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A New Approach to Prevent Waterborne Contamination in Detergent Production

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A New Approach to Prevent Waterborne Contamination in Detergent Production

Introduction

The environmental acceptability of detergents is of significant importance to customers. Properties related to their intended use are required, like grease-dissolving capacity, soil-removal capacity, loosening of lime-scale, etc. but additional criteria like biodegradability, low toxicity and good skin tolerance are also important. Public relation (PR) departments are often choosing to emphasize these additional properties in their communications with consumers.

Readily biodegradable ingredients in water-based preparations constitute optimum nutrient media for microbial growth. This can potentially lead to microbial-induced material destruction, e.g. a decrease in viscosity, the development of odour – or even coatings of mould. All of these examples would render the material unfit for use and un-saleable.

Uninhibited microbial growth in detergents can be reduced or prevented by adding chemical biocides. These substances are necessary for in-can and storage preservation. Strict demands with regard to ecological and toxicological safety concerns have to be followed when using these antimicrobial substances. In some cases, this means many manufacturers refrain from using substances such as halogen-organic compounds like methylchloroisothiazolinone or 2-bromo-2-nitropropane-1,3-diol. These substances are extremely effective, but they are not well accepted from certain consumer magazines like ÖKO TEST.

■ The Source of Contamination

Microbial contamination of detergent can occur during its manufacture. The majority of the contaminants are present in the source of water and in the raw materials as well as in equipment vessels and plumbing lines (tanks and pipes). Certain microorganisms produce biofilms that can adhere to the surfaces of plumbing systems containing water, to processing tanks and to other environments in the factory. These biofilms are in general very resistant to treatment with biocides.

The incoming water in factory pipe systems can originate from various sources. Each source supplies a different, usually specific composition of the organic and inorganic constituents of chemical ingredients in the water. Also, the hardness of the water has an important role. Possible water sources include:

a. Town water from a single public well
b. Town water from various public wells
c. Water from (river) shore filtrates
d. Water from (sea) shore filtrates
e. Water from reservoirs
f. Water from a privately owned source
g. Water from a privately owned well

Ion exchangers are often additional sources of contamination. The ion exchanger resins can be colonised by biofilms which are unharmed even after regeneration with sodium hydroxide solution or hydrochloric acid. An exchanger plant fed with drinking water (organism count <100/ml) often produces demineralised water with a count of 10 000 organisms/ml.

Additional problems arise as a result of intermediate storage of water in tanks where access is usually difficult. Maintenance on these can lapse resulting in them virtually never being cleaned. In some cases they are installed under a roof exposed to warming. During the first use on a Monday morning, water with an organism count of up to 10 million/ml may be used leading to an unacceptable initial organism count in freshly manufactured products. So called 'soft' preservatives, e.g. based on methylisothiazolinone (MIT) in combination with benzisothiazolinone (BIT) can fail under these conditions; their bactericidal efficacy is not strong enough. The slow speed of kill of these kinds of biocides comprise the risks distributing a product throughout the system before the preservative can act against the waterborne contamination.

■ How can the Risk of Contamination Production Water be Eliminated?

The use of chlorinated water for the production of detergents often leads to incompatibilities, e.g. the bleaching of dyes. There is a general recommendation to remove the chlorine before the water is used as process water. If a downstream reverse osmosis system is used, this is essential to ensure an acceptable life time of the filter membranes.
A general weakness of using UV lamps is that bacteria in areas of detached biofilms cannot be killed and therefore directly repeatedly inoculate the bulk batch from the process water.
Due to the fact that the water is also normally used for cleaning purposes, the permanent addition of a chemical preservative to the whole process water is not acceptable from economical and environmental aspects. The recommendation to add a low dosage of the preservative used in the finished product is especially dangerous; a germ flora resistant to the applied preservative will be selected. The use of a fast-acting preservative with long term protection to sanitise the process water used for bulk production directly in the production vessel is a solution to the problem. The killing of bacteria by such a preservative must occur within a few minutes, the very best situation would be before other ingredients are added. **Table 1** shows the recommended production process. The principle of adding the full amount of biocide during the first water addition to the vessel is recommended. The reason is the fact that standing water in pipework can, in extreme cases especially over a weekend, have bacterial counts >10^6 cfu/ml. This principle guarantees the highest biocide concentration for the worst case water quality. Also, in au-

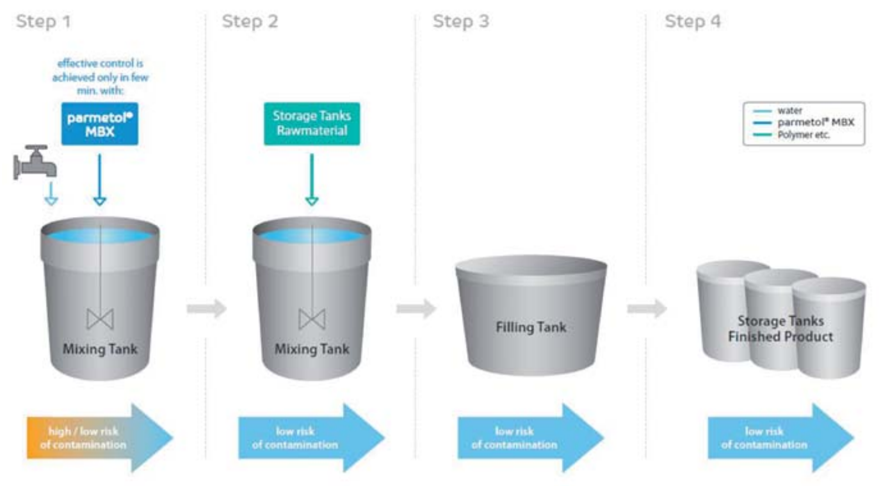

Fig. 1 Recommended process to control waterborne contamination

to blend systems for continuous production the preservative has to be added as the first compound to the water to avoid having unpreserved material in the system **(Fig. 1)**.

■ The New Synergistic Biocide Blend

Quick acting biocides have been known for many years, e.g. the well known combination of dimethylol glycol, methylchloroisothiazolinone and methylisothiazolinone. Because formaldehyde releasers and halogenated organic compounds are not accepted from all eco-labels and test magazines like ÖKO TEST, the challenge is to develop a fast-acting preservative with long term protection based on ingredients accepted from these organisations. Additionally, the actives have to be supported under the Biocidal Product Directive (BPD) for product type 6 (in-can preservatives).
From extensive research work, Bis(3-aminopropyl)dodecylamine (BDA) was recognized as an excellent synergist for today's standard 'soft' preservatives based on methylisothiazolinone (MIT) in combination with benzisothiazolinone (BIT). It is able to markedly reduce the necessary contact time to a few minutes. **Table 1** shows the tested formulations.
Dilutions of the preservatives were prepared using sterile hard water according to the European standard for testing chemical disinfectants and antiseptics. 50 ml portions of the end solutions were each inoculated with 0.5 ml microorganism suspension (initial microorganism count approx. 10^5 cfu/ml) and stirred. As test strains *Pseudomonas aeruginosa* (ATCC 9027), *Escherichia coli* (ATCC 11229), *Candida albicans* (ATCC 10231) as well as a freshly prepared mixture of *Enterobacter gergoviae* (ATCC 33028) *Escherichia coli* (ATCC 11229), *Klebsiella pneumoniae* (ATCC 4352), *Kocuria rhizophila* (ATCC 9341), *Pseudomonas aeruginosa* (ATCC 9027), *Pseudomonas fluorescens* (ATCC 17397), *Pseudomonas putida* (ATCC 12633), *Staphylococcus aureus* (ATCC 6538) were used. These so-

	MIT/BIT **	MIT/BIT/BDA ***
methylisothiazolinone (MIT)	2.5 %	2.5 %
benzisothiazolinone (BIT)	2.5 %	2.5 %
Bis(3-aminopropyl)dodecylamine (BDA)	–	2.7 %

** parmetol® MBS *** parmetol®MBX

Table 1 Tested formulations

lutions were streaked out onto tryptone soya agar (bacteria) or sabouraud-dextrose 4% agar (fungi) after 5, 10, 30 and 60 minutes. The cultures were incubated for 48 hours at 37 °C. The evaluation was made on the basis of semi-quantitative assessment of the microbial growth of the streaks **(Table 2)**.

Within the test period of 60 min the conventional mixture of methylisothiazolinone with benzisothiazolinone (MIT/BIT) showed no efficacy even in high use concentration. In combination with Bis(3-aminopropyl)dodecylamine (MIT/BIT/BDA) a complete sanitation within 5 min was possible. **Fig. 2** shows the results of the germ count reduction test.

Additionally, a quantitative suspension test for the evaluation of bactericidal activity of chemical disinfectants according to EN 1276 in the presence of no organic load was performed. Even under the high germ load in the quantitative suspension with 10^8 cfu/ml test the mixture MIT/BIT/BDA showed good performance. MIT/BIT alone showed no germ count reduction even after 6 hours. The detailed results are shown in **Fig. 3**.

Evaluation	Finding	Germ count/ml
–	no growth	<10
+	slight growth	approx. 10^2
++	moderate growth	approx. 10^3
+++	heavy growth	approx. 10^4
C	surface covered	approx. 10^5

Table 2 Semi-quantitative assessment of the microbial growth of the streaks

■ Summary

The synergistic combination of benzisothiazolone (BIT), methylisothiazolinone (MIT) and bis(3-aminopropyl)dodecylamine (BDA) has a broad spectrum of efficacy. It is a new blend which provides a fast acting and long term effect. It is able

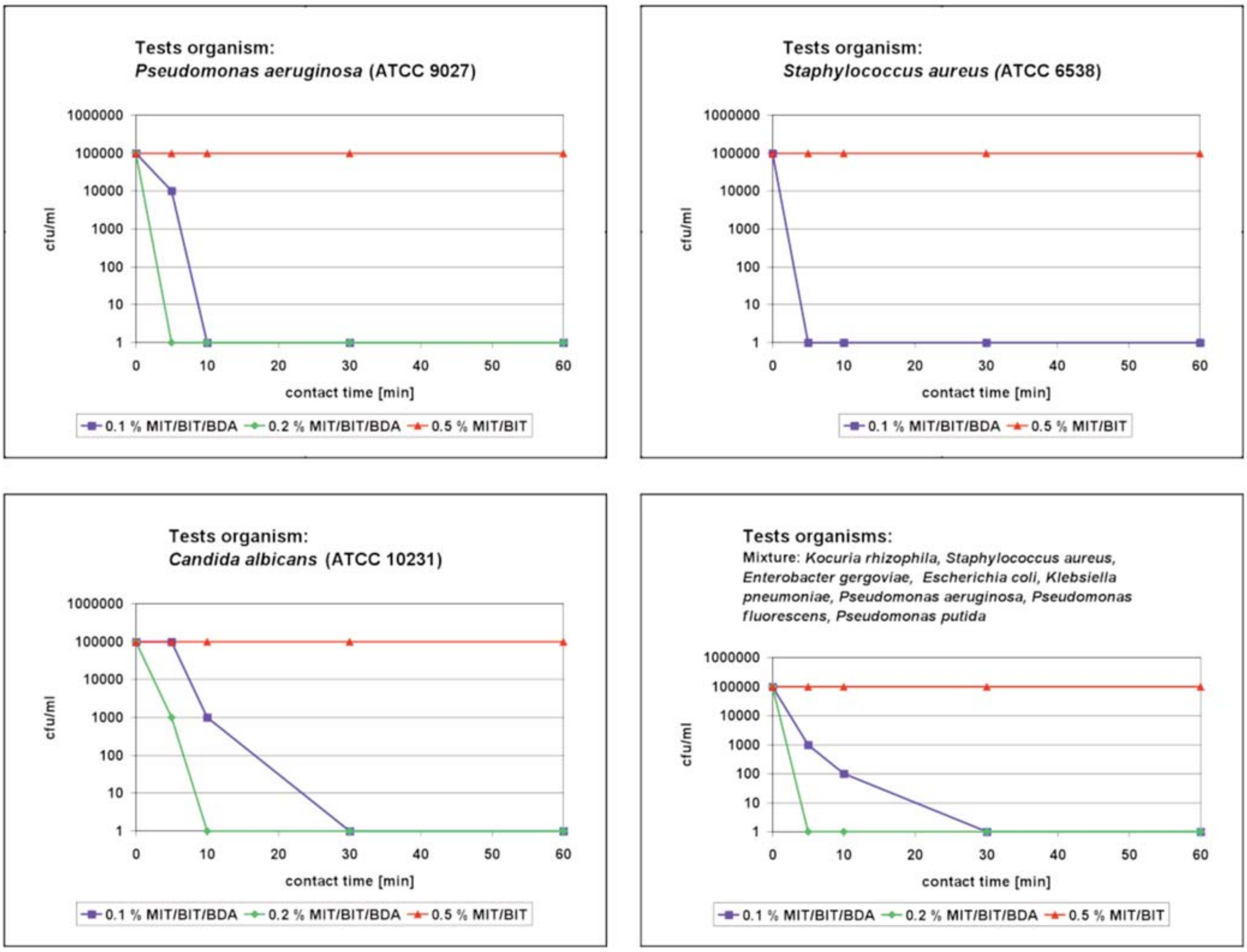

Fig. 2 Results of the germ count reduction test

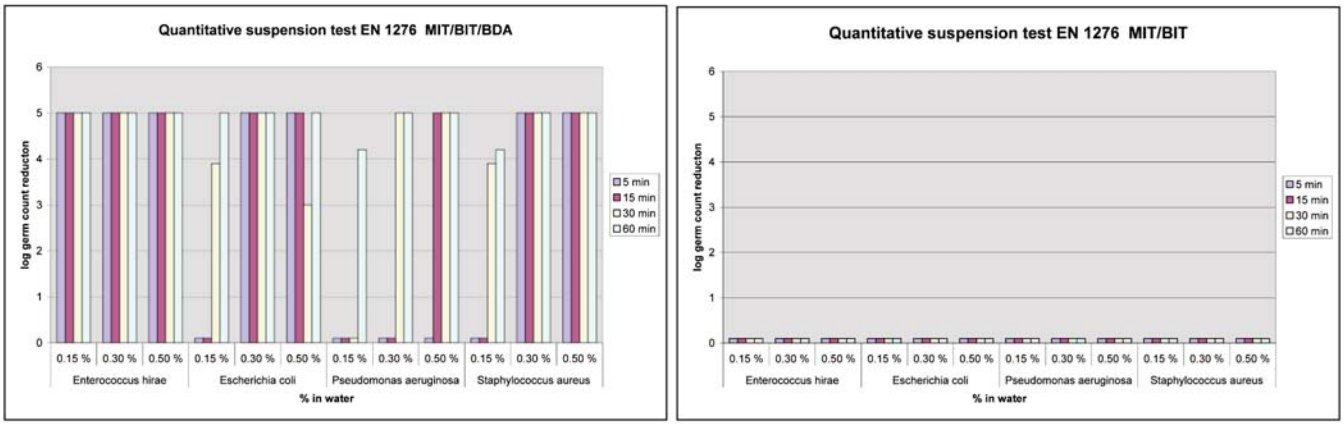

Fig. 3 Recommended process to control waterborne contamination

	Basic criteria	Product type	Max. use concentration
European Flower	2003/200/EC	Laundry detergents	0.4 %
European Flower	2005/342/EC	Hand dishwashing detergents	0.2 %
European Flower	2005/344/EC	all-purpose cleaners and cleaners for sanitary facilities	0.2 %
Nordic Ecolabel	Nordic Swan	all-purpose cleaners and cleaners for sanitary facilities	2.0 %

Table 3 Eco-labels parmetol® MBX can be used

to kill bacteria e.g. in production water, in only a few minutes and at the same time it provides long-term protection ensuring a well preserved final product. Another advantage is having only one preservative which includes two applications and is fully BPD supported. Only one dosage at the beginning of the production process is necessary to prevent or to minimize the effect of contamination during the manufacturing process. The speed of action causes less contamination of the process water, which results in less contamination throughout the whole production process and so the new product therefore provides a safer manufacturing procedure and environment because there is no quarantine time or blocking of filling lines or tanks by infected products.

Furthermore, the new preservative not only saves costs and time it also respects the environment due to its low use concentration.

The product is environmentally friendly, fully biodegradable and not bio-accumulating.

It is free of formaldehyde, formaldehyde donors and halogenated organic compounds. **Table 3** show the eco-labels the new product can be used.

This dual purpose, new and innovative product can solve production hygiene problems and has an integrated in-can preservative efficacy since it is an immediately acting preservative and provides long-term protection.

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