SEMI C6.6-90 (Reapproved 1111)
PARTICLE SPECIFICATION FOR GRADE 10/0.1 NITROGEN (N_2) AND ARGON (Ar) DELIVERED AS PIPELINE GAS

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NOTICE: This Document was reapproved with minor editorial changes.

1 Purpose

1.1 The purposes of this Document are: (1) to set a maximum permissible particle concentration for 10/0.1 grade nitrogen and argon bulk supply gases, and (2) to describe a reference method for its verification.

2 Scope

2.1 This Document applies only to nitrogen gas and argon gas delivered through pipelines; it is not applicable to cylinder gases or gases in their liquid state.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 None.

4 Terminology

4.1 *Abbreviations and Acronyms*

4.1.1 *SCF* — standard cubic feet

4.2 *Variables*

4.2.1 V_{Mi} — volume of the ith sample interval of the pipeline gas.

4.2.2 V_{Bi} — volume of the ith sample interval of the background.

4.2.3 X_{Mi} — concentration of particles observed in the ith sample interval of the pipeline gas.

4.2.4 X_{Bi} — concentration of particles observed in the ith sample interval of the background.

4.2.5 N_M — number of sample intervals of the pipeline gas.

4.2.6 N_B — number of sample intervals of the background.

4.2.7 $\overline{X}_M$ — average observed concentration of counts in the pipeline gas sample.

4.2.8 $\overline{X}_B$ — average observed concentration of background counts.

4.2.9 $\overline{X}_C$ — calculated concentration of particles in the pipeline gas.

4.2.10 S_M — standard deviation of $\overline{X}_M$.

4.2.11 S_B — standard deviation of $\overline{X}_B$.

4.2.12 S_C — standard deviation of $\overline{X}_C$.

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4.3 *Definitions*

4.3.1 *average observed concentration of counts* ($\overline{X}_M$, $\overline{X}_B$) — the average concentration of counts, that is:

$$\overline{X}_M = \frac{\sum X_{Mi}}{N_M} \qquad \overline{X}_B = \frac{\sum X_{Bi}}{N_B} \tag{1}$$

4.3.2 *calculated concentration of particles* ($\overline{X}_C$) — the concentration of particles in the pipeline gas obtained by correcting the observed concentration in the pipeline gas for the observed concentration in the background, that is:

$$\overline{X}_C = \overline{X}_M - \overline{X}_B \tag{2}$$

4.3.3 *gas sample volume* (V_{Mi}, V_{Bi}) — the volume of the sample interval, expressed in standard liters at standard conditions, 0°C (32°F) and 1.00° atmosphere pressure. Standard cubic feet (SCF) is defined at 21.1°C (70°F) and 1.00° atmosphere pressure.

4.3.4 *particle size/particle diameter* — the optical equivalent diameter as detected by a given light-scattering particle counter.

4.3.5 *standard deviation* (S_M, S_B, S_C) — a statistical measure of the spread of the concentration of the counts or particles. The first two are obtained from the interval and average concentrations and the number of intervals, that is:

$$S_M = \left[\frac{\sum\left(X_{Mi} - \overline{X}_M\right)^2}{\left(N_M - 1\right)}\right]^{1/2} \qquad S_B = \left[\frac{\sum\left(X_{Bi} - \overline{X}_B\right)^2}{\left(N_B - 1\right)}\right]^{1/2} \tag{3}$$

The third is obtained from the first two, that is:

$$S_C = \left(S_M{}^2 + S_B{}^2\right)^{1/2} \tag{4}$$

NOTE 1: These expressions are derived from an assumption of a Gaussian (Normal) distribution.

5 Apparatus

5.1 *Particle Counter* — An instrument suitable for counting particles in gaseous nitrogen or argon with a lower detection limit of 0.1 micrometers or less, based on calibration with polystyrene latex spheres.

5.2 *Pressure Reducer* — An accessory required for counters operated at atmospheric pressure, it should preferably use expansion of the gas through a critical orifice.

6 Test Method

NOTE 2: The details of sampling configuration, measurement procedure, and instrument calibration procedure and frequency must be agreed upon by the user and supplier, taking into account good engineering practice.

6.1 Determine the average observed concentration of counts in the background ($\overline{X}_B$) by passing air, nitrogen or argon, believed to be free of particles of 0.1 micrometers or more in diameter, through the instrument and recording the total number of counts. A suggested assembly for perfoming this test, using a filter which removes particles in this size range, is shown in Figure 1. A method recommended by the instrument manufacturer, such as internal recirculation through a filter, may be substituted for the system shown. Count a minimum of 8 sample intervals, each at least 25 standard liters (0.95 SCF) or 30 minutes, whichever is greater. Calculate $\overline{X}_B$ as defined in § 4. $\overline{X}_B$ must not exceed 2 particles per 25 standard liters.

6.2 The sampling point should be at outlet of system, and sampling lines should be as short as possible.

6.3 A suggested sampling probe configuration for turbulent main line flow is shown in Figure 2. The flow rate in the sampling tube at pipeline pressure should be set so that the mean sampling flow velocity at the probe inlet matches as closely as possible the axial flow velocity in the pipeline. The pitot sampling tube ID should be no less

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