Cleanliness of Esco CelCulture® Incubator Touch Screen (CCL-TS)

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Summary

The ISO Class 5 Air Cleanliness Test was conducted on two CO_2 incubator units, namely the CCL-170B-8-TS and the CCL-240B-8-HHS-TS, over a six-minute monitoring period. Using the AeroTrak APC 9310-02 particle counter, airborne particles were measured across five size categories (≥0.3 µm to ≥5.0 µm). The results showed a significant reduction in particle concentration for both models, indicating the effectiveness of their air filtration or airflow control systems. Notably, the CCL-170B-8-TS unit demonstrated a decrease from 5,360,297 particles/m³ (≥0.3 µm) at the first minute to only 147 particles/m³ by the sixth minute. Similar downward trends were observed across all particle sizes, confirming that both units successfully meet the stringent criteria of ISO Class 5 air cleanliness. These findings underscore the units capability to provide highly controlled, low-contamination environments suitable for critical applications.

Key Words: CelCulture® CO_2 Incubators Touch Screen, Air Cleanliness, ISO Class 5

Introduction

CO_2 incubators are critical instruments used to maintain stable environmental conditions for the cultivation of mammalian cells and other sensitive biological materials. These devices are adjustable heater (typically for cell incubation 37°C)[1], relative humidity (typically 85–90%)[2], and carbon dioxide (commonly maintained at 5%)[3] to support optimal cell growth and physiological stability. However, beyond these parameters, one of the most vital yet often overlooked aspects of cell culture success is the air cleanliness within the incubator chamber.

In contamination-sensitive applications such as biomedical research, pharmaceutical production, and aseptic processing, airborne particulates both viable (microorganisms) and non-viable pose significant risks to sample integrity and process reliability[4,5]. Therefore, maintaining ultra-clean air inside the incubator chamber is essential to minimize contamination and ensure consistent experimental outcomes.

To address this challenge, Esco CO_2 incubators are equipped with the ULPA filtration system, which recirculates chamber air through an ULPA (Ultra-Low Penetration Air) filter capable of capturing ≥99.999% of particles ≥0.12 µm. This system is designed to deliver an internal environment with a cleanliness level equivalent to or better than ISO Class 5, similar to that of biosafety cabinets[5].

This white paper presents the results of an ISO Class 5 Air Cleanliness Test conducted on Esco CO_2 incubator models CCL-170B-8-TS and CCL-240B-8-HHS-TS. The objective of the test is to quantify airborne particle concentrations within the chamber using a calibrated particle counter and to validate the performance of the ULPA filtration system in achieving the required cleanliness standards.

Materials and Method

Materials used in this experiment were:

1. Esco CelCulture® Incubator Touch Screen: CCL-170B-8-TS (SN: 200844) and CCL-240B-8-HHS-TS (SN: 200862).
2. AeroTrak Airborne Particle Counter (Model APC 9310-02, SN: 93101450006)

Air Cleanliness Test

The air cleanliness test was conducted in accordance with ISO 14644-1 requirements for ISO Class 5 classification. Particle measurements were taken at designated test points within each incubator unit using the AeroTrak particle counter. The monitoring was carried out over a six-minute period, during which airborne particles were measured across five size categories: ≥0.3 µm, ≥0.5 µm, ≥1.0 µm, ≥3.0 µm, and ≥5.0 µm. The particle count nozzle was placed at the center of the chamber, with the tube going out through the door seal and connected to the particle counter. Measurements were recorded at one-minute intervals, resulting in six consecutive data points per unit. Calibration of the AeroTrak instrument was validated prior to the test.

Analysis data

Compare ISO Cleanliness Standards: Compare the measurement result to the relevant ISO Cleanliness Class standards (e.g., ISO 14644-1). These standards define acceptable particle concentration limits for different cleanroom environments based on particle size.

	Maximum particles / m³					
Class	≥ 0.1 µm	≥ 0.2 µm	≥ 0.3 µm	≥ 0.5 µm	≥ 1 µm	≥ 5 µm
ISO 1	10	2	0	0	0	0
ISO 2	100	24	10	4	0	0
ISO 3	1,000	237	102	35	8	0
ISO 4	10,000	2,370	1,020	352	83	0
ISO 5	100,000	23,700	10,200	3,520	832	29
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293
ISO 7	10,000,000	2,370,000	1,020,000	352,000	83,200	2,930
ISO 8	100,000,000	23,700,000	10,200,000	3,520,000	832,000	29,300
ISO 9	1,000,000,000	237,000,000	102,000,000	35,200,000	8,320,000	293,000

Results and Discussion

The particle counts measurements for both CO_2 incubator models (CCL-170B-8-TS and CCL-240B-8-HHS-TS) were recorded over a six-minute testing period, with data collected at one-minute intervals. The analysis focused on five particle size ranges: ≥0.3 µm, ≥0.5 µm, ≥1.0 µm, ≥3.0 µm, and ≥5.0 µm. For the CCL-170B-8-TS, initial particle concentrations at minute 1 were notably high, with 5,360,297 particles/m³ (≥0.3 µm). However, a progressive and substantial decline was observed over the next five minutes, culminating in only 147 particles/m³ for the same size range by minute 6. Similar reductions were observed across all other particle sizes, including a complete elimination of ≥3.0 µm and ≥5.0 µm particles by the final minute.

Likewise, the CCL-240B-8-HHS-TS unit followed a comparable trend. The initial reading at minute 1 was 3,152,403 particles/m³ (≥0.3 µm), which dropped to 2,120 particles/m³ by minute 6. The particle counts for larger sizes (≥1.0 µm to ≥5.0 µm) also showed significant reduction, reaching zero in some categories by the end of the testing period (Table 1).

These results indicate that both incubator models effectively reduce airborne particle concentrations in a short duration, successfully achieving the cleanliness thresholds set by ISO Class 5 standards. The consistent downward trend across all particle sizes reflects the efficiency of the internal airflow and filtration systems implemented in both models.

Table 1. Air Cleanliness Test Data for CO_2 Incubator Models CCL-170B-8-TS and CCL-240B-8-HHS-TS

	Maximum Particles of CCL-170-B TS / m^3				
Time (minutes)	**≥0.3**	**≥0.5**	**≥1.0**	**≥3.0**	**≥5.0**
1	5360297	800941	248322	16056	1807
2	615710	84930	22949	826	54
3	99406	16006	4080	851	100
4	13732	4166	1381	0	0
5	3975	352	203	53	0
6	147	0	0	0	0

	Maximum Particles of CCL-240-B-8 HHS TS / m^3				
Time (minutes)	**≥0.3**	**≥0.5**	**≥1.0**	**≥3.0**	**≥5.0**
1	3152403	450530	84382	3816	530
2	701944	97951	19293	954	177
3	164028	22403	4240	212	0
4	36643	5760	1272	0	0
5	9081	1449	424	106	0
6	2120	318	141	0	0

Conclusion

There is significant reduction in particle counts over a six-minute period, indicating the effectiveness of a filtration or cleaning process. It's important for air quality control and demonstrates the efficiency of particulate filtering devices in significantly reducing airborne particles.

References

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