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Eckernförde,

Final Report

Hygiene Inspection (limited to single production and storage rooms)

Contents:

1 Plant overview

cooling chamber meat:	room temperature [°C]:	3 to 5,5
room 1	room humidity [%]:	80 to 84
	vaporiser cooler escape 85% at 4°C	
	room volume: approx. 100 m³	
	ozone concentration after 2 h with „APM“ (UV-C-ozone generator on packed products): 1,1 ppm prior 0 ppm	
salting room 2:	room temperature [°C]:	4
	room humidity [%]:	85
cooling chamber room 3:	room temperature [°C]:	1
	room humidity [%]:	84
vitrine counter/sale:	room temperature [°C]:	6
room 4	room humidity [%]:	41
ambient air	temperature [°C]:	2,2
	humidity [%]:	68

1.1 Plant in refrigerating area

cooling chamber meat R1

R1 MP01: compartment air, cooler working, approx. 1m high **prior to UV-C-ozone treatment**

R1 MP06: compartment air, cooler working, approx. 1m high **after UV-C-ozone treatment**

R1 MP02: supply air escape, cooler working, approx. 2m high

salting room R2

R2 MP03: compartment air, approx. 1m high (air sample)

cooling chamber R3

R3 MP04: compartment air, approx. 1m high (air sample)

vitrine counter/sale R4

R4 MP05: Compartment air approx. 0,7 m high (air sample)

2 Preliminary notes to the hygiene inspection

Ventilation and air conditioning of interiors by room air-technical (RLT) plants requires a high degree of operational safety in terms of technical and hygienic precautions.
RLT plants, operated using a major portion of circulating air, are particularly susceptible to germination. Microbial growth is favoured by the accumulation of organic deposits in the canal sections as well as by residual moisture.
Besides being a constructional effective plant, which main criterion must be the avoidance of humidity, examination in form of a **hygiene inspection** has to be performed in regular intervals. Found deficiencies and lacks of the air cooler must lead to appropriate cleaning, disinfection and a corrective maintenance. The Association of German Engineers (VDI) offers guidelines (no. 6022) as assistance, applicable when all air conducting components of an RLT plant are properly designed, operated and maintained in order to guarantee the prevention of an additional load caused by pollutants or inorganic and organic impurities.

3 Hygiene inspection contents

Space-oriented hygiene inspection covers the following key activities:

- inspection of the productive enterprise (just several single rooms were measured and examined)
- visual inspection and description of hygiene-relevant, visually perceivable deficiencies on plant components
- withdrawal of air samples in previously specified locations.

4 Microbiological examination

4.1 Airborne germ examination

4.1.1 Mensural methodology

Sampling of air-polluting fungal spores was done according to impaction techniques (Desaga GS100), in particular DG18-Agar for mould fungus / yeasts and CASO-Agar for bacteria. Thus obtained loaded nutrient solutions were incubated during a period of 7 days at 25 °C (mould fungus / yeasts) and 2 days at 30 °C (bacteria). Formed colonies were counted several times until consistency.

4.1.2 Results

Fig. 1: Concentration of fungal spores in air samples

Sample Labelling	Sample Volume [l]	Temp. [°C]	Relative Humidity [%]	CFU*/m³	Notes
R1 MP01	100	5,5	84	150	prior to ozone
R1 MP06	100	5,5	80	0	after ozone, reduction approx.100%
R1 MP02	100	3	85	220	vaporiser escape
R2 MP03	100	4	85	120	
R3 MP04	100	1	84	130	
R4 MP05	100	6	41	140	
Ambient air	100	2,2	68	10	

* CFU = colony forming units

Fig. 2: Concentration of bacteria in air samples

Sample Labelling	Sample Volume [l]	Temp. [°C]	Relative Humidity [%]	CFU*/m³	Notes
R1 MP01	100	5,5	84	940	prior to ozone
R1 MP06	100	5,5	80	20	after ozone, reduction approx.98%
R1 MP02	100	3	85	1200	vaporiser escape
R2 MP03	100	4	85	350	
R3 MP04	100	1	84	420	
R4 MP05	100	6	41	410	
Ambient air	100	2,2	68	230	

* CFU = colony forming units

4.1.3 Evaluation standards

When evaluating supply and compartment air, respectively, the following evaluation standards were applied. The concentration of microorganisms found in supply and compartment air strongly depends on

ambient air. Germinal concentration in ambient air is, however, subject to major seasonal fluctuations. Therefore using absolute values in order to evaluate the measured germinal concentration is not recommendable. A reliable reference in terms of germination can be considered the appearance of a significantly increased germinal concentration in compartment air compared to the concentration measured in ambient air. But even when only a minor germinal concentration in compartment air is registered the source of the germs can nevertheless eventually be recognised. Just very few microorganisms are generally released from such a source and tend to dominate the compartment air, while only minor concentrations (or even no germinal pollution at all) can be found in ambient air.
An analytical research of the microbiological composition of the compartment air and a subsequent comparison to the genera of microorganisms registered the ambient air allows therefore an unequivocal reference to germinal pollution within the building.
The evaluation criteria appearing on the following table are derived from the mould fungus reference manual by the German Federal Office for Environment Protection (Federal Office for Environment Protection, ed.; reference manual concerning prevention, examination, evaluation and decontamination of mould fungus growth in interiors; 2002).

Fig. 3: Evaluation aid for mould fungus in supply air samples

Supply air parameters	**mould fungus growth in RLT plant improbable**	**mould fungus growth in RLT plant eventually possible**	**mould fungus growth in RLT plant probable**
Fungus genera that could reach major concentrations in ambient air (e.g. Cladosporium, Alternaria, Botrytis, yeasts)	If the number of CFU/m³ of a genus registered in supply air doesn't exceed 0,2x to 0,5x the value found in ambient air	If the number of CFU/m³ of a genus registered in supply air doesn't exceed 0,7x to 1,2x the value found in ambient air	If the number of CFU/m³ of a genus registered in supply air exceeds 1x the value found in ambient air
Sum of CFU/m³ for ambient air untypical genera	If the difference between the CFU sum of for ambient air untypical genera found in supply air minus the ambient air value lies below 0 CFU/m³	If the difference between the CFU sum of for amb. air untypical genera found in supply air minus the amb. air value lies below 50 to (100) CFU/m³	If the difference between the CFU sum of for amb. air untypical genera found in supply air minus the amb. air value exceeds 50 (100) CFU/m³
One sort of genus untypical for ambient air	If the difference between supply air and amb. air concerning an amb. air untypical genus doesn't exceed 0 CFU/m³	If the difference between supply air and amb. air concerning an amb. air untypical genus doesn't exceed 20 (up to 50) CFU/m³	If the difference between supply air and amb. air concerning an amb. air untypical genus doesn't exceed 20 (50) CFU/m³

For relative classification of bacteriological compartment air measurements the EU (COMMISSION OF THE EUROPEAN COMMUNITIES [1993])[2] provides the following references.

Fig. 4: Categories of different degrees of bacteriological air pollution

Category [2]	Tenements [2] (CFU*/m^3)	Offices, schools [2] (CFU*/m^3)	Production enterprises (CFU*/m^3)
very low	< 100	< 50	<10
low	< 500	< 100	<50
average	< 2.500	< 500	<150
high	< 10.000	< 2.000	<500
very high	> 10.000	> 2.000	>500

* CFU = colony forming units

2 COMMISSION OF THE EUROPEAN COMMUNITIES (1993): Indoor Air Quality and its Impact on Man; Report no. 12, Biological Particles in Indoor Environment, EUR 14988 EN

4.1.4 Evaluation

Bacteria and mould fungus concentration found in ambient air is 10 KbE/m³ and 230 KbE/m³, respectively. In comparison to this mould fungus concentration in room no. 1 is almost 22 times higher. In room no. 1 bacteriological concentration exceeds 5 times the value registered in ambient air.
This clearly shows the appearance of germination inside the building. It becomes clear that mainly condensers but also other parts such as suspension track conveyors, door seals and damaged packings are directly involved in this major problem.

Compared to this UV-C -Ozone treatment of the air led to a total elimination of mould fungus after operating the APM for a period of 2 hours. The concentration of bacteria was reduced from an initial value of 940 to 20 CFU/m³, which corresponds to a reduction rate of 98%.

5 Recommendations

Concentration of germs and bacteria in air can be subject to significant fluctuations. In particular performed activities and sampling conditions inside the room affect in a very decisive way the concentration found in interiors. Particularly noticeable fluctuations are possible when doing short-time measurements, due the fact that they only represent sort of snap-shots and germs never appear uniformly distributed in an area.
Concentration of bacteria in the compartment air partially lay considerably over the measured values in the ambient air samples.
Compartment air quality did not meet the hygiene requirements conform to the guidelines in VDI 6022 sheet 3 (hygiene requirements for room air-technical plants, production enterprises). Concentrations were partially about 15 times higher than recommended.
Major compartment air concentration of mould fungus and bacteria, compared to ambient air, points to a source located inside the building. Condensers but also porous joints, dirty suspension track conveyors, etc. are probably involved in the problem. Condensation water, discharged through the outflow, merges with compartment air's dust forming a residual product that gets accumulated in the drain pan. Slime mould found there led to the major concentrations of bacteria.

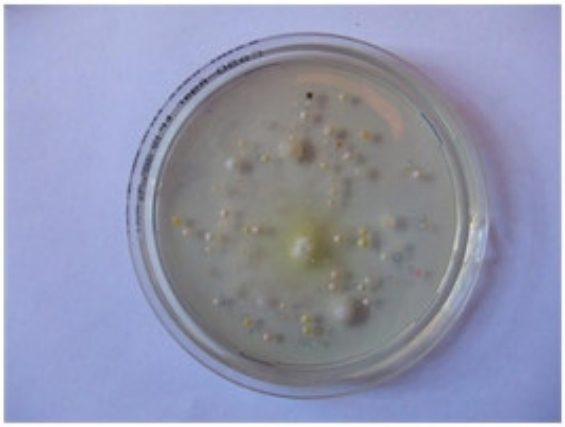
To avoid this VDI 6022 guidelines e.g. demand that heat exchangers should be designed in order to be easy to clean and, eventually, to disinfect. The drain pain necessarily has to be properly accessible to allow cleaning and disinfection (see cover air cooler finished product delivery). In addition, heat exchangers and related accessories must be periodically revised (conform to VDI every 3 months) regarding air-related soiling, corrosion and damage. Even slight soiling has to be necessarily cleaned. An exhaustive cleaning of the condensate collectors is essential (conform to VDI 6022 every 6 months, ideally every 3 months).

Due the relatively high concentration of germs in compartment air, compared to the values measured in ambient air, it is recommended to perform a complete cleaning of all condensers, door seals and technical installations such as suspension track conveyors, repeating this procedure every 6 months. When registering warm humid atmospheric conditions, e.g. in autumn, the low ambient air concentrations increase, impacting on internal air. The results of the UV-C/ozone treatment show however clearly that this kind of reduction offers an optimal solution in accordance to the germs found in this company; therefore UV-C technique with ozone treatment should be taken into consideration as a possibility for a long-term solution. Ozone concentration must be controlled to accomplish industrial safety and food hygiene regulations.

6 Photographic documentation

Fig. 5: Pictures of the nutrient solution

Bacteria (R1 MP01) prior to ozone



Bacteria (R1 MP06) after ozone