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Application Note

Impact of the new EN 17141 on the ISO 14698 Validation of MAS-100® Air Samplers

General Requirements and Validation

The scope of the new norm is to establish the requirements, recommendations and methodology for microbiological contamination control in clean controlled environments. The document is limited to viable microbial contamination and refers to ISO 14644 about non-viable contamination. ISO 14698 is valid throughout the rest of the world while EN 17141 2020 will replace it in the European Union.

This application note will evaluate if the new EN 17141 norm will affect the validation requirements of volumetric air samplers described in ISO 14698.

Comparison of EN 17141 and ISO 14698 requirements on microbial air samplers

ISO 14698 requirements for microbial air samplers are more detailed, but generally match the requirements of EN 17141.

The requirements for validation are newly defined in the EN 17141. The supplier of the sampler shall demonstrate the collection efficiency of the sampler, the sampling techniques shall be validated, and the volumetric air flow of the sampler shall be periodically calibrated.

The basis for an efficient microbial air sampler is a good physical and biological efficacy:

"The physical collection efficiency is the cut-off size (d50 value) which defines the aerodynamic equivalent particle diameter size at which the sampler collects 50 % of the particles in the air [12] [13]. The average equivalent diameters of microbe-carrying particles (MCPs) that form the cfu are generally larger than 1 µm and a d50 value smaller than 2 µm is considered appropriate. The d50 value can be calculated for impaction samplers with multiple holes or those using rectangular slits. For active air samplers based on impingement and or cyclonic operational principles, no d50 value can be calculated. For all active microbiological air samplers, the effects of impact stress and the effect of the media dehydration during the sampling period are further considerations.

The physical collection efficiency is influenced by both inlet or extraction efficiency and by separation efficiency. Inlet or extraction efficiency is a function of the inlet design of the sampler and its ability to collect particles from the air in a representative way and transport the particles to the impaction nozzle or the filter. Separation efficiency is the ability of the sampling device to separate and collect particles of different sizes from the air stream by impaction onto the collection medium or into the filter medium. The physical collection efficiency is based on the physical characteristics of the sampling device such as airflow, orifice shape, orifice size and the number of orifices."

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The following table will compare the requirements for sampling devices, especially volumetric microbial air samplers as indicated in EN 17141 and ISO 14698-1.

Table 1. Comparison of requirements for sampling devices and microbial air samplers in EN 17141 and ISO 14698:

Requirements EN 17141	Corresponding Requirements out of ISO 14698
Accessibility into the clean controlled environment for the sampling device	• Ease of cleaning and disinfection or sterilization • Ease of handling (weight, size) and operation (ease of use, auxiliary equipment, dependence on vacuum pumps, water electricity, etc.)
Effect of the sampling device on the process or environment to be monitored	• Disturbance of unidirectional air flow by sampling apparatus • The exhaust air from the sampling apparatus should not contaminate the environment being sampled or be re-aspirated by the device • Possible intrinsic addition of viable particles to the biocontamination to be measured
Efficiency and precision of the sampling method	• Collection accuracy and efficacy
.. a d50 value smaller than 2 µm is considered appropriate … / …For all active microbiological air samplers, the effects of impact stress and the effect of the media dehydration during the sampling period are further considerations	• Appropriate suction flow rate for low levels of viable airborne particles • Appropriate impact/airflow velocity • Sensitivity of the viable particle to the sampling procedure

Requirements and Methods for the Validation of Microbial Air Samplers

The method for a complex validation of microbial air samplers is described in both norms with no significant differences. According to EN 17141 this complex method should be preferably performed by an external competent body and the supplier of the air sampler shall demonstrate the collection efficiency of the microbial air sampler. A re-validation of a qualified instrument is not required.

The method for validation of collection efficiency is separated into the validation of the physical efficiency and the biological efficiency. The physical efficiency demonstrates the ability of the air sampler to collect various particle sizes down small particles sizes, such as 1 µm. The d50 value indicates the particles size at which 50% of the airborne particles are impacted onto the agar surface by the microbial air sampler. The biological efficiency is the ability of the air sampler to safely capture organisms from the air.

A new requirement according to EN 17141 is a defined d50 value of smaller than 2 µm, which was not specified before in the ISO 14698-1.

As an alternative, a simpler method is added to the complex method in order to allow on-site validation. This method is a side-by-side comparison against an already qualified air sampler that has been validated to the more complex biological and physical efficiency method. The simplified test should be performed in minimum at two different locations with a contamination level of in minimum 80 cfu/$m^{3.}$ he chosen sampling volume should result in a count of 80 to 150 cfu per plate. A previously qualified instrument or membrane filtration method may be used as a reference.

If using a qualified instrument, which is validated by the supplier according to the described method in Annex E of 17141, an on-site simplified validation as well as a re-qualification is not required.

Validation Results for MAS-100® Microbial Air Samplers

Every variance of air flow, such as flow rates or configuration of the sampling head (e.g. numbers and size of holes of the sieve plate) might influence the physical and biological efficiency of microbial air samplers. Therefore, we validate various instruments of the MAS-100® air sampler family at a competent external body (PHE Biosafety group in Porton Down), England individually. The qualified instruments are indicated in **figure 1**.

1.

2.

3.

4.

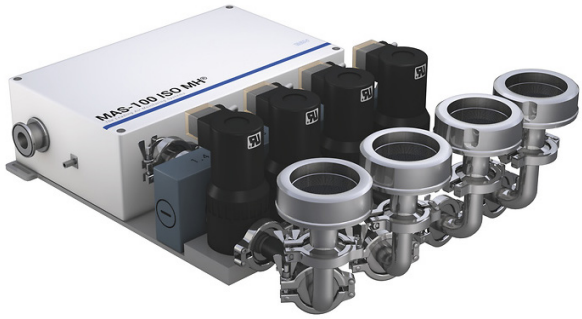

Figure 1. Instruments validated according ISO 14698 and consequently to EN 17141 by an external competent body

1.1. MAS-100 NT® (instrument configuration identical to MAS-100 NT® with filter and MAS-100 NT Ex® with or without filter)

1.2. MAS-100 VF®

1.3. MAS-100 Iso NT®

1.4. MAS-100 Iso MH® (2 separate validations for either 1 m or 9 m tube length between sampling head and control unit)

The validation of the physical efficiency takes place in test room of 20 m^3 with turbulent air. The test sampler and reference membrane filtration device are positioned in the same distance and height from the spinning top aerosol generator. Washed spores of *Bacillus atrophaeus* NCTC 10073 are mixed with different concentrations of potassium iodide in order to achieve the various particles sizes. The spores are distributed homogeneously using spinning top aerosol generator to the sampling devices. As culture medium TSA w. LTHTh - ICR_{plus} (reference number 1466830020) plates are used. After sampling, the filter is transferred on to culture medium plates and all plates are incubated. Afterwards the CFU are counted and the recovery rate for each particles size is calculated.

The test results of the validation of physical efficiency of the instruments show a d50 value of less than 1 µm for all test samplers **(see figure 2)**. The test results are comparable for all tested instruments and are better than the calculated values. The calculated d50 of the tested microbial air samplers is 1.1 µm at a flow rate of 100 liter/min and using a sieve plate with 300 x 0.6 mm holes.

The biological efficiency is validated against a Casella Slit Sampler and the results are indicated in **figure 3**. The biological efficiency is calculated by the recovery of the ratio of cfu of a mixture of *Bacillus atrophaeus* NCTC 10073 spores and *Staphylococcus epidermidis* NCTC 11047.

Biological efficiency = Ratio of SE/BA sampled by test device/Ratio of SE/BA sampled by Casella Slit sampler x100

The biological efficiciency of the MAS-100® air samplers is indicated in figure 3. For all tested MAS-100® microbial air samplers, the biological efficiency is above 70%.

The full test reports can be reviewed during an audit.

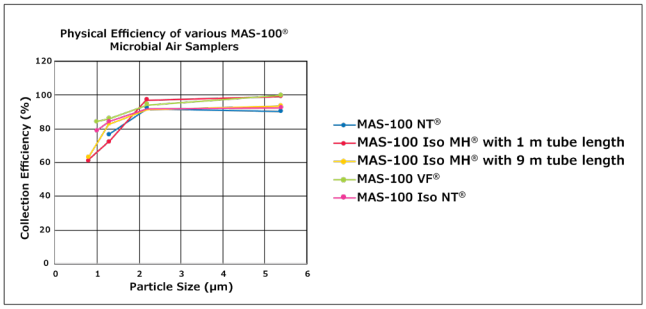

Figure 2. Test results of physical efficiency for various MAS-100® microbial air samplers

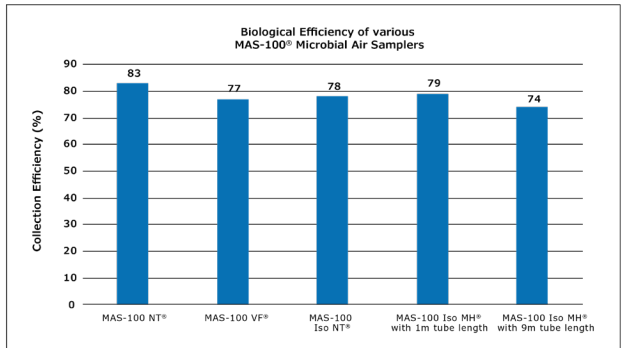

Figure 3. Test results of biological efficiency of various MAS-100® microbial air samplers

Conclusion

The requirements for volumetric microbial air samplers do not differ significantly between the EN 17141 and ISO 14698-1. They should provide accurate and reliable results.

The MAS-100 NT, MAS-100 VF, MAS-100 Iso NT® and the MAS-100 Iso MH® have been validated according to the requirements of ISO 14698-1 and consequently to EN 17141 by an external competent body.

The physical efficiency is comparable for all tested instruments and provide a d50 value of less than 1 µm. The biological efficiency is above 70% compared to a Casella Slit Sampler.

According to the validation results a re-qualification of these instruments is not required.

References

- EN 17141 (2020): Cleanrooms and associated controlled environments - Biocontamination control
- ISO 14698-1 (2003): Cleanrooms and associated controlled environments - Biocontamination control - Part 1: General principles and methods
- Physical and Biological Efficiency Testing of MAS-100 VF® - Techniques described in ISO 14698-1: Report No. 14/013 A (2015) - (PHE Biosafety group in Porton Down)
- Physical and Biological Efficiency Testing of MAS-100 Iso MH® - 1m - Techniques described in ISO 14698-1: Report No. 14/013 B (2015) - (PHE Biosafety group in Porton Down)
- Physical and Biological Efficiency Testing of MAS-100 Iso MH® - 9m - Techniques described in ISO 14698-1: Report No. 14/013 C (2015) - (PHE Biosafety group in Porton Down)
- Physical and Biological Efficiency Testing of MAS-100 Iso NT® - Techniques described in ISO 14698-1: Report No. 14/013 D (2015) - (PHE Biosafety group in Porton Down)
- Physical and Biological Efficiency Testing of MAS-100 NT® - Techniques described in ISO 14698-1: Report No. 14/013 E (2015) - (PHE Biosafety group in Porton Down)

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