Tech Article

Upfront Surface Engineering Drives Yield, Compliance, and Speed

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Controlled manufacturing environments are essential for minimizing particulate and chemical contamination during medical device production, reinforcing the need for preplanned cleaning processes

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For manufacturing engineers, achieving stable, repeatable, and compliant production processes is the ultimate goal. Yet many of the most common manufacturing challenges, such as inconsistent yields, cleaning validation failures, coating defects, and delayed product launches, can be traced back to insufficient planning of cleaning, lubrication, and surface treatment strategies early in the product lifecycle. By integrating these considerations during design and process development, engineers can set up robust, scalable operations. The use of advanced solutions such as Duraglide™ dry lubricants, Swellex™ swelling fluids, and Tergo™ precision cleaning fluids, combined with the support of critical cleaning laboratories and field technical expertise, enables manufacturers to optimize contamination control and avoid costly delays or false starts.

The Role of Early Planning in Manufacturing Success

Manufacturing engineers are responsible for translating product designs into efficient, repeatable production processes. When cleaning and surface treatments are treated as afterthoughts, engineers often face late-stage changes, poor process capability, and unexpected contamination issues that disrupt production. Early planning ensures that cleaning, lubrication, and coating are designed as integral process parameters rather than reactive fixes. This proactive approach allows engineers to define stable process windows, select proper equipment, and ensure compatibility across all manufacturing steps, ultimately improving throughput and reducing risk.

Designing for Cleanability and Process Integration

Device geometry and material choice play a critical role in determining how effectively components can be cleaned and prepared for downstream processes. Complex features such as tight crevices, blind holes, and intricate assemblies can trap contaminants and complicate cleaning validation, leading to longer cycle times and increased variability. From a manufacturing perspective, designing for cleanability simplifies fixturing, improves process consistency, and reduces the likelihood of residual contamination. At the same time, early choice of compatible materials ensures that cleaning chemistries, lubricants, and coatings work together without adverse interactions. Incorporating Tergo™ precision fluids for high-purity cleaning, along with Duraglide™ dry lubricant and Swellex™ swelling solutions for lubrication and material swelling, ensures that surface performance requirements are met without compromising manufacturability.

Developing a Robust Cleaning Process

A stable cleaning process begins with a clear understanding of contamination sources throughout manufacturing, including machining residues, particulates, assembly aids, and environmental exposure. Manufacturing engineers must define a controlled process window that accounts for chemistry, temperature, time, and mechanical action, ensuring consistent removal of contaminants while meeting production takt times. Tergo™ precision fluids provide a reliable foundation for precision cleaning by enabling residue-free performance and compatibility with sensitive medical device materials. Early process development, supported by lab-scale trials, allows engineers to optimize parameters before scaling to full production, reducing the risk of equipment mismatch or process inefficiency.

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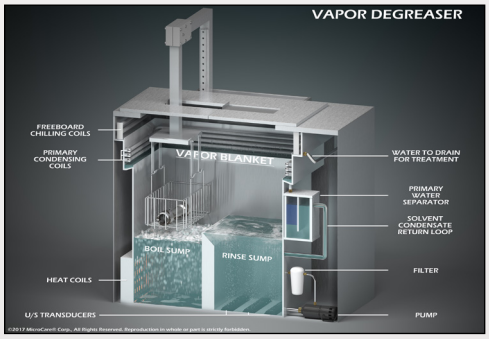
Complex geometries such as tight crevices and internal channels can trap contaminants, making early design for cleanability critical to achieving consistent cleaning outcomes and process repeatability



Precision cleaning systems using optimized chemistry, temperature, and solvency remove manufacturing residues and enable consistent, validated cleaning performance

MicroCare Critical Cleaning Labs provide contamination analysis and root cause identification, helping engineers optimize cleaning processes before production scale-up

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Integrating Lubrication into the Production Process

Dry lubrication is not simply a functional requirement but a critical manufacturing variable that affects assembly performance and product reliability. Duraglide™ dry lubricants can be incorporated into the process to reduce friction, minimize wear, and enable smoother, more consistent assembly operations. Similarly, Swellex™ swelling fluids play a key role in applications involving elastomers, where controlled interaction or swelling is necessary to achieve proper sealing and fit to connectors. For manufacturing engineers, the key challenge is ensuring that these lubricants are applied consistently and remain compatible with cleaning and sterilization processes. Early integration and testing help prevent unintended removal or degradation of lubricants, which can otherwise lead to variability and performance issues.

Surface Preparation and Coating Optimization

Effective coating application depends on proper surface preparation, making precision cleaning a critical prerequisite. Residual contaminants can interfere with coating adhesion, resulting in defects, increased scrap rates, and potential field failures. By incorporating Tergo™ precision fluids into the cleaning process, engineers can achieve the high-purity surfaces needed for reliable coating performance. Process sequencing must be carefully engineered so that each step, from first cleaning to lubrication and final coating, works in harmony. This integrated approach ensures that surfaces are properly prepared, coatings adhere consistently, and the overall process stays scalable and repeatable.

Leveraging the MicroCare Critical Cleaning Lab Support

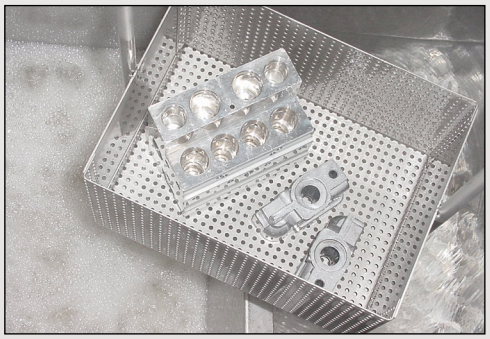
Our Critical Cleaning Laboratory provides essential support for manufacturing engineers by offering contamination analysis, cleaning trials, and validation help. Through advanced analytical techniques, our labs can identify unknown residues and find their sources, enabling data-driven root cause analysis. Cleaning trials conducted in a controlled environment allow engineers to evaluate different chemistries and process parameters before committing to production equipment. This reduces risk and ensures that the selected process will meet both performance and regulatory requirements. Additionally, our lab support extends to validation protocol development and worst-case scenario testing, helping manufacturers achieve compliance with industry standards.

Field Expertise and Troubleshooting

Even well-designed processes can meet challenges during scale-up and production. MicroCare technical field experts provide valuable on-site support to troubleshoot cleaning, coating or swelling issues, optimize process parameters, and ensure smooth ramp-up. For manufacturing engineers, access to this expertise reduces downtime, accelerates problem resolution, and minimizes the need for internal trial-and-error. Early consultation with our experts also helps ensure that contamination risks, surface interactions, and cleaning processes are fully optimized before production begins, preventing delays and false starts.

Controlled application of Duraglide™ lubricants ensures consistent friction performance and supports reliable, repeatable assembly operations

Swellex™ fluids enable controlled elastomer interaction, improving sealing performance and dimensional consistency in critical attachments



Proper surface preparation using Tergo™ precision fluids ensures contaminant-free substrates, enabling reliable coating adhesion and performance

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Avoiding Delays and Ensuring Smooth Production

One of the most significant benefits of early planning is the ability to avoid costly disruptions during manufacturing. When cleaning, lubrication, swelling and coating processes are not properly aligned, manufacturers may face re-validation, equipment modifications, and production delays. By contrast, a well-integrated approach ensures that all processes are compatible, validated, and ready for scale-up. This leads to improved yield, reduced scrap, and faster time-to-market. For manufacturing engineers, this means fewer surprises during production and greater confidence in process performance.

Conclusion

Preplanning cleaning, lubrication, and coating is essential for manufacturing engineers looking to build robust and efficient medical device production processes. By integrating solutions such as Duraglide™ dry lubricant, Swellex™ swelling fluids, and Tergo™ precision cleaning fluids early in the design and manufacturing lifecycle, and by leveraging the capabilities of critical cleaning laboratories and technical field experts, organizations can optimize contamination control and ensure process reliability. This initiative-taking approach not only reduces risk and cost but also enables smoother production, faster validation, and successful product launches without delays or false starts.

About the Author:
Elizabeth Norwood is a Senior Chemist at MicroCare, LLC, which offers precision cleaning solutions. She has been in the industry for more than 25 years and holds a BS in Chemistry from the University of St. Joseph. Norwood researches, develops and tests cleaning-related products. She currently has one patent issued and two pending for her work. For more information, visit www. microcare.com.