

Cleanroom Gas Sampling Using a Particle Counter

by Jason Kelly

Cleanroom Gas Sampling using a Particle Counter

Author: Jason Kelly Vice President of Lighthouse Worldwide Solutions

Testing of compressed gases is a GMP requirement when such gases are used in cleanroom applications. It is critical for such testing to occur since product process zones in ISO 5 cleanrooms and zones require tight control on contamination and compressed gases used may also if not checked correctly be an avenue for particulate contamination that may affect the quality and safety of sterile products.

ISO 14644-1 states the required air cleanliness for different classes of cleanrooms based on a cubic meter sample of air taken at given locations. The result is compared to a table which validates the cleanroom ISO class. Testing gas lines mitigates against adding another source of cleanroom contamination that may impact on the cleanroom maintaining its set classification based on operating conditions. For example ISO 14644-1 requires a cleanroom to have the following limits per cubic meter of air sampled.

ISO Class (N)	Maximum allowable concentrations (particles/m ³) for particles equal to and greater than the considered sizes, shown below					
	≥ 0.1µm (m ³)	≥ 0.2µm (m ³)	≥ 0.3µm (m ³)	≥ 0.5µm (m ³)	≥ 1.0µm (m ³)	≥ 5.0µm (m ³)
ISO 1	10 ^a	d	d	d	d	e
ISO 2	100	24 ^a	10 ^a	d	d	e
ISO 3	1,000	237	102	35 ^a	d	e
ISO 4	10,000	2,370	1,020	352	83 ^a	e
ISO 5	100,000	23,700	10,200	3,520	832	d,e,f
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293
ISO 7	c	c	c	352,000	83,200	2,930
ISO 8	c	c	c	3,520,000	832,000	29,300
ISO 9 ^a	c	c	c	35,200,000	8,320,000	293,000

In the Pharmaceutical Industry sterile processing mainly occurs in cleanrooms with an ISO 5 classification. Therefore the particle concentration should be below the limits for the sizes tested. If 0.5µm and 1.0µm particles were tested using a particle counter then the limit for each size would be 3,520 and 832 respectively per location. *The number of locations are based on a lookup table (outlined in ISO 14644-1:2015) and the size of the cleanroom. If all sample locations are below the particle sizes per cubic meter at each sample then the cleanroom would be classified as an ISO 5 cleanroom.

If there was a contaminated gas line then there is potential for the introduction of the gas to contaminate the room further and potentially fail the ISO 5 classification and this could lead to a risk of product safety and quality. ISO 8573 is a standard to follow when testing gas lines. There are several parts to ISO 8573 but parts 4 and 7 refer to particulate contamination. ISO 8573-1:2010 outlines the maximum number of particulates per m³ similar to same concept as ISO 14644-1:2015.

ISO 8573 – Part 4;

- (1) Provides a method for sampling compressed air
- (2) A guide for choosing suitable measuring equipment to determine its particle size and concentration by number
- (3) Establishes a minimum sampling volume of 1000L (1m³)

(4) Use of Optical Particle Counter for testing sizes from ≥ 0.1 to $\leq 10\mu\text{m}$

ISO 8573-1: 2010 table for Solid Particle Classes

For Example Class 5 with particle diameter $0.5 < d \leq 5.0\mu\text{m}$ the expected maximum number of particles per m^3 sample should be less than 100,000 for Class 4 that value would be $\leq 10,000$. Class 3 it would be ≤ 1000 and Class 2 would be ≤ 100 and Class 1 would be ≤ 10 .

ISO8573-1:2010 CLASS	Solid Particulate			
	Maximum number of particles per m^3			Mass Concentration mg/m^3
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron	
0	As specified by the equipment user or supplier			
1	$\leq 20,000$	≤ 400	≤ 10	-
2	$\leq 400,000$	$\leq 6,000$	≤ 100	-
3	-	$\leq 90,000$	$\leq 1,000$	-
4	-	-	$\leq 10,000$	-
5	-	-	$\leq 100,000$	-
6	-	-	-	≤ 5
7	-	-	-	5 - 10
8	-	-	-	-
9	-	-	-	-
X	-	-	-	> 10

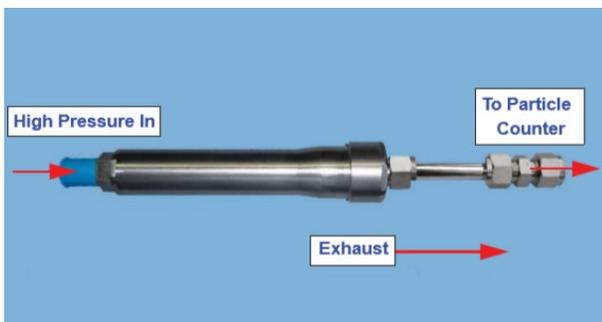
Using an Optical Particle Counter (ISO 8573-4)

- Isokinetic sampling should be maintained (High Pressure Diffuser if particle diameter is $> 1\mu\text{m}$)
- OPC Particle size range $0.1\mu\text{m}$ to $5\mu\text{m}$
- Sample Report to include;
 - Sterile or non-sterile statement
 - Date of sampling
 - Date of measurements
 - Location

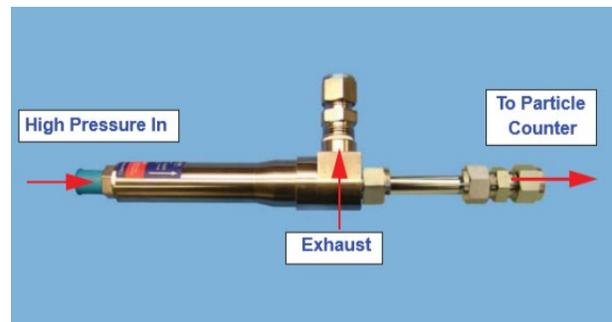
Using a Particle Counter to sample compressed gas lines

A particle counter will need an accessory called a High Pressure Diffuser (HPD). The HPD connects between the particle counter and the compressed gas line. The HPD is an accessory that must be used to diffuse the gas pressure before the gas enters the particle counter sample inlet. If the high pressured gas enters the particle counter sample inlet without the HPD then the sensor inside the particle counter can be damaged and the results of the testing will not be accurate. There are two types of HPD's offered by Lighthouse Worldwide Solutions (1) Vented Return HPD (2) Ported Exhaust HPD. Where compressed gases such as air are to be tested the vented return HPD can be used as this type vents the gas into the environment it is being tested. If testing a gas where it is undesirable to vent into the test environment the ported exhaust HPD should be used and the gas should be safely vented outside the test environment.

(1) Vented Return HPD

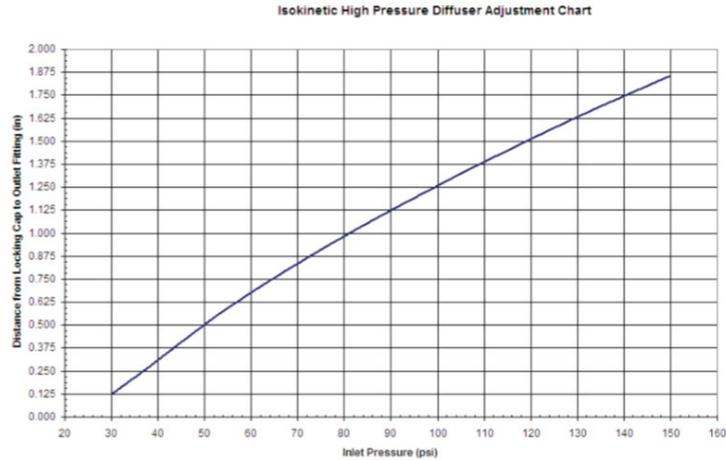


(2) Ported Exhaust HPD



Another critical step to take when using the HPD is to try to match the flowrate of the particle counter used to test the compressed gas.

Setting the proper air flow depending on the HDP and Particle Counter model is necessary in order to verify the system is setup correctly and the results are as accurate as they can be based on iso-kinetic sampling. Iso-kinetic sampling maintains the correct airstream and also with the right pressure enables the particle counter to maintain the right flow rate as the flow rate is critical to the accuracy of the sample results. The table below outlines the correct HPD adaptor adjustment based on the inlet pressure of the compressed gas to be sampled to maintain ideal flow into the particle counter for accurate sampling.



Particle Counter and HPD setup for compressed air sampling

The HPD connects between the compressed gas line and the particle counter based on the diagram below. Care should be taken to make sure adaptor fittings are tight and the gas line is free from any leakage. If the gas needs to be vented away from the test environment for safety reasons then a HPD with a ported vent should be used. Care must be taken to make sure the flow direction from gas to particle counter is followed correctly.

