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PARTICLE MONITORING IN HIGH PRESSURE GAS LINES

In today's high-technology manufacturing processes, there are numerous procedures demanding minimal levels of particle contamination. Continuous monitoring reveals process improvements within manufacturing environments that transcend minimum thresholds, which leads to cleaner processes. Standard clean practices include particle monitoring to manage and reduce particle contamination. These practices require particle monitoring at multiple levels to identify existing particles, restrict the introduction of new particles, and prevent the generation of new particles. The benefits of particle monitoring enhance product yields, through reduction of particle contamination, and identifying problems before a catastrophic particle event.

Pharmaceutical and semiconductor manufacturers frequently use clean gases for process materials and manufacturing operations. These gases can be inert, flammable, or toxic, and normally transported at pressures ranging from slightly above ambient at 14.7 pounds-force per square inch gauge (psig) up to a few hundred psig. Process gases must be pure and meet acceptable levels of particulate cleanliness, so the optimal method to certify these requirements is through particle monitoring. High purity gases used in manufacturing processes require particle measurements less than 10 particles per cubic foot (@ standard temperature and pressure) in size ranging from 0.1µm to 0.2 µm. Particle Measuring Systems offers several instruments capable of sensing particles at 0.1 µm entrained in pressures up to 150 psig. Additionally, Particle Measuring Systems' instruments employ nonintrusive monitoring for various inert, reactive, and flammable gases.

When removing samples from a compressed gas line, the particle content must not be affected. Unfortunately, the simple act of extracting and testing a gas sample could result in particle loss, with greater losses occurring for particles above 1.0 or 2.0µm. These particle losses occur with airflow disturbances and commonly seen when using sampling devices such as nozzles, valves, sample lines, etc. Due to the inherent inertia of particulate material, the particle trajectory in the sampling system departs from the airflow path, resulting in deposition of particles on the sampling device's inner wall. Therefore, particle monitoring requires isokinetic sampling or nonintrusive measurements. Conversely, if a sample line must reduce the pressure for the particle sample, losses of larger particles will occur during the reduced pressure range. In this situation, measurements are restricted to particles less than 2.0~3.0 µm. Furthermore, monitoring toxic or flammable gases cannot allow leakage or venting to the environment, so the system requires nonintrusive observation or positive retention of side-stream sample lines.

Currently, SEMI standards have published numerous documents regarding particle specifications for specific clean gases. These standards discuss maximum particle concentrations at threshold size, verification methods, and particle measurement ranging from 0.02 to 0.2 µm.

Measuring particles at line pressure and with high sensitivity requires the Particle Measuring Systems' HPGP or Micro-LPC-101-HP (MLPC-101-HP) particle counters. The HPGP works in conjunction with a PDS-PA, a separate microprocessor-based data system, and the PDS-PA can accommodate two HPGP probes. The MLPC-101-HP incorporates the particle counter and the data system in one unit. However, the MLPC-101-HP cannot sample reactive gases, but the HPGP can sample reactive gases.

Gas Particle Counter Specifications

	Size Range (µm)	***Operating Pressure (psig)***	***Flow Rate***
HPGP-101	0.1 ~ 5.0	40 ~ 150	0.1 CFM
MICRO LPC-101-HP	0.1 ~ 5.0	40 ~ 150	0.1 CFM

Measuring particles in a compressed gas line with a standard particle counter requires a Particle Measuring Systems' pressure diffuser. The pressure diffuser, known as a high-pressure

diffuser (HPD), can reduce the gas line pressures to ambient levels and send the reduced pressure sample into the particle counter. Remember, install isokinetic sampling within the compressed gas line, but expect particles larger than 2.0 µm to be lost in the flow control system.

When installing a sample probe, minimize losses by installing a straight sample tube into an elbow within the high-pressure line. The sample tube must face in opposition to the flow. Do not install a curved pitot tube into the high-pressure line. Connect the sample probe's other end—the exhaust—to the pressure diffuser. **DO NOT USE THIS METHOD WITH HAZARDOUS GASES**. Using this method allows measurement of particles as small as 0.1 µm, but requires a Particle Measuring Systems' HPD and an appropriate particle counter.

Again, if the system requires side-stream particle monitoring, use the appropriate HPGP or MLPC-101-HP particle counter. Since the HPGP's design incorporates a containment vessel, the HPGP is the best choice for flammable or reactive gases. If the gases are inert, the MLPC-101-HP offers the best solution.

Application Note No. 6
Last Updated 11/04
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