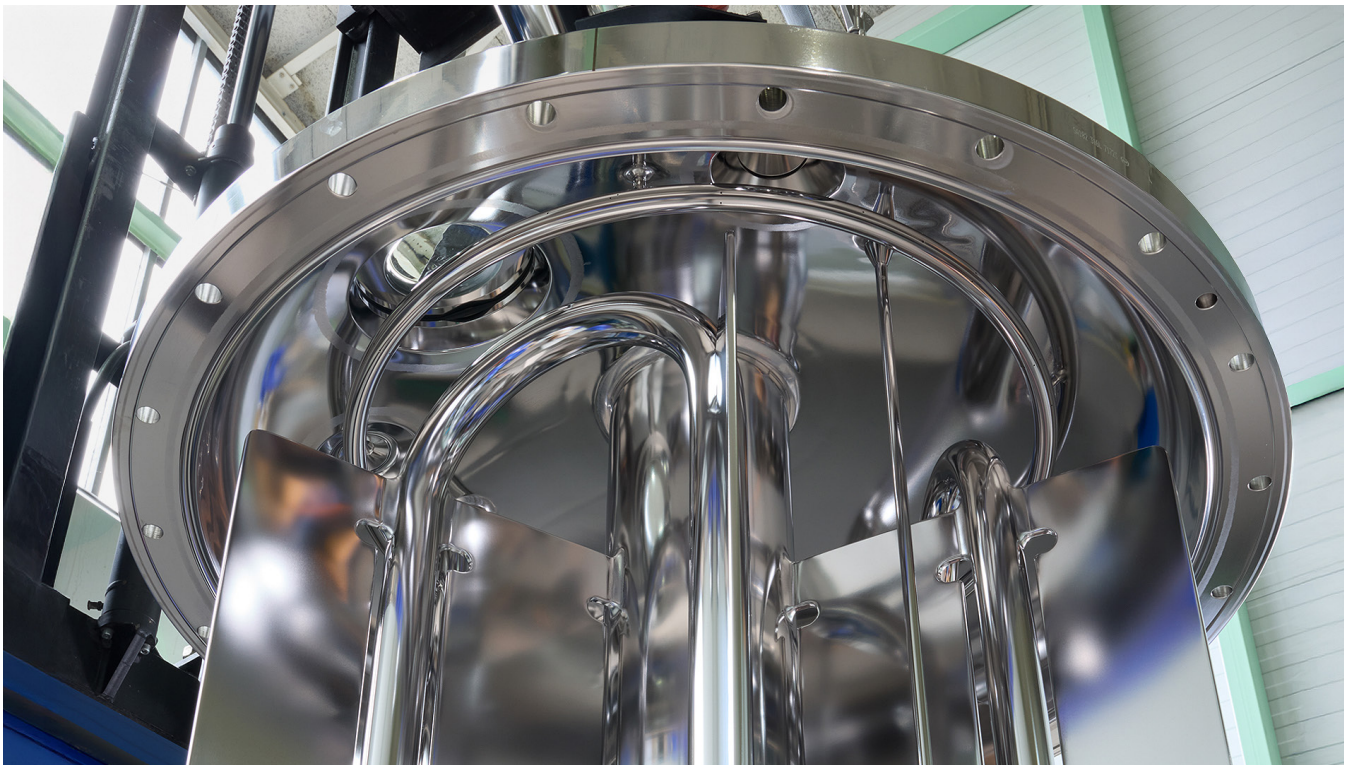

Professional Grinding of Product-Contacting Stainless Steel Surfaces and Weld Seams in the Pharmaceutical Industry

In the pharmaceutical and biotechnology industries, the quality of product-contacting stainless steel surfaces, particularly in the area of weld seams, is a critical factor. It plays a key role in ensuring product safety, meeting strict hygienic standards, and maintaining the integrity and cleanability of complex system components that come into contact with the product. Poorly processed surfaces can significantly increase the risk of microbial contamination, reduced cleanability, and localized impurities, posing a serious threat to the entire manufacturing process.

Assessment of Stainless Steel and Weld Seam Surfaces in Product-Contact Areas

In practice, stainless steel and weld seam surfaces in product-contact areas are often specified solely by a maximum permissible roughness value (e.g., Ra ≤ 0.40 µm). However, this purely quantitative specification is not sufficient to ensure full compliance with hygienic and regulatory requirements.

Technical Assessment

Although the Ra-value provides a quantitative measure of surface roughness, it offers only limited insight into the technical and hygienic suitability of the surface, particularly in the case of weld seams. To ensure consistently high surface quality, additional criteria related to the processing method and grinding procedure are required. The following aspects are essential in this context:

1. Grinding Methodology

The surface quality is largely determined by the grinding technique applied. To avoid thermal damage, material distortion, or changes to the microstructure of the stainless steel, the following key factors must be considered:

- **Use of sharp abrasive materials** to achieve a uniform grinding pattern and minimize the risk of smearing or material buildup.
- **Limitation of contact pressure** during grinding to prevent excessive heat generation and surface deformation.
- **Prevention of surface overheating** through intermittent grinding.
- **Application of the cross-grinding method** (where feasible), which is one of the most effective techniques for producing high-quality stainless steel surfaces. It ensures a consistent, fine, and smooth finish that enhances both cleanability and hygiene, while also improving the material's corrosion resistance.
- **No use of grinding pastes or oils.**

2. Defined Grinding Process
A clearly defined grinding process that gradually refines the surface structure is essential. The following stepwise approach has proven effective:

- **Pre-grinding** with grit size 80–120 to remove coarse irregularities and weld protrusions.
- **Intermediate grinding** with grit size 180–240 to further smooth the surface.
- **Fine grinding** up to grit size 320–600, depending on the required final Ra-value, potentially followed by an electropolishing process for further refinement.

3. Grinding of Weld Seams
Proper grinding of weld seams in product-contact areas is essential to meet hygienic and regulatory requirements. In addition to selecting appropriate grinding techniques and following a defined grinding process, special attention must be paid to achieving a smooth, seamless transition between the weld seam and the base material. Undercutting (i.e., grinding below the level of the surrounding surface) must be strictly avoided, as it can lead to local depressions, crevice formation, and consequently to cleaning issues and an increased risk of contamination. The objective is a seamless, tangential transition zone that meets the required surface specifications both visually and through measurement.

4. Suitable Abrasive Materials for Stainless Steel
When working with stainless steels of material group 1.4404 (AISI 316L) or comparable austenitic grades, only abrasives specifically recommended for this application should be used.

5. Electropolished Surface
A technically flawless electropolished surface can only be achieved if the preceding grinding work has been carried out carefully and professionally. If the grinding process is not properly executed, any defects will become clearly visible after electropolishing and will compromise the surface quality. Therefore, precise surface preparation is the key to achieving an ideal electropolished finish that also meets the pharmaceutical industry's stringent requirements for hygiene, corrosion resistance, and cleanability.

Summary

Defining a roughness limit alone is not sufficient to meet regulatory and hygienic requirements. Only the combination of a quantitative surface specification with quality-assured processing methods and a controlled selection of abrasives ensures that product-contact surfaces reliably comply with the requirements of hygienic design, cleanability, and GMP compliance.

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