

# An Introduction to Technical Cleanliness Inspection

Component cleanliness is an integral part of industrial manufacturing processes

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The cleanliness of components and parts is at the center of most industrial manufacturing processes, as these components must be free of contaminants to ensure a high-quality finished product. Technical cleanliness inspection involves quality control, process management, and manufacturing departments taking samples from the production line and utilizing particle extraction through filter membranes to quantify contaminants that may affect the performance, lifetime, and reliability of final products.

## **What are the basics of technical cleanliness?**

The growing complexity of today's technical products, especially within the aerospace, automotive, heavy equipment, and electrical engineering industries, has resulted in an increasingly high demand for product reliability and quality assurance. The durability and life cycle of a finished product depends on a number of characteristics, all of which contribute to its measurable technical cleanliness:

- Quality and characteristics of the product material
- Fitting tolerances
- Overall cleanliness of a surface or particle load

## **How does technical cleanliness affect a product's reliability?**

Product contamination, which usually occurs during manufacturing but can also be the result of storage, cleaning, or handling, has a direct influence on a finished product's reliability and its lifespan. The dangers of unclean surfaces or production liquids can range from function loss to product failure to complete breakdown.

For instance, the coolant flowing through a radiator's tube helps cool an automobile's engine. If contaminants are left inside the tube when a radiator is manufactured, it may decrease cooling efficiency and even damage the engine. The inside of the tube must be thoroughly cleaned throughout the manufacturing process, and the cleanliness level rigorously inspected.

Residues on the surface of technical devices used in manufacturing and assembly processes can cause unreliable or poor device performance, downtime in production, or

the waste of materials and energy. Large residue particles (sometimes called “killer particles”) may cause complete function loss. With the ever-decreasing size of system components, smaller residue particles can also cause catastrophic failures and lead to the breakdown of an entire end product.

### **In what application areas is technical cleanliness most important?**

The cleanliness of components and parts is critical to the manufacturing process. Here are a few basic illustrations of the importance of technical cleanliness in relation to specific industries:

- **Heavy machinery:** Because the very large parts that make up a lot of heavy machinery can be difficult to reach and directly inspect, the inspection of these products can become costly. Therefore it is more cost- and time-effective to inspect used oil for particles rather than inspect the machine itself. The status of the oil is an extremely accurate indication of the condition of a machine.
- **Electrical engineering:** If there are particles on an interconnect during the production process, that is an indication that they have not been properly built. The detection of these particles, and subsequent eradication, is a good way to avoid short circuits on printed circuit boards.
- **Automotive:** Within the automotive industry, there are many intricate systems and parts that need to be free from contaminants. These may include ABS systems, fuel injectors, brake calipers, and hydraulic fluid systems. For instance, a diesel injector is a vital, ultra-precision part used in diesel engines. The injector has a small nozzle orifice (50 to 250  $\mu\text{m}$ ) that injects diesel fuel into the engine’s combustion chamber at high pressure. If the nozzle is clogged with contaminants, the engine’s efficiency may decrease, and the engine or injector may be damaged.

### **What is the technical cleanliness inspection process?**

Proper technical cleanliness inspection is based on a clear, established process that utilizes particle extraction on membrane filters to quantify contaminants that directly affect the performance, lifetime, and reliability of finished products. Particles are taken from sample components via flood, squirt, rinse, or ultrasonic bath, and then collected on a membrane filter. Once the filter is dried, it is then inspected using a multi-step inspection process to identify and analyze the contaminants in question. The contaminants are analyzed in accordance with international standards such as ISO 16232 (VDA 19.1) and ISO 4407.

In the case of the diesel injector inspection process, counting the number of contaminant particles is an important method for evaluating the cleanliness of injectors. The

contaminant particles are first removed using a liquid shower or an ultrasonic bath. The washing rinse is then filtered through a membrane to collect the extracted particles, and the filter membrane is dried for the further analysis. Once the sample is fully prepared, the particles trapped on the filter surface are evaluated using a microscope. Once the size and number of particles are quantified, the data must be analyzed and evaluated according to industry standards to determine the injector's technical cleanliness.

### **What kind of system is required to conduct technical cleanliness inspection?**

Technical cleanliness inspection presents a number of unique challenges, including the need to regularly check results during inspection, view multiple particles simultaneously, revise results based on various standards, and quickly circulate results. Designed specifically to address these challenges, the Olympus **CIX100 technical cleanliness inspection system** is a dedicated, turnkey solution for manufacturers that need to maintain high-quality standards regarding the cleanliness of manufactured components.

The CIX100 makes it easy to quickly acquire, process, and document technical cleanliness inspection data while maintaining the highest quality standards. Dedicated, easy-to-use software workflows minimize user action and guarantee reliable data while enabling the detection of reflective and nonreflective particles and contaminants, from 2.5 µm up to 42 mm in a single scan. The system also counts and sorts particles into size classes defined in the inspection configuration.

Operators can review, revise, and recalculate inspection data at any point in the process on a single screen, including live and overview images, with simple-to-use “Delete Particle,” “Split Particle,” and “Merge Particle” software tools. Full-sample views display the complete particle even when the image has been stitched together. Analytical reports that comply with the standard used during analysis can be created as Word documents or PDFs with a single mouse click. There's also an option for digital image zooming.

From extraction, filtration, and weighing, through inspection, review, and reporting, the CIX100 simplifies and optimizes every step of the technical cleanliness inspection process.

The system is intuitively designed to guide users through each step of the process—from extraction, filtration, and weighing through inspection, review, and reporting—so that even novice inspectors can acquire important cleanliness data quickly and easily.

# 清洁度检测技术的简介

零件清洁度是工业制造过程中的一个组成部分

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件和零部件的清洗是大多数工业制造工艺的核心部分，因为这些零部件必须要求没有被污染，从而确保成品的品质。清洁度检测技术包括质量控制、工艺管理和制造部门从生产线上取样并利用滤膜进行颗粒物的提取来量化可能影响最终产品性能、寿命和可靠性的污染物。

### 清洗技术的基本原理是什么？

随着当今技术产品的日益复杂，尤其是在航空航天、汽车、重型设备和电气工程行业，对产品可靠性和质量保证的需求也越来越高。成品的耐用性和生命周期取决于许多特性，所有这些特性都有助于其可测量的清洁度检测技术：

- 产品的品质和特性
- 拟合公差
- 表面或颗粒负载的整体清洁度

### 技术清洁度如何影响产品的可靠性？

产品的污染通常发生在生产过程中，但也可能是储存、清洗或处理不当造成的结果，对成品的可靠性和寿命都有直接影响。不干净的表面或生产中的液体造成的危险可以从功能损失到产品的失败，到完全崩溃。

例如，经过散热器软管流动的冷却剂有助于冷却汽车的发动机。如果在制造散热器时污染物残留在软管内，可能会降低冷却效率，甚至会损坏发动机。软管内部在整个生产过程中必须完全清洁，并严格检测其清洁程度。

在制造和装配过程中使用的技术设备表面的残留物会导致不可靠或设备性能不佳、生产暂停或材料和能源的浪费。大量残留颗粒(有时称为“致命粒子”)可能导致完全的功能丧失。随着系统组件尺寸的不断减小，较小的残留颗粒也会导致灾难性的故障，从而毁掉整个最终产品。

### 清洁技术在哪些应用领域最重要？

元件和零部件的清洁对制造工艺至关重要。以下是一些有关特定行业清洁技术重要性的基本说明：

- **重型机械:** 由于组成很多重型机械的非常大的部件很难摸到和直接检查，这些产品的检查可能会变得昂贵。因此，检测用过的油中的颗粒代替对机器本身进行检查，需要更多的成本和时效。油的状态是机器状况的一个非常准确的指示。
- **电气工程:** 如果在生产过程中存在相互连接的粒子，那说明它们还没有被正确地构建起来。检测这些粒子以及随后的根除，是避免印刷电路板短路的好方法。

•**汽车行业:**在汽车产业中，有许多复杂的系统和零部件需要清除污染物。这可能包括 ABS 系统，喷油器，制动卡钳和液压流体系统。例如，柴油机喷油器是一种用于柴油机中十分重要的超精密零件。喷油器有一个小的喷嘴 (50 - 250 $\mu\text{m}$ )，在高压力的环境下注入柴油到发动机的燃烧室。如果喷嘴被污染物堵塞，发动机的效率会降低，发动机或喷油器可能会损坏。

### 什么是颗粒清洁度检测技术?

合适的颗粒清洁度检测技术是建立在一个明确的、已建立的工艺之上，它利用滤膜进行颗粒提取来量化检测直接影响成品的性能、寿命和可靠性的污染物。颗粒物能通过水、水枪、漂洗或超声波槽从样品部件中提取出来，然后收集在一个滤膜上。当滤膜经过干燥后，再使用一个多步骤的检测仪器来识别和分析有问题的污染物。对污染物的分析是符合国际标准，如 ISO 16232(VDA 19.1)和 ISO 4407。

在柴油机的喷油器检测过程中，计算污染物颗粒的数量是评价喷油器清洁度的重要方法。首先是使用液体喷头或超声波槽来冲洗污染物颗粒。然后通过漂洗提取出来的颗粒物收集在一片滤膜上，滤膜干燥后进行进一步的分析。当样品充分准备好，留在滤膜表面的颗粒物将使用显微镜对其进行评估。当颗粒物的大小和数量都被量化，就必须根据行业标准对数据进行分析 and 评估，以确定喷油器的表面清洁度。