Christian Dunne
Director of Global Corporate Business Development
ChargePoint Technology

Future-proofing aseptic manufacturing



The pharmaceutical aseptic product manufacturing space is experiencing significant growth, driven partly by increased demand for biologics, such as cell and gene therapies, monoclonal antibodies and vaccines.

Innovative technologies are also changing the field rapidly, with manufacturers placing a strong emphasis in quality control systems and advanced process analytical technologies, utilizing data analytics and digitalization technologies to predict potential challenges, address existing issues and ensure compliance.

The remarkable growth in this field is reflected in the global aseptic manufacturing market value, expected to rise from $1.21 billion in 2022 to $2.76 billion by 2029 at a compound annual growth rate (CAGR) of 12.6%.[1] Growth in sizable markets, such as the pharmaceutical development and manufacturing industry in India, means that new areas of opportunity open in both small molecule and biologic aseptic production. This underscores the need for solutions that not only enhance production but also maintain quality and compliance across these emerging markets.



Handling actives safely and efficiently

The global biologics drug market is booming, valued at $322.8 billion in 2021 and projected to be worth $689.59 billion by 2030, growing at a CAGR of 8.8%.[2] The increasing prevalence of chronic diseases, such as cancer and autoimmune disorders[3, 4] and advances in biomanufacturing technologies, such as single-use systems and continuous processing, have enabled more efficient and scalable production of biologics. These advancements have facilitated higher-volume sterile processing.

Handling sterile actives in various volumes is still proving to be a challenge for manufacturers. They experience unique challenges in handling both small and large volumes of drug product (DP) for filling operations.

How to proactively manage contamination risks and ensure product safety and quality

MICHAEL ANNINO | SHUTTERSTOCK-AI

Handling powders in bulk and not splitting batches into a larger quantity of smaller containers has advantages related to both productivity and risk management. This means that manufacturers rely on larger-volume SUT solutions — such as single-use bags and closed connections — to handle higher volumes while maintaining sterile integrity. Expert aseptic processing technologies partners work closely with manufacturers to develop cutting-edge solutions that accommodate a wide range of volume transfers and packaging options, including standard and customized 2D and 3D formats.

As the biologics field continues to advance and the demand for these innovative therapies grows, it is expected that the need for efficient and scalable sterile processing solutions will continue to increase.

Reducing product loss

Custom single-use assemblies for sterile manufacturing, including aseptic handling of powders, offer numerous advantages in terms of efficiency, contamination control and cost reduction. They closely align with the needs and priorities of manufacturers of aseptic products, making them a popular choice in the industry as a way of keeping up with market demands and an answer to new trends. As these solutions are designed as closed systems, they minimize the potential for product exposure to the environment during transfer and processing, minimizing the risk of product loss. They are designed with optimized flow paths, reducing the amount of product that remains in the system after processing.

Experienced partners who can provide custom single-use assemblies work closely with manufacturers to design and configure their solutions to meet specific process requirements. This includes selecting appropriate materials and connection configurations to reduce product loss, streamline operations and minimize contamination risks.

Meeting legislation requirements

Many manufacturers are still working through specific strategies to adhere to the principles and requirements of the updated EU's Good Manufacturing Practice (GMP) Annex 1, which provides guidelines for sterile medicinal products. Annex 1 outlines how a contamination control strategy (CSS) should be embedded in all aspects of sterile manufacturing, including personnel, premises, equipment, processes and materials.[5]

> “ As these technologies continue to advance, there will be even greater adoption of automation in the aseptic processing industry, leading to safer, more efficient and cost-effective sterile products as well as benefits to workers.

Manufacturers have to ensure that they are meeting these standards and implementing all required control measures so they can establish a proactive and effective approach to managing contamination risks and ensuring the safety and quality of their aseptic products.

Single-use solutions have played a critical role in helping pharmaceutical organizations meet these stringent requirements in many ways:

- **Reduced human intervention:** These innovations can be integrated into automated processes, minimizing the need for manual interventions, which are potential sources of contamination. Closed automated systems help reduce human error and contamination risk.
- **Flexibility and adaptability:** Versatile containers with easy handling solutions and different choices of materials offer flexibility in design and operation, allowing manufacturers to quickly adapt to changing production needs. This aligns with Annex 1's focus on quality risk management, where flexibility can be a key factor in mitigating risks.

Minimizing contamination risk

By eliminating the need for cleaning and sterilization, which are major sources of contamination in traditional stainless-steel systems used in the aseptic manufacturing of pharmaceuticals, single-use solutions align with current CSS guidelines.

- Faster turnaround times: Innovative single-use equipment enables faster changeovers between batches, reducing downtime and increasing productivity. This can be particularly beneficial for smaller volumes of DP, which are becoming more

common in the industry with the rise of personalized therapies.
- Cost-effectiveness: Reduced cleaning, sterilization, and validation requirements mean that manufacturers can increase productivity and save costs.

Upgrading each production line and setup of existing sterile facilities has its unique logistical and technical challenges. Occasionally, there is not one single ideal solution, so using combinations of different technologies in new ways may be required. Experienced partners with expertise in aseptic processing can help manufacturers develop, enhance and qualify systems in new ways to ensure they remain compliant with evolving regulatory requirements.

The power of robotics and automation

Robotics and automation have been transforming pharmaceutical aseptic manufacturing. They have shown their potential in streamlining processes, increasing throughput, improving accuracy and reducing contamination risks to help ensure compliance. These technologies are used in various stages of aseptic manufacturing, including:

Filling and sealing

Robotics can aid in the precise filling of vials, syringes and cartridges with sterile drugs and sealing them to maintain product integrity. This minimizes human intervention, reducing the risk of contamination. Robots perform tasks with high precision and repeatability, ensuring consistent product quality.

Material handling

Automated systems can transport materials within or between facilities, preventing cross-contamination and ensuring smooth workflow. Recently, closed robotic powder handling solutions have increasingly been used in all powder applications in bioprocessing, fill-finish, solid dosage and drug substance manufacturing thanks to their ability to create semi-continuous production cells with readily available pre-engineered and off-the-shelf components that are ready to deploy. These solutions use existing systems for closed transfer between the process and the container, ensuring high performance and safety when sterile or even toxic materials are being handled.

Quality control

Automated systems can inspect the product, ensuring consistent quality and compliance with regulatory standards. Automated systems can collect and analyze data throughout the manufacturing process, improving traceability and quality control.

Packaging

Robotics can help package finished products, reducing the need for manual labor and improving efficiency.

The benefits of introducing robotics and automation into pharmaceutical aseptic manufacturing are substantial. These solutions speed up processes, improve efficiency, and reduce lead times, bringing products to market faster and safer. They eliminate staffing challenges and problems such as ergonomic issues that arise with extensive manual handling. As these technologies continue to advance, there will be even greater adoption of automation in the aseptic processing industry, leading to safer, more efficient and cost-effective sterile products as well as benefits to workers.

Companies specializing in aseptic processing technologies are collaborating with manufacturers to provide tailored solutions and advance robotic manufacturing through innovation and partnership.

The future of aseptic manufacturing

As aseptic pharma manufacturing grows rapidly, it's set for major transformation driven by new developments. SUTs are expected to gain popularity for enhancing compliance, reducing contamination risks, and improving cost-effectiveness and flexibility. Innovations in materials and designs will further improve compliance with quality standards, broadening their use. SUTs not only support compliance by reducing contamination risks but also contribute to companies' environmental sustainability strategies with their reduced water and energy consumption.

The integration of advanced robotics and automation into pharma production is set to expand, minimizing human intervention, reducing contamination risks and improving efficiency and consistency. Manufacturers will use robotic systems to perform complex tasks, like aseptic transfer and manipulation, streamlining processes and ensuring smooth workflows and consistent product quality. Integrating AI with robotics enables smarter automation, with AI algorithms analyzing data from sensors and cameras in real time, allowing robots to autonomously adjust and enhance reliability.

Collaborating with suppliers of equipment designed to meet stringent compliance and quality needs will help manufacturers stay at the forefront of innovation, ultimately ensuring patients receive safe, high-quality therapeutics faster.

For the complete list of references, visit pharmamanufacturing.com