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Technology Care
Protecting Mission Critical Air

Laboratory Report

Multilevel BOOKMARKS are included to facilitate navigation within this document. If the bookmarks are not visible (left side) click the "Bookmarks" tab or F6 key (Adobe Acrobat).

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
Test End (dmy):	**16.01.2020**
Test Length (days):	**17**

Technology Care LLC based in Zurich, Switzerland, is a leading provider of environmental audits and precision cleaning in data centers. For over 25 years, many of the world's largest corporations have relied on our products and services to ensure that their critical environments consistently meet required standards. Our laboratory located in Zurich, Switzerland uses the latest, most innovative technologies to provide analysis of the highest quality. Many of our technologies have been developed in-house and as a result we have been awarded various patents and trademarks. Technology Care LLC is a member of the Swiss Contamination Control Society: SRRT-SwissCCS

Contents

ISO 14644-1:2015 Air Particle Report

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
Test End (dmy):	**16.01.2020**
Test Length (days):	**17**

SCOPE:

Test results correspond to ISO 14644-1:2015 which is a widely accepted standard for qualifying indoor air cleanliness. ISO 14644-1:2015 specifies the classification of air cleanliness in terms of concentration of airborne particles. ASHRAE recommends that data centers maintain ISO 14644-1 Class 8 or lower (see "Gaseous and Particulate Contamination Guidelines For Data Centers" - ashrae.org).

TEST RESULTS:

The average test result during the sampling period corresponds to the following ISO 14644-1 Class:

ISO 14644-1 Class 8

Particle Parameter:	Test Result:	Class Limit:
0.5 Micron/m3	546'941	3,520,000 >=0.5 µm particles/m3 (ISO 14644-1 Class 8)
1.0 Micron/m3	129'277	832,000 >=1µm particles/m3 (ISO 14644-1 Class 8)
5.0 Micron/m3	4'553	29,300 >=5µm particles/m3 (ISO 14644-1 Class 8)

Information:

ISO 14644-1:2015 is an internationally accepted standard that specifies the classification of air cleanliness in terms of the concentration of airborne particles per cubic meter. ISO 14644-1:2015 cannot be used to characterize the physical, chemical, radiological, viable or other nature of airborne particles.

Particle Metrics Report

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
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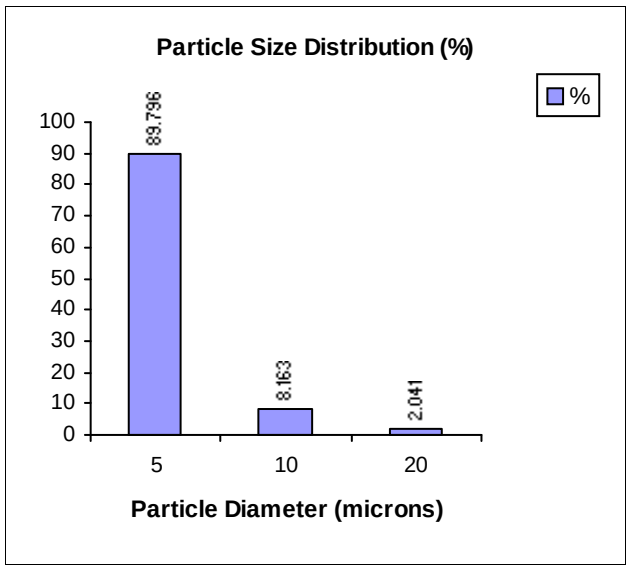
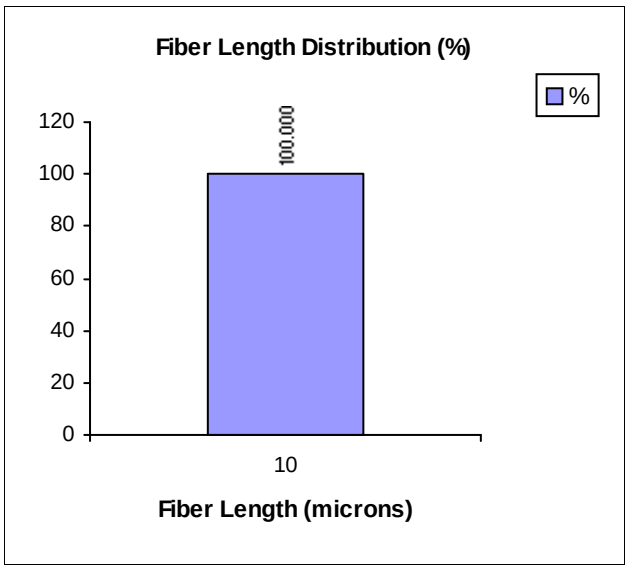
Test Length (days):	**17**

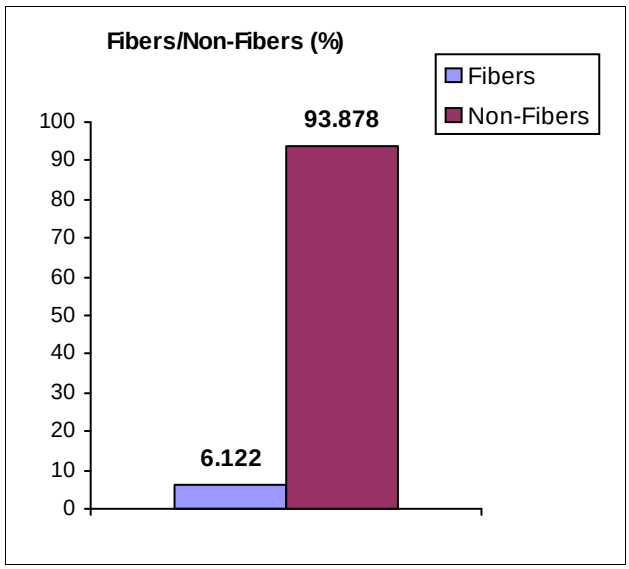
SCOPE:

This report provides comprehensive particle metrics including size and shape. In-depth particle knowledge is invaluable for accessing contamination risks as well as identifying sources of particle contamination and improving air cleanliness.

TEST RESULTS:







ANSI/ISA-71.04-2013 Air Corrosivity Report

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
Test End (dmy):	**16.01.2020**
Test Length (days):	**17**

SCOPE:

Test results correspond to ANSI/ISA-71.04-2013 which is an internationally accepted standard that categorises environmental conditions in relation to the deployment and reliability of electronic equipment. ANSI/ISA-71.04-2013 defines 4 levels of air quality that relate to different rates of reactivity or corrosion of copper and silver: G1, G2, G3 and GX. ASHRAE recommends that data centers maintain Level G1*.

TEST RESULTS:

Copper: 221 Angstroms/30 Days	Test result corresponds to severity level G1 – Mild (European standard EN 60721-3-3 Level 3C1). An environment sufficiently well controlled such that corrosion is not a factor in determining equipment reliability.
Silver: 32 Angstroms/30 Days	Test result corresponds to severity G1 – Mild (European standard EN 60721-3-3 Level 3C1). An environment sufficiently well controlled such that corrosion is not a factor in determining equipment reliability.

INFORMATION:

This report shows the actual amount of corrosion measured on the metal coupons. The corrosion of metals is caused by both gaseous and particle contaminants and is accelerated by heat and moisture. Gases which cause metal corrosion include hydrogen sulfide, sulfur and nitrogen oxides, chlorine and hydrogen fluoride; as well as caustic gases, such as ammonia and oxidizing gases, such as ozone. Particulates which corrode metals include chlorides (salt).

Since metals do not react in the same way, it is important to monitor the corrosion rates of different metals (combination corrosion coupon testing). Copper is particularly sensitive to temperature and humidity (water). It is also more sensitive to hydrogen sulfide (H2S). Silver is less sensitive to humidity and temperature, and it is more sensitive to sulfur dioxide (SO2) than hydrogen sulfide (H2S). Copper coupons cannot detect the presence of chlorine, a particularly dangerous contaminant to metals while silver is sensitive to chlorine. Iron (Fe) is particularly sensitive to humidity and aluminium is very sensitive to chlorides (salt).

Metal corrosion can weaken the integrity of structures and indicate the presence of pollutants that endanger human health. Metal corrosion in electronic equipment can cause needles or nodules to grow out of electronic components including silver solder causing short circuits. Corrosion can also cause metal plated surfaces to flake thereby causing short circuits. Metal corrosion can also cause failure of electrical contacts as well as thermal related failures.

The switch to lead-free (RoHS complliance) manufacturing affects almost all electronic products, and some of the more common materials used as replacements were more sensitive to common atmospheric pollutants than lead-based materials. Manufacturers of industrial process control equipment have used ISA-71.04 since its initial publication for warranty compliance because they understood that their equipment had to be protected due to the corrosive nature of the environments in which it would be used (see “Gaseous and Particulate Contamination Guidelines For Data Centers” – ASHRAE.org).

* Source: "Gaseous and Particulate Contamination Guidelines For Data Centers" - by ASHRAE TC 9.9 (ashrae.org)

Chloride Report

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
Test End (dmy):	**16.01.2020**
Test Length (days):	**17**

SCOPE:

This test is an important indicator for metal corrosion potential caused by contamination which contains chlorides (salt). The test results show the chloride deposition rate as well as the total amount of chlorides collected by the sampler during the sampling period.

TEST RESULTS:

Chloride Deposition Rate: 0.90 years until the limit of 5 ug/cm2 is reached.	Caution. The test result is less than 5 years which is the average life span of IT equipment. This means corrosion may cause equipment to malfunction before reaching the end of it's life cycle.
Total Chloride: 0.2570 ug/cm2	The test result is lower than the limit of 5 µg/cm² for electronic devices and installations.

INFORMATION:

The following chloride limits, relevant in terms of corrosion chemistry, have been established by international organizations* and insurers:

- 10 µg/cm² for buildings and general installations.
- 5 µg/cm² for electronic devices and installations.

Since chloride (salt) corrodes metals, it is recommended that electronic equipment be cleaned or replaced if chloride levels exceed 5 µg/cm2. Possible sources include smoke, chemicals and acids. Elevated levels of chlorides are very serious for a technical installation since they cause severe corrosion of system components, especially when air humidity is higher than 50 RH. Even small amounts of smoke from burning PVC can cause large amounts of chlorides to contaminate equipment components. Chlorides may also be contained in concrete dust. This measurement is particularly important in assessing insurance claims resulting from damages caused by smoke or other particle events.

* Source: “Comparative investigations of corrosive fire gas condensates” EMPA - Swiss Federal Laboratories for Materials Testing and Research.

pH Report

SAMPLER DATA:

Sampler ID:	**130384**
Test Start (dmy):	**30.12.2019**
Test End (dmy):	**16.01.2020**
Test Length (days):	**17**

SCOPE:

This test is an important indicator for metal corrosion potential caused by contamination which is acidic (low pH) or caustic (high pH).The test result shows the pH of the airborne contaminants collected by the sampler during the sampling period.

TEST RESULTS (blue)

pH of contamination: 6.800 pH	Good. pH is within the 5 to 8.5 range and has little corrosive impact on most metals.

Information

When contaminants have a pH between 5 and 8.5, the pH has little corrosive impact on most metals. However, the corrosion rate increases rapidly when the pH is outside of that range. pH levels of 5 or below can lead to extreme corrosion rates and premature pitting of metallic objects. Studies* have shown that even small amounts of low pH (acidic) contaminants can corrode metals.

Metals typically develop a passivation layer with moderately alkaline (high pH) exposure, which lowers the corrosion rate as compared to acidic (low pH) exposure. While the passivation layer provides a measure of immunity to further corrosion, corrosion rates can be expected to be comparable in the transpassive region (i.e. highly alkaline versus highly acidic).

Possible sources of corrosive contaminants include smoke, chemicals and acids. This measurement is particularly important in assessing insurance claims resulting from damages caused by smoke or other particle events. In chemistry, pH is a scale used to specify how acidic or basic a water-based solution is. Acidic solutions have a lower pH, while basic solutions have a higher pH.

* Source: “Comparative investigations of corrosive fire gas condensates” EMPA - Swiss Federal Laboratories for Materials Testing and Research.