TECHNICAL PAPER

Real Time Process Monitoring

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Real Time Process Monitoring

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A common approach to controlling contamination in high technology manufacturing cleanrooms is the continuous monitoring of particles. Either dedicated, discrete, “real-time” particle counters or a multi-port pneumatic manifold system to sample multiple locations throughout the cleanroom can be used to accomplish this goal.

These approaches will give a good indication of overall particle contamination in the cleanroom but may be difficult to correlate to product yields. As manufacturing moves to greater levels of automation, products are becoming more and more isolated from the general cleanroom. Cleanroom particle counts, though important, may not have correlation with product failure, so this data is becoming less critical. The future is with process monitoring. Obtaining the sample close to the product is the key. Close sampling allows for direct correlation to hard defects, yield hits, and particle contamination.

The idea is to bring the monitoring location as close to the product as possible. It is often impossible to get close because of physical limitations such as robotic movement, isolation technology, or human limitations. Some different techniques to monitor effectively within a minienvironment will be discussed in a different paper.

In addition, when monitoring processes, the critical nature of contamination requires a fast response to events. A few particles can have such a detrimental effect on yields that it is not prudent to wait for human intervention.

How long does it take for a person to (a) notice an event, and (b) take corrective action? If individuals are left to decide, then the human factor will come into play. Production supervisors may not allow a tool or line to be shut down when contamination occurs because they feel pressure to keep throughput high. Conversely, Quality Assurance may push to have immediate action taken. The example below illustrates how one company harnesses hard data to determine shutdowns automatically.

A high tech manufacturer implemented a real time monitoring system on its production lines. Its production staff is able to track each product as it flows through the product cycle. At the same time, it is possible to see the real time particle contamination at each tool. Should a defect occur on their products, the first step is to analyze the data for the production run. Looking back to the real time data would show which process contributed to the contamination. A spike would be seen at one tool or another.

Analysis was done on the data and compared to which products had hard defects. A trigger limit was determined based on the optimal yield. This goes far beyond traditional classification limit settings based on ISO 14464-1 or Federal Standard 209E cleanroom standards. These industry standards are useful for the design and construction of the general cleanroom but should not be used to setup limits for specific processes.

In the real world, each process and each product may require different tolerances for airborne particles. Industry standards may serve as guides to initial settings but the data—and ultimately the acceptable yield—are the true guides to a final trigger limit. In the case at hand, production staff was able to apply Six Sigma rules to establish optimal limits based on well-founded empirical data.

Their next step was to determine the time and cost of a product build cycle. Production staff determined that they wanted to do an automatic shutdown of certain tools when contamination limits were exceeded. This avoided human intervention or denial of events. The real time monitoring system was connected to their manufacturing system, which tracked all parts throughout the facility. Because a typical sample time for a particle counter is anywhere from 1 to 10 minutes, a data point represents the sum of all contamination during that time. Thus, the real time system enabled this manufacturer to identify and flag all parts produced during the 10 minutes immediately preceding the trigger event under analysis.

This process has enabled a drastic reduction in the Defective Parts Per Million. Many factors contributed to the overall reduction, but the most critical factor was implementation of real time process monitoring of contamination.