

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 identification of problems before a catastrophic particle event occurs.

Pharmaceutical, semiconductor, and aerospace companies 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 (at standard temperature and pressure) in sizes ranging from 0.1 μm 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 2.0 μm . These particle losses occur with airflow disturbances and are 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, several standards describe particle specifications for clean gases. These standards provide guidelines for maximum particle concentrations at different threshold sizes, verification methods, and particle measurements in process gases.

Particle measurements are based upon the gas pressure. If the pressurized process gas lines are $\geq 10^5$ Pa, the preferred particle detection starts at 0.003 μm (3 nm) and should use a condensation nucleus counter (CNC) for particle counting. If the pressures are $\leq 10^5$ Pa, the preferred particle detection is 0.2 μm (or smaller) and should use an optical particle counter (OPC) for particle counting.

Measuring particles at line pressure with an OPC requires a high-sensitivity instrument like the Particle Measuring Systems HPGP-101-C or MLPC-101-HP particle counters. The HPGP works in conjunction with a PDS-PA, which is a separate microprocessor-based data system. The PDS-PA can accommodate two HPGP probes. The MLPC-101-HP integrates the particle counter and the data system in one unit. The HPGP is separate from the data system because it can sample reactive gases, and it is often placed in somewhat volatile locations. The MLPC-101-HP cannot sample reactive gases, so damage to both the counter and data system is not a concern.

Gas Particle Counter Specifications

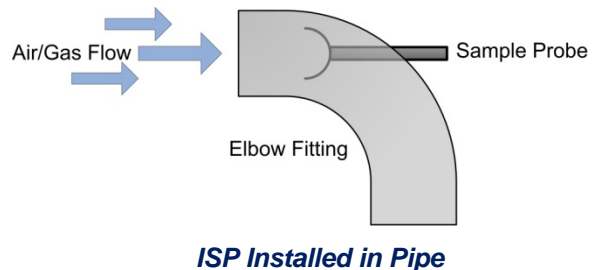
	Size Range (μm)	Operating Pressure (psig)	Flow Rate
HPGP-101-C	0.1 ~ 5.0	40 ~ 150	0.1 CFM
MICRO LPC-101-HP	0.1 ~ 5.0	40 ~ 150	0.1 CFM

Measuring particles in a compressed gas line with a standard particle counter requires a high-pressure

diffuser (HPD). Particle Measuring Systems provides different types of HPDs, depending upon the particle counter's sample flow requirements. The HPD can reduce gas line pressures to ambient levels and send the reduced pressure sample into the particle counter.

Regardless of the particle counter, the sampling probe inside the gas stream should sample gas *isokinetically*. In brief, isokinetic sampling occurs when the probe's sampling velocity closely matches the air/gas velocity. Even with careful isokinetic sample probe (ISP) design and installation, particle losses can occur because, often, particles larger than 2.0 μm settle within the flow control system.

Minimizing particle losses is achieved by installing the probe, attached to a straight sample tube, into an elbow within the high-pressure line. The sample tube must face in opposition to the flow. Connect the sample probe's other end—the exhaust—to the pressure diffuser. Using this installation method provides accurate measurement of particles as small as 0.1 μm with a Particle Measuring Systems HPGP-101-C or MLCP-101-HP. Alternatively, an HPD with an appropriate airborne particle counter can provide similar benefits.



DO NOT USE THIS METHOD WITH HAZARDOUS GASES, AND DO NOT INSTALL CURVED “PITOT” TUBES INTO HIGH-PRESSURE LINES.

If the system requires side-stream particle monitoring, use the appropriate HPGP-101-C or MLPC-101-HP gas 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.

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