MICROBIOLOGICAL CONTAMINATION AND CLEANING OF BALANCE TANKS

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ABSTRACT
The Swimming pool operator of Cologne (KölnBäder GmbH) and the local water laboratory (RheinEnergie AG) developed a suitable and effective approach for self-control, which is simple and economical. Reliable microbiological results could be shown by using agar contact plates (RODAC plates) for determination of the bacterial colony count. A microbiological culture medium (Caso agar), which enables the detection of a wide variety of heterotrophic bacteria, proved to be the most suitable means for the investigation of balance tanks. An evidence of the cleaning efficiency was a reduction of the bacterial count by one order of magnitude or more. The control of the cleaning efficiency was carried out by application of one contact plate per wall side before and after the cleaning. In about 50% of the cases the balance tanks could be rated as „clean" already before the cleaning process. Further 40% of the cases showed a significant cleaning effect. It is discussed, whether the required cleaning frequency should depend on further variables (e.g. structural wall composition, cleaning procedure, disinfection conditions, contamination of bathing water).

Keywords	Balance tank, microbiological contamination, cleaning control, cleaning frequency

1. INTRODUCTION

A balance tank serves as buffer for the polluted swimming pool water, which flows from the pool to the water treatment system. With time, pollutants are deposited on the walls of the tank and stay there as nutrients for biofilm organisms. To prevent additional contamination of the circulating water through bacteria, balance tanks should be cleaned regularly. In most German baths such a cleaning procedure takes place once a year. The water is drained, deposits on the ground are removed and the walls are cleaned mechanically and chemically. Although the regular cleaning of balance tanks itself is a requirement in Germany (DIN 19643-1, 1997), existing regulations actually do not contain clear instructions for the cleaning procedure or the microbiological check of the cleaning efficiency.

2. METHODS

2.1 CONTACT PLATE METHOD (SQUEEZE METHOD)

Agar contact plates, also known as RODAC plates (viz. Replicate Organism Detection and Counting), are suitable instruments for the estimation of the microbiological colony count on smooth surfaces (DIN 10113-3, 1997). For this purpose, Petri dishes with a surface of 25 cm^2 are used; they contain a sterile growth medium (solidified with agar). The surface of an opened Petri dish is pressed evenly for approximately 10 seconds on the surface, which shall be tested (in order to transfer the microorganisms). The Petri dish is covered with their lid and incubated subsequently (at 37°C / 48 hrs in the present study). On the lower surface of the transparent Petri dishes is a Grid network, which enables the evaluation.

The contact plate method is semi-quantitative, indicating the number of Microorganisms present on a surface, which grow under defined experimental conditions (composition of growth medium and temperature) in presence of atmospheric oxygen.

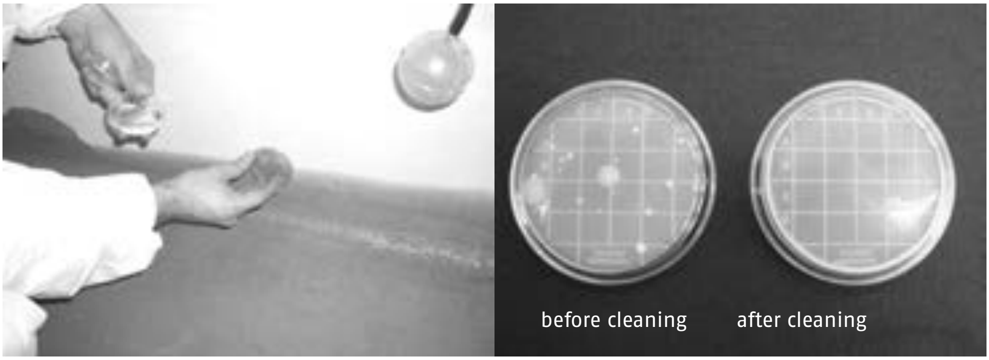

Figure 1 Pictures of the application (left) and evaluation (right) of contact plates (Caso agar)

2.2 CHOICE OF CULTURE MEDIUM

The composition of both growth medium and incubation temperature determines which groups of transferred microorganisms will be able to develop. The growth medium must be selected in such a way that differences before and after the cleaning process become recognizable, because plates with more than 200 colonies/cm^2 are not evaluable. With strongly contaminated surfaces it may be advisable to choose a selective medium that only seizes a specific part of the microbiological spectrum. On the other hand, the growth medium should not be too selective. If only very few colonies are able to grow the influence of the cleaning is not seized. For this reason, three different media were tested:

- Caso agar, an universal culture medium, which enables the detection of a wide variety of heterotrophic bacteria;
- Cetrimid agar, a selective culture medium to detect *Pseudomonas aruginosa*;
- Chromocult agar, a selective culture medium to detect *E. coli* and Coliformes.

Preliminary investigations showed that the use of Caso agar was an improvement. The cleaning efficiency could be proved with a reduction of the bacterial count by one order of magnitude or more. However, it was not possible to detect *Pseudomonas aruginosa* (Cetrimid agar) or *E. coli* and Coliformes (Chromocult agar) on the walls of the balance tanks. Thus, the further cleaning control investigations were restricted to Caso agar. Cetrimid agar was used additionally to determine whether balance tanks might be an area within the pool circulation where *Pseudomonas aeruginosa* is able to multiply. This question was interesting, because Pseudomonas aeruginosa grows in biofilms and can cause skin, ear and eye infections when present in large numbers and outbreaks of skin infections have been attributed to swimming pools.

2.3 SAMPLING AND MONITORING PROGRAM

The control of the cleaning efficiency was carried out by application of two contact plates (Caso agar and Cetrimid agar) per wall side of the balance tank (right, left, front-side, back-side) before and after the cleaning. The sampling takes place at a humid, smooth wall side of the container. Particularly on concrete walls with partial strong relief a suitable sample place must be selected carefully. Since the investigation material must be applied under sterile conditions and with a constant pressure, the sampling cannot be accomplished from outside, e.g. with the help of a bar. Working in a balance tank is listed under 'working in confined space regulations' and should only be done by qualified persons.

3. INVESTIGATION CONDITIONS

39 balance tanks were investigated before and after cleaning (312 samples, 156 data pairs for each parameter). Most of the tanks (plastic or uncoated concrete) are associated with indoor pools, only few with outdoor pools.

3.1 CLEANING CONDITIONS

For cleaning an alkaline cleaning agent (pH 10,6) is rubbed on the walls with brushes in horizontal and vertical direction. The cleaning agent contains a biocidal disinfectant (didecyledimethyleammonium-chloride, a quaternary ammonium compound). The impact time is at least 30 minutes. Subsequently, the cleaning agent is thoroughly rinsed out. Meanwhile, the ground of the tank is cleared.

3.2 OPERATING CONDITIONS

According to German regulations, the water flowing through the tanks has usually a chlorine concentration of 0,3 – 0,6 mg/L. The organic load (as oxygen consuming capacity in mg/L O_2) was always below 2,5 mg/L.

4. RESULTS

Contact plates with Caso agar were well suitable as check parameters of cleaning efficiency of balance tanks, even under the conditions of the present study. Experiences of the last 5 years show that in about 50% of the cases the balance tanks could be rated as "clean" already before the cleaning process. Further 40% of the cases showed a significant cleaning effect.

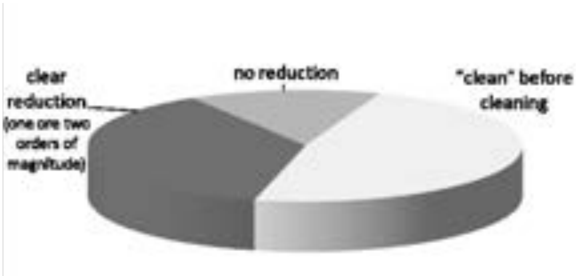

Figure 2 Cleaning efficiency of balance tanks, showed as reduction of the bacterial count (Caso agar; 156 data pairs)

This refers probably to a comparatively small load of the introduced balance tanks. Due to very high colony counts, Caso agar was unsuitable for cleaning control of surfaces in the swimming pool area (e.g. seats, barefoot range, changing rooms) in a similar study (Sakhri, M., 2005). In this case, a selective agar for determination of yeasts and molds (Sabourauld agar) was more useful as a check of the surface disinfection.

Beyond that, it could be shown in the present investigation that balance tanks of indoor pools seems to be cleaner than those of outdoor pools, which are exposed to a higher load of pollutants and to discontinuous disinfection conditions, due to the downtime during the winter break.

The fact that *Pseudomonas aruginosa* (Cetrimid agar) was not detectable on the walls of the tanks points out that the balance tank probably does not have significance as a source of microbiological contamination (specially with biofilm organisms such as *Pseudomonas aeruginosa*) within the circulation system, as it was frequently assumed.

5. CONCLUSIONS

The German swimming pool guidelines (DIN 19643) state that a balance tank should be cleaned and flushed every 6 months. Usually it is practicable, however, only once a year (during the regular revision phase), the complete emptying of the tank is necessary.

Based on the present results the following subjects should be discussed, which factors are suitable, in order to regulate the cleaning frequency of balance tanks:

- Conditions of use and pool water disinfection;
- Cleaning conditions;
- Pollution from bathers and other sources (e.g. biofilms within the pipe work, soil, grass, leaves...);
- Structural composition of walls;
- Periods of downtime.

Further investigations are required to determine the importance of the individual factors for the risk of contamination. If a balance tank in a certain location has been clean for years, it should be possible to reduce its cleaning frequency.

6. REFERENCES

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