CHARACTERIZATION OF ENTEGRIS CSP-36 AMC FILTER PERFORMANCE FOR HVAC APPLICATIONS IN SEMICONDUCTOR MANUFACTURING FABS

Summary

CSP-36 has been shown to significantly lower ammonia (NH_3) concentrations from the photo-bay ambient, both in tests at Entegris' full-scale testing laboratory and in high volume manufacturing fabs.

Laboratory Testing

Tests were conducted at Entegris' full-scale filter testing facility in Franklin, MA. The facility is equipped with air handling and conditioning equipment to control the flow, temperature, RH and purity of air used during filter evaluation. The testing facility utilizes both trap sampling and an Extraction™ System TMB-150 real-time monitor to measure the levels of NH_3 during the tests. Particle and flow monitoring equipment were used for those portions of the filter characterization. Introduction of NH_3 is controlled to specified levels automatically from a gaseous source. A portion of the filter testing facility is shown in Figure 1.

Figure 2 shows test data with a full size filter at 500 FPM (2,000 CFM, 3,398 m^3/hr.) demonstrating performance in a return air handler (RAH). The data was generated with a challenge of 115 ppbv NH_3. Figure 3 shows the same test data for two filters tested in parallel at 500 FPM to replicate the return air handler performance and one filter at 125 FPM (500 CFM, 850 m^3/hr) to replicate the flow if the filter were placed directly above the HEPA filter in the ceiling grid or in a fan filter unit (FFU) application. The data was used to extrapolate performance at typical wafer fab NH_3 levels, shown in Figure 4.

Figure 1: Full size testing showing two sets of filters at Entegris' Franklin, MA facility during a performance test.

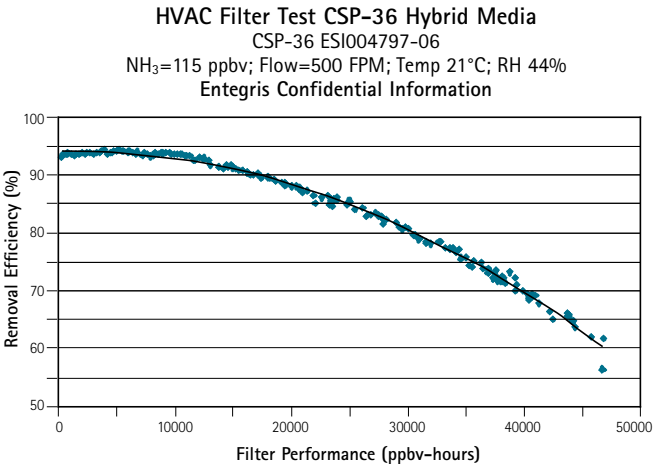

Figure 2: NH_3 test data from full size filter test at 500 FPM replicates performance in a return air handler.

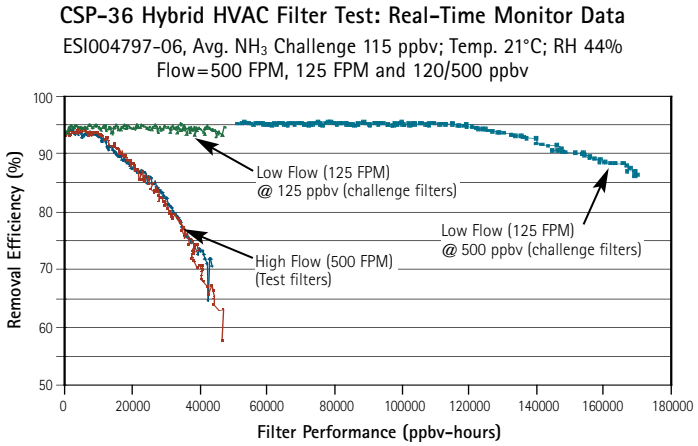

Figure 3: NH_3 test data from full size filter testing at 500 FPM replicates performance in a return air handler and 125 FPM replicating a fan filter unit application. At 50,000 ppbv-hours the NH_3 challenge was increased for the low flow application to accelerate the test.

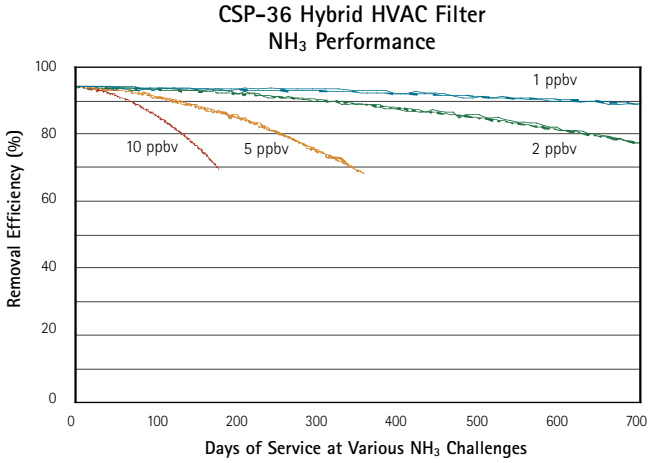

Figure 4: Filter life in a return air handler application at 500 FPM (2,000 CFM, 3,398 m³/hr.) extrapolated using typical cleanroom NH_3 levels.

During testing three samples were taken and analyzed for volatile anions. Data from the three tests were averaged and shown in Table 1. All measured anions were at the reporting limit. Figure 5 displays the pressure drop for CSP-36 filters at various flows.

Anion	Concentration	Anion	Concentration
F^-	<0.1 µg/m³	NO_3^-	<0.1 µg/m³
Cl^-	<0.1 µg/m³	SO_2^{2-}	<0.1 µg/m³
Br^-	<0.1 µg/m³	PO_4^{3-}	<0.1 µg/m³
NO_2^-	<0.2 µg/m³		

Table 1: CSP-36 filter downstream anions at 500 FPM during a 120 ppbv NH_3 challenge, Temp. 21°C, RH 44%. Values are the average of three separate tests.

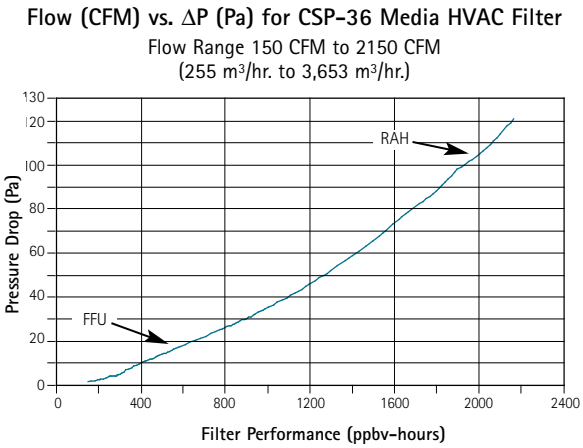

Figure 5: CSP-36 filter pressure drop at various flows.

When NH_3 challenge testing was complete, a HEPA filter was introduced before the CSP-36 filter to protect it from upstream particles during the particle release test. Figure 6 shows data from a PMS particle counter downstream from the CSP-36 filter in the test tunnel fixture. Particle release was recorded at 0.1 µm and larger. The total particle count downstream of the CSP-36 filter was approximately 200. The CSP-36 is recommended for use where a HEPA or ULPA filter is downstream from the filter.

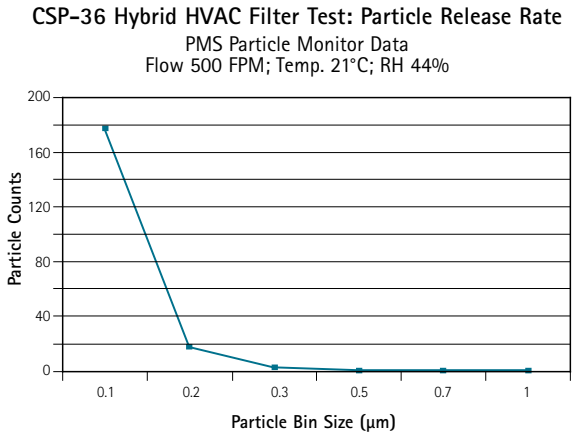

Figure 6: CSP-36 filter particle release data.

Performance of CSP-36 in a photobay was monitored for a year, with periodic sampling combined with post-mortem testing of returned filters. Figure 6 demonstrates the removal efficiency of the filter and the effect of filtration to lower the ambient NH_3 levels in an open ballroom fab design where only the photobay is filtered. Mixing of unfiltered air

from adjacent bays limits the lower level of NH_3 in the photobay. Measuring the filter inlet and outlet demonstrates filter performance. Figure 8 shows data from post-mortem testing. Returned filters are tested with a 50 ppbv NH_3 challenge to measure initial removal efficiency, followed by a 250 ppbv challenge to verify remaining capacity. The two filters verify data from the airborne sampling, with removal efficiencies >90%.

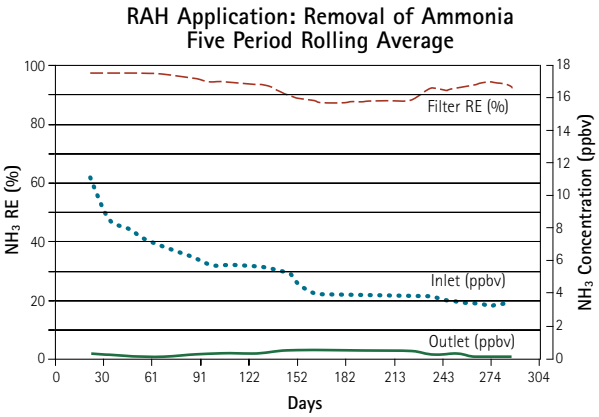

Figure 7: CSP-36 filter performance shows initial photobay ambient NH_3 levels of 11 ppbv dropping to 4 ppbv over a four month period. Filter performance for the eight months is maintained at 90% RE. The lower limit in the photobay is defined by the filter performance and mixing with air from adjacent process bays.

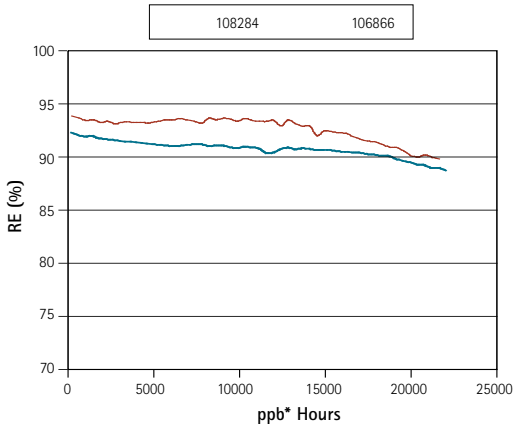

Figure 8: Post-mortem testing of used CSP-36 filters validate field testing and laboratory performance for NH_3 for removal efficiency and remaining capacity.

Additional characterization of CSP-36 was performed for NMP removal. Because NMP is a molecular base, a mixed challenge was used with a ratio of NH_3 to NMP of 5.5:1, which is representative of photobays where NMP is used.

Figure 9 confirms the ability of CSP-36 to remove NMP without degrading NH_3 performance.

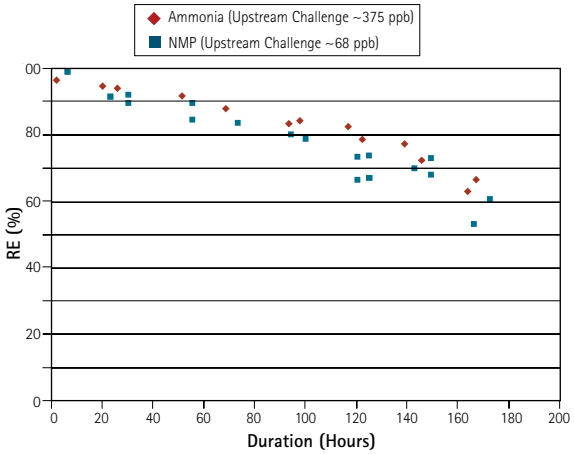

Figure 9: Characterization of CSP-36 performance with a mixed challenge of NH_3 and NMP confirms performance is maintained.

Figure 10: CSP-36 filters in full and half-size format. Filters are also available for header design air handlers and for custom configurations and sizes.

Conclusions

CSP-36 has been characterized both in Entegris' filter testing facility in Franklin, MA and installed in high-volume manufacturing wafer fabs. Performance of the filter for control of NH_3 and NMP shows initial removal efficiency >90%, and life times of up to one year at >70% RE for a continuous challenge of 5 ppbv. CSP-36 filters have been deployed to control photobay ambient levels to prevent exposure tool optics and reticle contamination, t-topping and extend exposure tool and coater/developer filter life.

ENTEGRIS, INC.
Corporate Headquarters
3500 Lyman Boulevard
Chaska, Minnesota 55318 USA
Customer Service Tel. 952-556-4188
Customer Service Fax 952-556-8022
www.entegris.com

Printed in USA
4511-2663ENT-1206

The materials integrity management company