Biofilm Monitoring System

Online version available at:

http://biofilm.online/faqs

What is biofilm?

The term biofilm refers to the layer of microorganisms (bacteria, diatoms, fungi, etc.) that grows on any surface in contact with water or other liquids. Most often (including this website), this term is used to indicate bacterial biofilm. It has been demonstrated that biofilm can grow even in extreme conditions, causing damages that can range from Legionella contamination to Microbiologically Influenced Corrosion (MIC).

Why water sampling and laboratory analyses are not enough?

It is universally accepted that, once the first bacteria coming from the liquid bulk settled on a surface, biofilm growth continues almost independently from the bacteria free-floating in the liquid.
For this reason it is useless to analyze water samples, for what concerns

biofilm monitoring. Moreover, laboratory culturing techniques, used by default for microbiological analysis of water samples, are able to detect less than 1% of the bacteria really present. Indeed, it is well known that more than 99% of the bacterial species present in a sample will not grow in laboratory culture media.
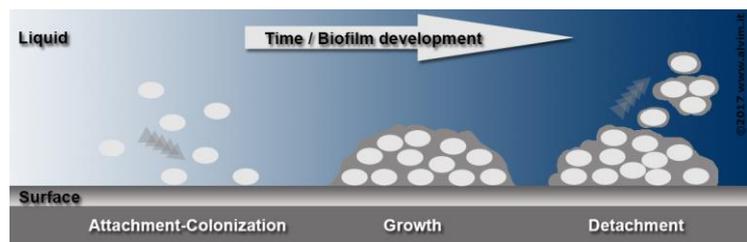
I noticed large fluctuations in the amount of bacteria in my industrial water. What can be the reason?

According to our experience, it happens quite often to observe large and unexpected fluctuations in the amount of bacteria detected in industrial waters (but the same happens also in piping systems transporting other liquids), whatever the method used to detect bacteria in the samples of liquid. What you observe is something like this:
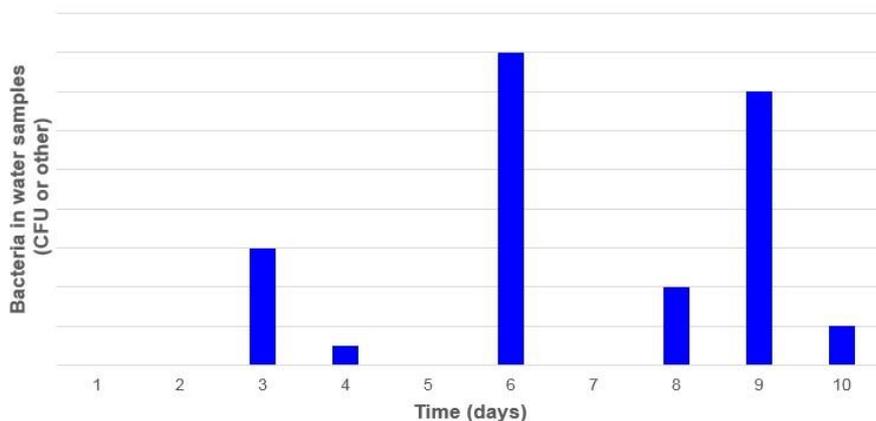
The first thought is that there is something wrong with the feed water, since the bacteria are expected to arrive mainly with the water:

...unlikely...
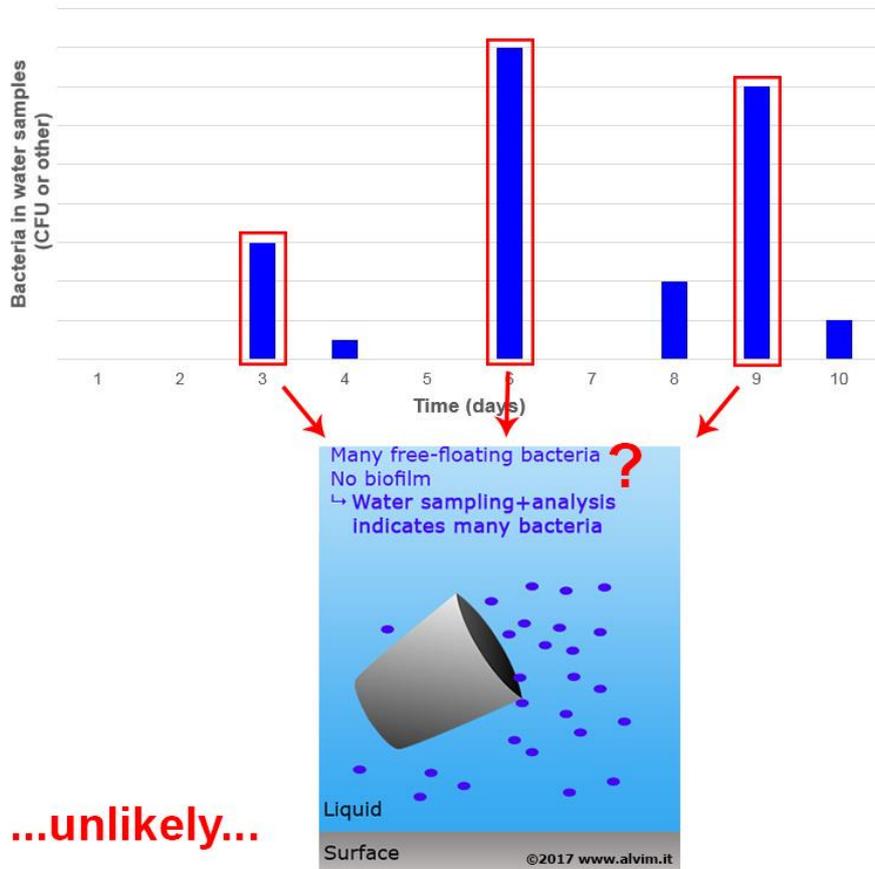
This underestimates the importance of bacterial growth on the internal surfaces of the piping system (biofilm). Even when the feed water contains few bacteria (and even when such water is filtered), the few microorganisms entering in the piping system can settle on the surfaces in contact with the liquid (see for example this application case). Then they start duplicating, giving rise to a bacterial layer than can host many more bacteria than those free in the water. Once the biofilm is mature, parts of it detach and flow away, transported by the water:
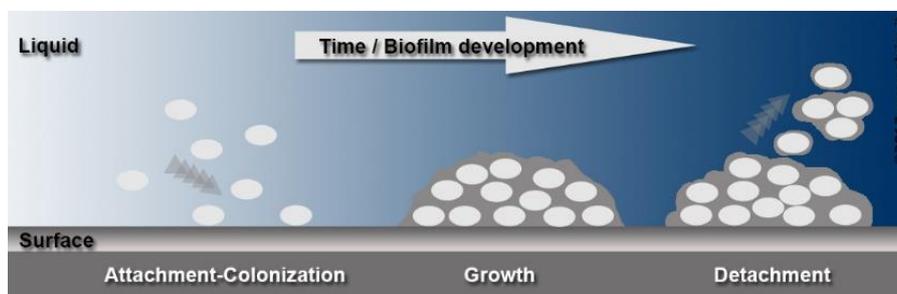
In many cases this phenomenon explains the mentioned fluctuations in the amount of bacteria in the water:

...most likely...

Few free-floating bacteria
A lot of biofilm
↳ Water sampling+analysis
  indicates few bacteria

Few free-floating bacteria
Biofilm detachment and dispersal
↳ Water sampling+analysis
  indicates many bacteria

(Not in scale)
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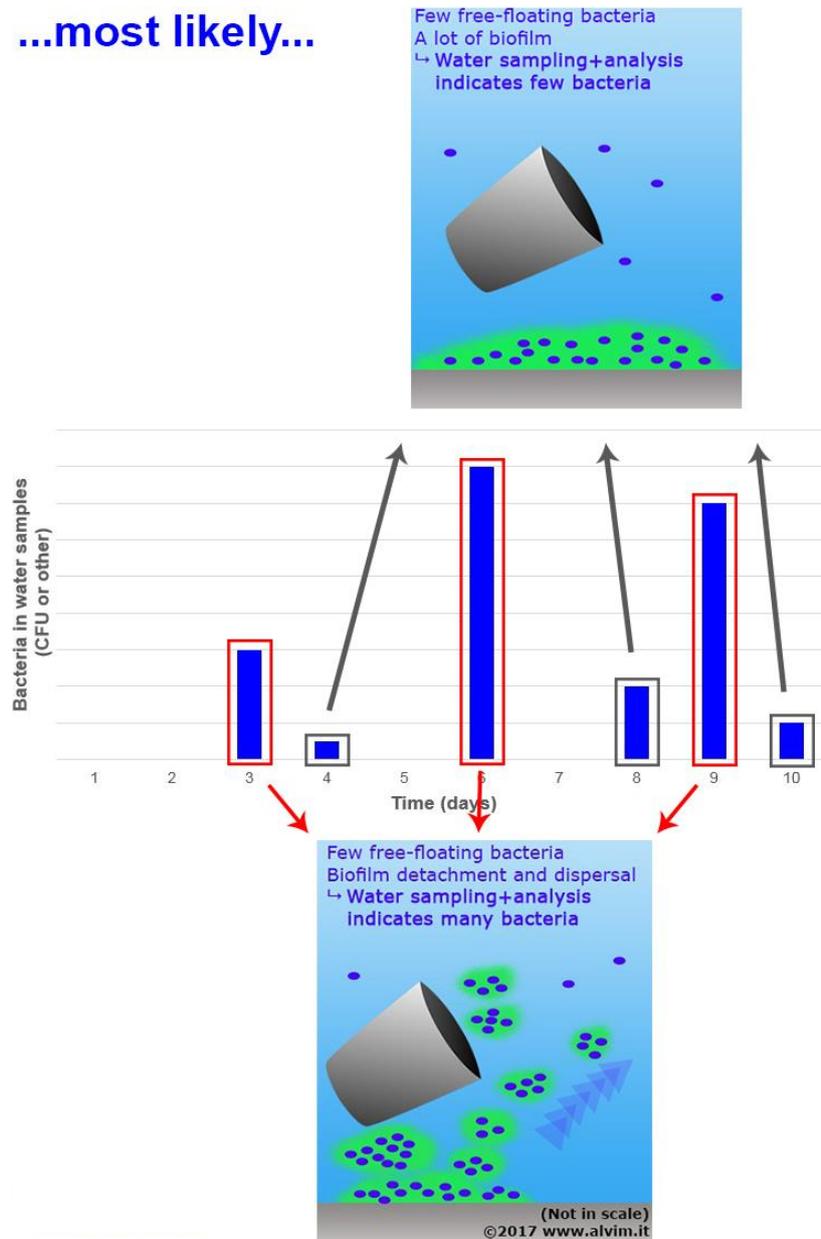
This underlines why water sampling and analysis is not enough, to prevent bacterial contamination and related issues. Biofilm monitoring should be applied, to have an early warning about possible problems.

Which are the differences between a fouling sensor and a biofilm sensor?

The term fouling indicates any kind of deposit accumulating on a surface, including minerals, proteins, fats, microorganisms, etc. Therefore, a fouling sensor detects generic deposit, with no specificity.

On the contrary, the term biofilm refers only to the layer formed by microorganisms, in particular bacteria. So a biofilm sensor detects only microbiological growth.

For such reason, the information provided by a biofilm sensor is more specific than that given by a fouling sensor.

For example, if you want to trigger a sanitation or biocide treatment, or to check its effectiveness, you shall use a biofilm sensor, not a fouling sensor. Indeed, the biofilm sensor can tell you if microorganisms are growing or not, and if a sanitation treatment is really effective.

What are the advantages of the ALVIM technology compared to the sensors available on the market?

Compared to many biofilm sensing techniques applied in commercial devices (e.g. measurement of heat exchange, light scattering, turbidity, electrochemical impedance, vibration response of the monitored surface, diffusion limitation) the ALVIM technology offers important advantages:

- ✓ **actually detects biofilm, not other kinds of deposit/fouling** (e.g. calcium carbonate, etc.); this is extremely important, since these two different kinds of fouling requires different treatments;
- ✓ **has a very high sensitivity**, i.e. detects biofilm initial colonization phase; indeed, many biofilm related problems, such as Microbiologically Influenced Corrosion (MIC), start as soon as the first bacterial spots appear on a surface.

Compared to the mentioned approaches, electrochemical techniques give the advantage of an early-warning monitoring of biofilm growth. Some of the electrochemical sensors available on the market produce an environment that encourages biological growth on their sensitive surface, therefore bacterial growth may occur before on those instruments with respect to plant components / pipelines. This means that the data provided by those sensors *could be* an esteem/forecast of plant future conditions, however it is not possible to confirm this, and from the scientific point of view this is highly unlikely. In any case, such information is not a view of the actual presence of biofilm in the water system to be monitored. The ALVIM sensor, instead, measures the natural electrochemical activity of bacterial **biofilm**, indicating its **real presence and extent** in a given moment.

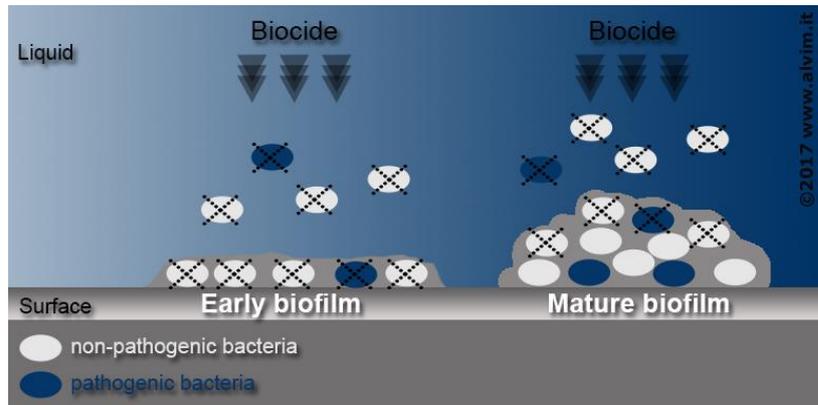## How does the System work? What does it monitor?

The ALVIM System monitors the bioelectrochemical signal produced by bacteria. This signal is directly linked to the biological activity of bacteria, and it is proportional to the surface area covered by biofilm. Therefore the ALVIM System monitors just (living) bacteria, not other kinds of fouling (e.g. mineral deposit, fats, proteins, etc.).

More info about ALVIM working principle are available on the research paper:

Exploiting a new electrochemical sensor for biofilm monitoring and water treatment optimization - Published on Water Research 45 (2011), pp. 1651-1658

Which is the sensitivity of the ALVIM probe? Do I need such a high sensitivity? In my application field we can afford XX microns of biofilm

The ALVIM sensor monitors the first layer of biofilm (1-100% of surface covered by bacteria). For what concerns cleaning treatments and sanitation, this is the most important phase of biofilm development, since biocide treatments applied during the first phases of biofilm development provide the best results. If cleaning/sanitation treatments are applied when biofilm is mature, their efficacy is greatly reduced, since the Extracellular Polymeric Substances (EPS) produced by bacteria shelter them from external agents.

What are the working conditions of ALVIM sensors?

Please refer to the technical datasheets.

Which communication protocols does the ALVIM System support?

Please refer to the technical datasheets.

How many probes do I need to monitor a plant / water line?

The suggested number of probes to be installed strongly depends on the structure of a plant / water line: if there are similar conditions in the whole water system, one or few ALVIM sensors can provide enough information about biofilm development inside the whole plant. If just one sensor is going to be installed, a "worst case approach" is suggested, installing ALVIM sensor where biofilm growth is expected to take place sooner. With the purchase of the ALVIM System, our Technical Staff provides a free-of-charge support to evaluate the best installation point(s) inside your plant (if needed).

How long does it take to learn to use the ALVIM Biofilm Monitoring System? Does ALVIM Srl provide training/support?

All the users of the ALVIM System have been able to manage it completely independently after a few weeks of use. During such period, ALVIM Srl provides free-of-charge support for the use of the System and the interpretation of collected data, that does not require any particular expertise.

In which industrial fields is the ALVIM System used?

The ALVIM Biofilm Monitoring Technology is used in the Food&Beverage, Pulp&Paper, Oil&Gas, Power Production, and many other fields. This System showed to be extremely useful also for Legionella prevention in cooling towers and hospitals. Some examples are mentioned here. Application cases regarding detection of biofilm in different industrial systems are available on ALVIM website.

Are you interested in biofilm monitoring? Contact our experts and ask for a free custom-tailored consultancy, you will receive further information about ALVIM products and services.

The ALVIM Biofilm Monitoring System is a reliable tool for the early detection of bacterial growth on surfaces, on-line and in real time, in industrial production lines, cooling water systems, etc.

The ALVIM Technology has been developed in collaboration with the Italian National Research Council, Institute of Marine Sciences, and it is currently used worldwide in many different application fields.

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