge on the vessel's top motor mount to move water or other fluids away from the top of the vessel; tank or kettle covers can be sloped to allow water or other fluids to run off the top of the cover; and vessel legs and support hardware can be made from round stock instead of flat bars to prevent water collection.

Pipeline metal detection enhancements: Scraper blades, impregnated with stainless steel powder, can be used to enable visibility on pipeline metal detection systems and to prevent foreign object contamination of food-grade or other lubricant products during processing.

Lee Industries Mixing Systems: *Meeting the Challenges of High-Viscosity Lubricant Processing*



Lee vessels feature a robust agitator drive system, Uniflow™ heating jacket, vacuum operation and other essential features required for optimal processing of high-viscosity lubricant products.

Key features of Lee mixing systems:

Robust agitator drive for continuous high-viscosity mixing operations:

The entire drive train of a Lee processing vessel, from gearbox to agitator shaft, bearings and mixing arms, is designed and constructed to withstand years of continuous high-viscosity mixing—for extended durability and long service life.

Double-motion, counter-rotating agitator arms for thorough, consistent high-viscosity blending:

The inner agitator, which rotates in the opposite direction of the outer agitator, provides powerful double-motion mixing action for thorough and continuous mixing of high-viscosity ingredients.

Vacuum ingredient addition for complete blending of individual ingredients & batch deaeration:

Lee vessels can be equipped for vacuum operation, with a secondary valve to load dry ingredients under vacuum into the vessel. This enables thorough blending and helps to prevent formation of fisheyes or dry lumps of unmixed materials in the batch. Vacuum deaeration removes air bubbles, which ensures accurate dispensing of high-value lubricants.

Stainless steel construction for sanitary food-grade lubricant processing:

To meet USDA standards, all Lee vessels are fabricated from stainless steel, with several sanitary surface finish options available for processing food-grade lubricants. Lee's manufacturing capabilities extend beyond stainless steel to include higher alloy materials such as: AL6XN, hastelloy, inconel and incoloy.

Maximum batch product yield with centerline agitator frame design:

Lee's unique offset agitator frame design (see page 13) places the scraper blades on the same axis as the vessel's outlet valve. This enables efficient and complete product discharge which maximizes product yield and eliminates the need to clean out or recover excess material from the bottom of the vessel.

Ultra-high temperature operation with durable Uniflow™ jacket construction:

The patented Lee Uniflow™ jacket (see page 14) features a unique cross-section design which places the maximum surface area of steam or heat transfer fluid against the vessel sidewall, maximizing heat transfer in the vessel. Each Uniflow™ coil edge is continuously welded to the vessel sidewall, providing a solid, long-term bond that minimizes the potential for vessel leakage that can occur over time in continuous high temperature operations.

Agitator Frame Design

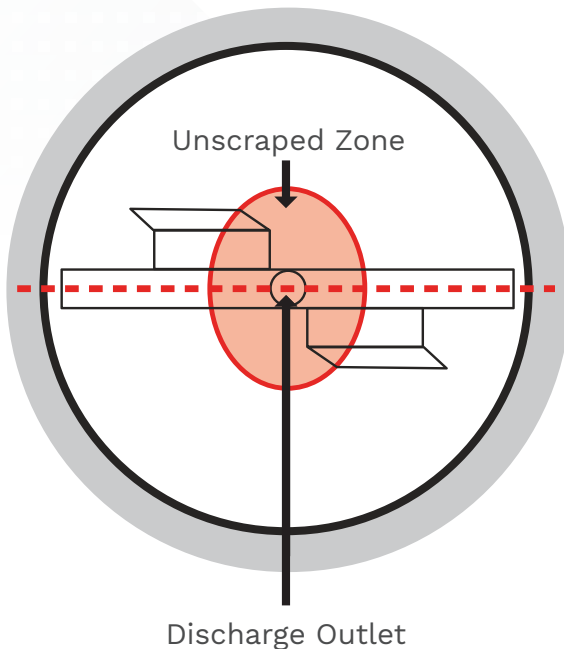
The Lee Offset Agitator Frame design increases product yield to minimize costly ingredient waste in high-performance lubricant processing

Competitor Centerline Agitator Frame (diagram A) designs do not fully scrape the bottom of the vessel, leaving areas where unscraped excess product collects. This reduces batch yield and increases production costs—especially when processing high-performance lubricants that contain expensive additives and ingredients.

The Lee Offset Agitator Frame (diagram B) design eliminates vessel waste by placing scraper blade edges along the centerline axis of the vessel bottom. This provides scraper coverage as close as possible to the outlet for complete blending and discharge of high-viscosity products, leaving no residual product at the bottom of the vessel.

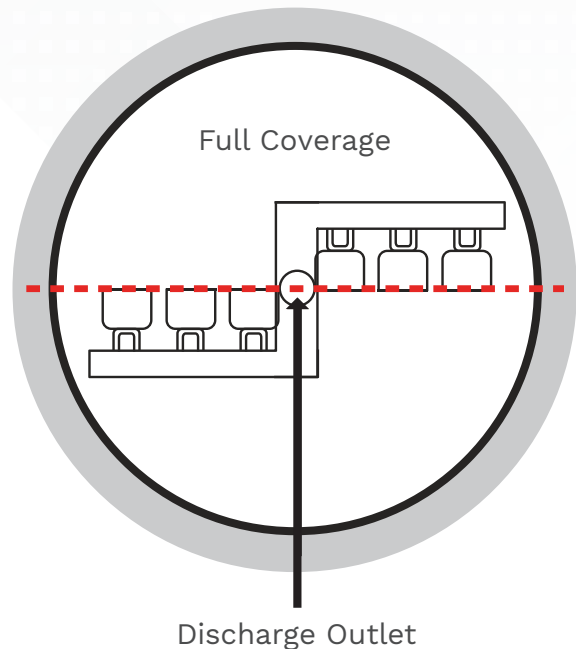
A

Competitor Centerline Agitator Frame



B

The Lee Offset Agitator Frame



Uniflow™ Jacket Design

The Lee Uniflow™ Jacket design improves heat transfer & service life when using steam or high temperature heat transfer fluids in lubricant processing

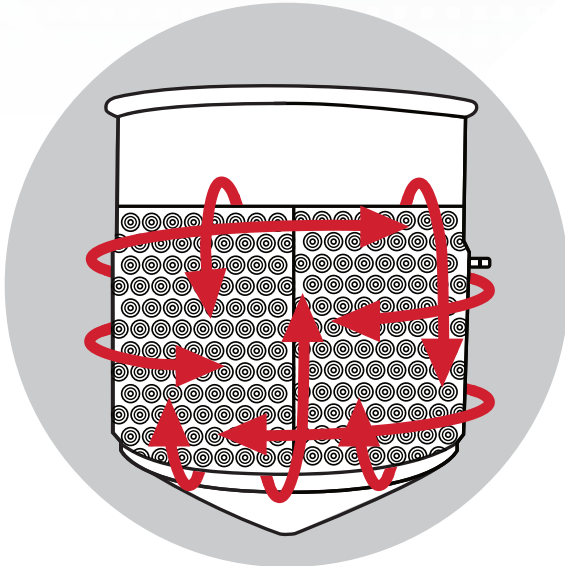
Compared to conventional dimple jacket designs, (diagram C) **the Lee Uniflow™ coil jacket design** (diagram D) maximizes heat transfer of steam or thermal fluids from each coil to the vessel sidewall and provides uniform heating/cooling with directional flow—a major advantage for high temperature lubricant processes that use heat transfer fluids.

Full penetration welding bead around each coil section of the Uniflow™ jacket (diagram E) tightly bonds the coil to the vessel sidewall, preventing the risk of leakage during extended continuous high temperature operation.

C

Dimple Jacket Design

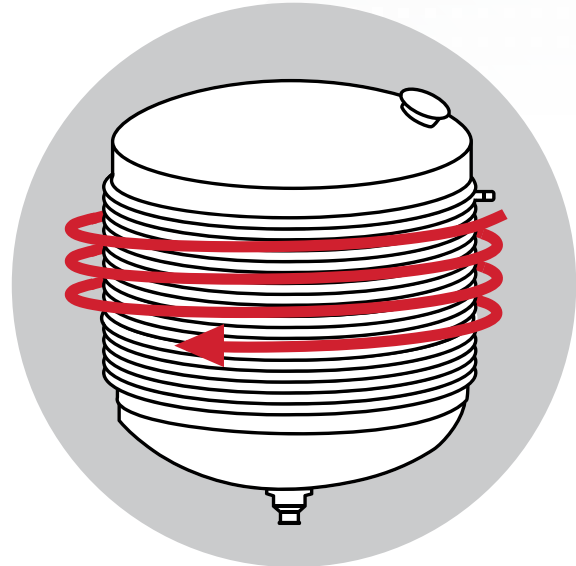
Random fluid flow throughout jacket creates pockets of lower temperature, decreasing vessel heat efficiency.



D

Lee Uniflow™ Jacket

Highly efficient steam or thermal fluid path and maximum heat transfer to vessel sidewall.

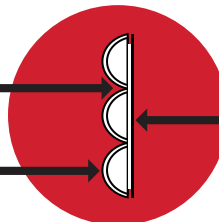


E

Single Full Penetration Weld

Vessel Sidewall

120° Cross Section



Designing a processing system to handle high-viscosity products can be a demanding process, and there are many factors to consider. To learn more about how Lee Industries can help you meet these challenges, search our website for the **Engineering Services for Lubricant Product Manufacturers Guide** or contact a Lee process engineer to discuss your specific requirements.



About Lee Industries

The mission of Lee Industries is to assure our customers are successful by focusing on their custom processing needs and providing them with the highest quality, most durable products and services available. Lee Industries is committed to the success of your company by providing you with world-class, high-quality stainless alloy process equipment and service. We design and manufacture the most technologically advanced equipment in the industry. Our customer service team, backed by over 90 years of innovation and experience, provides Lee clients with a single source for all their processing system needs.



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