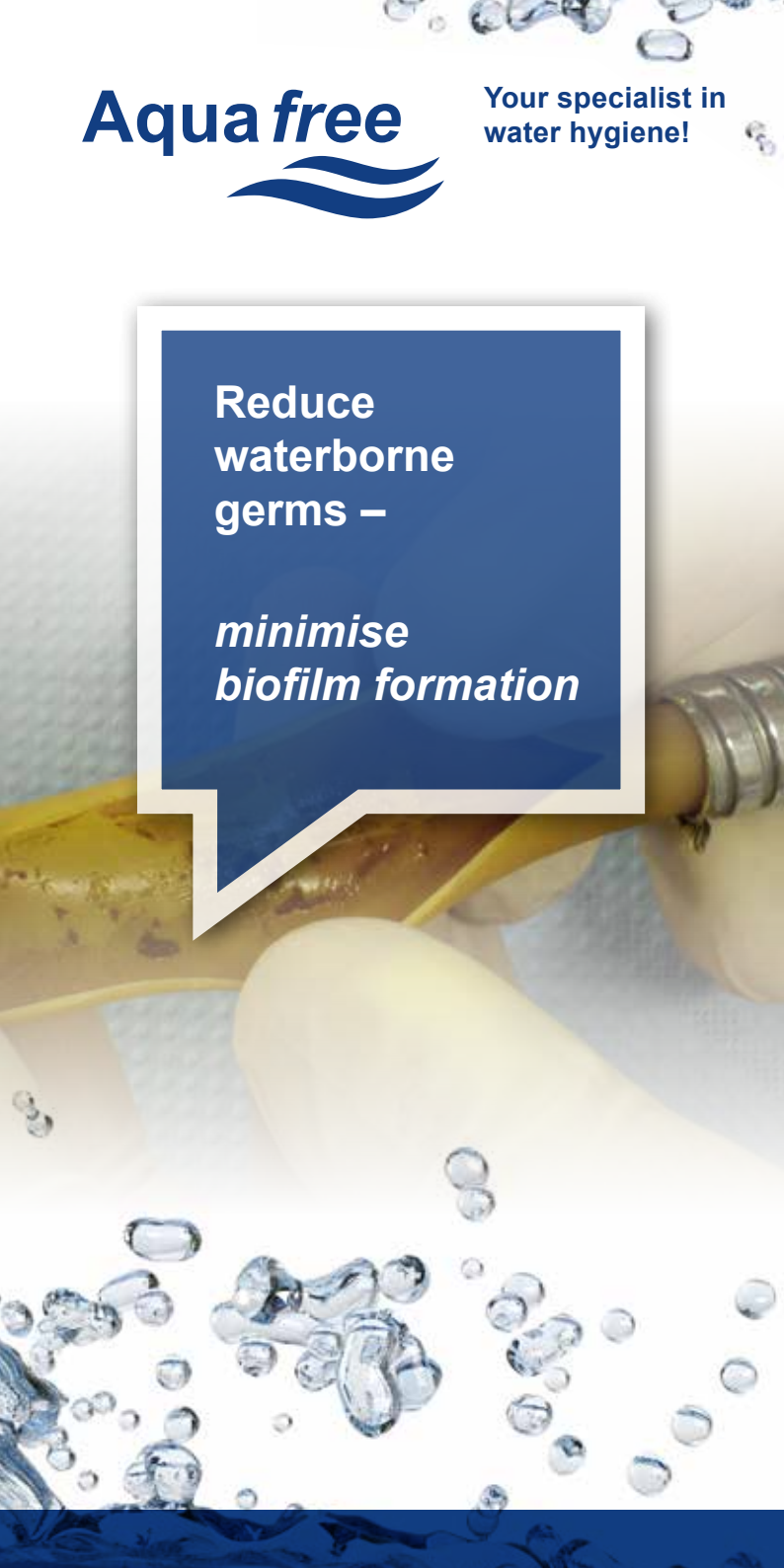
Aqua *free*

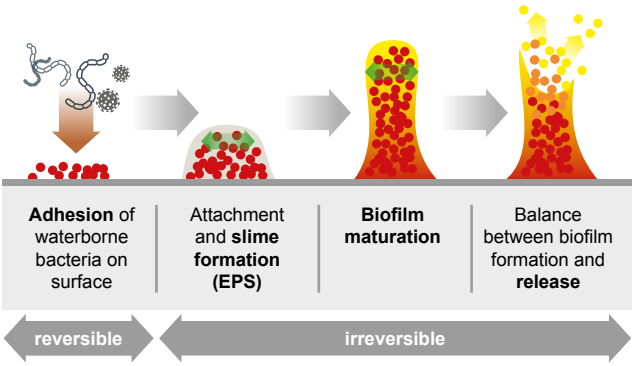
Your specialist in water hygiene!



What is biofilm?

A biofilm is a layer of slime consisting of EPS (extracellular polymeric substance) in which microorganisms, such as bacteria are embedded and form a living community. Biofilm is formed primarily at border areas between solid surfaces and water, for example in water pipes, shower hoses and taps. It becomes critical when the embedded microorganisms include pathogens such as legionella or Pseudomonas aeruginosa. That harmful bacteria can then reach the consumer as the biofilm beco mes detached and enters the water flow.

Biofilm is formed in phases:



The layer of slime is characterised by high strength and irreversible binding [1]. The EPS provides ideal conditions for the bacteria to proliferate and also protects the bacteria as well so disinfectants (e.g. chlorine) and antibiotics only have a limited impact [2, 3]. Indeed, residues of detergents and disinfectants in low concentration can even serve as nutrition for the bacteria.

The microbial detection of bacteria in tap water is complicated by biofilm, because sudden release of bacteria, as the biofilm breaks off into the water stream, can lead to large fluctuations in the number of bacteria from the same water outlet.

What is the role of pseudomonads in the biofilm?

Pseudomonads are rod-shaped, slime-forming bacteria that occur as widespread ground and waterborne bacteria in moist environments. They are frequently present on sanitary objects, such as washbasins, aerators, showers, seals in fittings and cleaning utensils, and they form biofilms there. *Pseudomonas aeruginosa* is one of the most widespread infectious bacteria in hospitals and is able to grow under both nutrient-rich and nutrient-poor conditions. *Pseudomonas aeruginosa* proliferate at temperatures ranging from 9°C to 42°C and given that *Pseudomonas aeruginosa* occurs in drinking water, both the cold water supply and the hot water supply are potential sources of contamination [4].

Pseudomonas forms biofilm and is also able to be integrated into existing biofilm. In addition, *Pseudomonas aeruginosa* can also reach the drinking water by retrograde contamination.

Where do legionella colonize the biofilm?

Legionella are typical environmental bacteria, which use water as a habitat. They are frequently present in surface water, ground water and in drinking water. A temperature of 25°C to 45°C is ideal for legionella to proliferate in the water system. Moreover, areas with little or no flow of water – stagnation – contribute to optimal living conditions. Legionella occur not only in hot water but also in cold water supplies [5]. However, they do not proliferate significantly at temperatures below 20°C. Legionella have unipolar flagella and move in fluid environments.

In contrast to *Pseudomonas aeruginosa*, legionella do not form biofilms. However, the biofilm provides the optimal living conditions and protection against environmental factors such as chlorine, UV light and high temperatures. Legionella have developed the clever strategy of proliferating in host cells, e.g. in amoebae, which are in fact their natural predators. In other words, the legionella are encapsulated and protected by the amoebae.

After the intracellular reproduction process, the amoebae burst and legionella are released into the water supply. Thus, very different concentrations of legionella can be found in water from the same source.

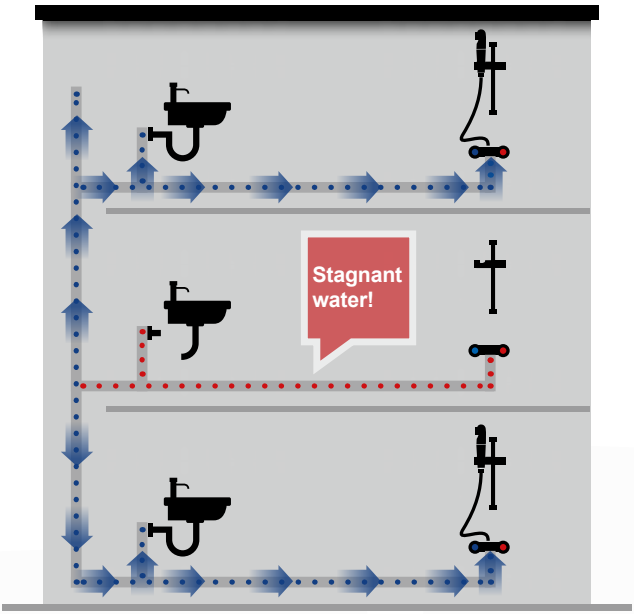
Legionella are bacterial pathogens, which cause serious forms of pneumonia. *Legionella pneumophila* is the most common facultative pathogen and causes legionellosis (also known as legionnaires' disease). This disease can be fatal. [5].

What are „sleeping" bacteria?

Microbiological analyses of drinking water is based on the quantification of germs in cultures. These colonies are quantified and referred to as colony-forming units (CFU). However, it should be noted that both *Legionella pneumophila* and *Pseudomonas aeruginosa* can be present in the biofilm of drinking water fittings not only in a form that can be cultivated but also in a temporary state, which cannot be cultivated. In this VBNC (viable-but-non-culturable) state, bacteria cannot be grown on the culture medium, even though they are viable [6]. Bacteria go into the VBNC state when they are "stressed", e.g. by disinfectants, UV radiation or heat. As soon as better living conditions are restored, these "sleeping" bacteria can become infectious again. Therefore, there is the risk that even in drinking water systems with negative CFU sample results these "sleeping" legionella or pseudomonads may be present.

What is the effect of stagnant water on biofilm formation?

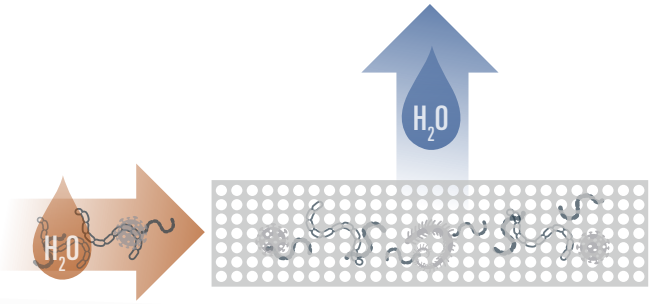
A potential source of biofilm formation is the stagnation of water. Stagnant water is the term used for water that does not move in a pipeline for more than 4 hours [7]. Long periods of stagnation allow waterborne bacteria such as *Pseudomonas aeruginosa* to become attached to surfaces of pipes and hoses, initiating the biofilm formation.



How can biofilm be minimised – what provides reliable protection against waterborne bacteria?

In order to minimise the biofilm formation it is recommended that stagnant water should be avoided. Aqua *free* provides innovative technical solutions for this purpose.

To protect consumers from harmful bacteria such as legionella or pseudomonads, the Robert Koch-Institute (RKI) recommends the use of point-of-use filters [8-10]. Aqua *free* Germlyser® hollow fibre membrane filters provide fast and reliable protection – for both taps and showers.



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We offer innovative water hygiene

- Protection against waterborne germs by point-of-use hollow fibre membrane filters
- Prevention of stagnant water through innovative technical solutions
- Minimising biofilm formation by expert advice
- Solutions at the highest level

Aqua *free* is your specialist in water hygiene – let us support you!

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