Sampling Compressed Gases Using the TSI AeroTrak™+ Portable Particle Counter A100 Series

Application Note CC-120 (US)
Rev B

Introduction

Compressed air is used abundantly in pharmaceutical and electronics cleanrooms. Some uses of compressed gases include de-dusting, spray-coating tablets, over-pressurizing mixing and holding tanks, driving liquids through fill lines and filters, and operating control valves. However, compressed gases can be a source of contamination if not sufficiently clean. Leading facilities will therefore routinely test their compressed gases.

Measuring the cleanliness of compressed gas is challenging. The high pressure of a compressed gas system can overwhelm a particle counter, forcing more air through the particle counter than it was designed for. The higher flow rate will cause errors in the particle measurements and could even damage the particle counter. Gases also have different densities, but particle counters are generally calibrated for sampling air. This results in an inaccurate result because, unless corrected for, the sample volume is incorrect.

To obtain accurate particle counts for a compressed gas requires two considerations:

- Reducing the flow rate using a high-pressure diffuser
- Correcting for the specific gravity of the gas being sampled

Selecting a High Pressure Diffuser

Gas pressures above ambient room pressure require the use of pressure-reducing equipment specifically designed for particle counting applications. TSI High Pressure Diffusers (HPDs) allow sampling with a particle counter of non-reactive gas with pressures up to 120 PSI (8.3 bar) without introducing contaminants into the sample.

There are two TSI HPD models that can be used with the AeroTrak+ Portable Particle Counter A100 Series. The Model 7960 HPD is suitable for use for most gases, being used with sample flow rates of 1 CFM, 50 LPM and 100 LPM.

However, for sampling very low humidity gases used in electronic manufacturing, the TSI Model 7955 HPD must be used. This is because extremely dry air can abrade the fan and optics of the particle counter. The Model 7955 HPD uses HEPA-filtered room air to add moisture to the sampled air to allow the air to flow smoothly, without damaging the particle counter. It can only be used with a sample flow rate of 1 CFM.

Correcting for Specific Gravity

Particle counters are calibrated to measure volumetric flow based on a specific gas, normally air. If other gases are sampled, the results will not reflect the programmed sample volume because of varying gas densities. Specific gravity, also known as relative density, of gases is defined as the ratio of the density of the gas to the density of the air at a specified temperature and pressure.

Specific Gravity can be calculated as

$SG = \rho_{gas} / \rho_{air}$

where
SG = specific gravity of gas
ρ_{gas} = density of gas [kg/m3]
ρ_{air} = density of air (normally at NTP - 1.204 [kg/m3])

NTP - Normal Temperature and Pressure - defined as 20oC (293.15 K, 68oF) and
1 atm (101.325 kN/m2, 101.325 kPa, 14.7 psia, 0 psig, 30 in Hg, 760 torr)

Molecular weights can be used to calculate specific gravity if the densities of the gas and the air are evaluated at the same pressure and temperature. (Source: https://www.engineeringtoolbox.com/density-specific-weight-gravity-d_290.html)

Depending on the flow control method of the particle counter, a gas sample other than air can be normalized to the correct result for the actual sample volume desired by use of a correction factor based on specific gravity. For example, a 1 cubic foot sample result for nitrogen taken in a particle counter calibrated for air would have to be multiplied by 0.972 to obtain the equivalent result if an actual cubic foot of nitrogen is sampled. Because the particle counter is flow calibrated to the density of air, it would actually be taking a slightly larger sample of nitrogen because of the lower density of nitrogen.

Other gases have similar correction factors, some larger or smaller, depending on the actual gas density. The AeroTrak+ Portable Particle Counter A100 Series can automatically apply the applicable correction factor for the gases listed in Table 1.

Table 1: Gas Specific Gravity

Gas	Specific Gravity
Air	1
Argon (Ar)	1.379
Carbon Dioxide (CO_2)	1.519
Nitrogen (N_2)	0.972

To apply the correction factor, simply select the appropriate Sample Gas from the Sample Parameters dropdown menu in the Manual Mode Quick Settings or Monitor Zone creation screens. The selected sample volume is automatically programmed for the selected gas and results are corrected to obtain and accurate result.

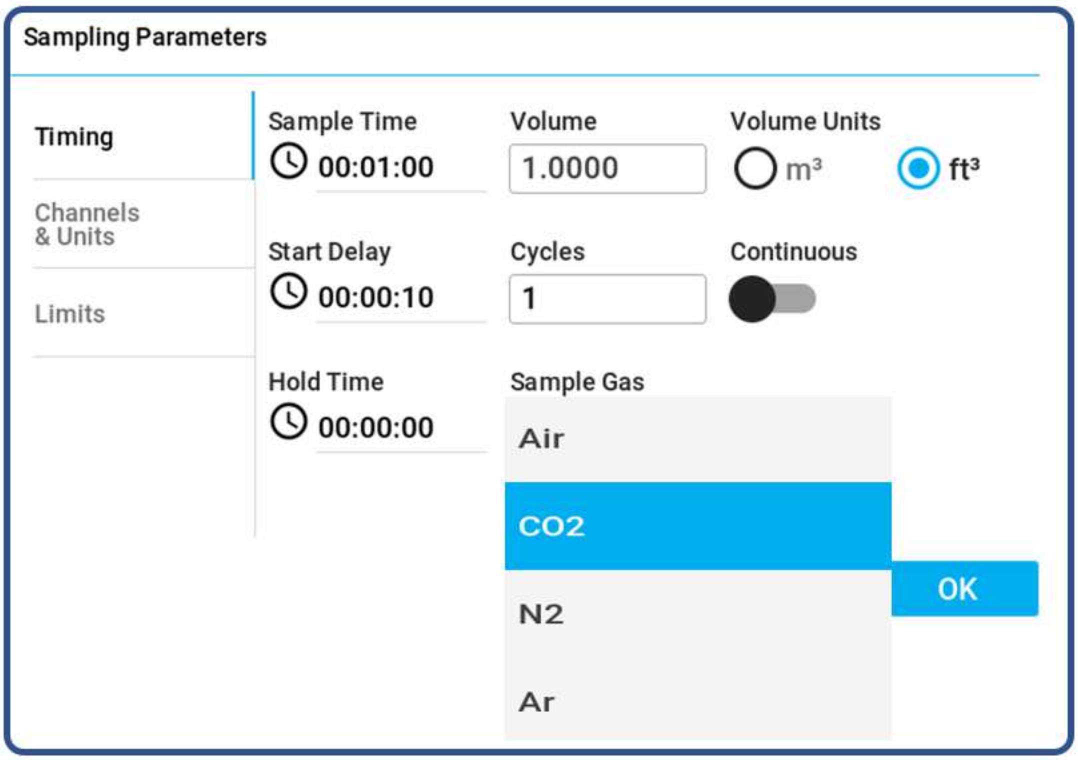

Figure 1 — Selecting a Sample Gas on the Sampling Parameters Screen

Evaluating Results and Industry Standards

Life Sciences and other established cleanroom manufacturing operators typically use cleanroom standards, notably ISO 14644-1, as guidelines for compressed air and gas particulate levels. SEMI E49 contains material pertinent to the electronics/semiconductor industry. ISO 8573 addresses compressed air (but not any other gas) limits and procedures for various types of contamination. The particulate limits for compressed gases in ISO 8573-1:2010 differ from the particulate limits for cleanrooms from ISO 14644-1:2015.

Cleanroom personnel should determine the appropriate particulate contamination limits of compressed air or gas used in a cleanroom based on established risk assessment tools for the process taking place in the cleanroom. Specifying compressed air to be cleaner than the surrounding clean space may not be cost-effective, whereas specifying insufficiently clean air may introduce contamination. For pharmaceutical applications, the US Food and Drug Administration requires compressed gases to be at least as clean as the area into which the gases are introduced.

Knowledge Beyond Measure.

TSI Incorporated – Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 680 1220	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8251 6588
France	**Tel:** +33 4 91 11 87 64	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

CC-120 Rev B (4/25/2023) US Printed in U.S.A