EnviroAqua CONSULTANTS INC.

Water Talk

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Biofilms in Cooling Systems

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What are biofilms? What problems do they cause? How can they be controlled?

Description

A biofilm consists of an accumulation of microbiological matter and the extracellular polymers they produce attached to a solid surface. A biofilm has a small % of organisms with polysaccharides and a large % of water. The polysaccharides are responsible for the slimy nature of biofilms

Problem Areas

- Biofilms form on heat transfer surfaces resulting in reduces heat transfer efficiency. The thermal conductivity of a biofilm is much lower than other deposit forming compounds, such as calcium carbonate, iron oxide and calcium phosphate. As a result, biofilms have a more adverse effect on heat transfer efficiency.
- Biofilms act as a sticky surface to capture suspended solids in the recirculating water such as silt and sand, iron oxide deposits, hardness deposits etc. The biofilm acts as glue to keep other extraneous matter attached to the heat transfer tube surfaces.
- Biofilms promote corrosion through various mechanisms including under deposit corrosion and microbiological induced corrosion.
- Biofilms can accumulate on cooling tower fill, basin and distribution deck of the tower. After a period of time the air and water flow may be impeded. This reduces the efficiency of the cooling tower operation as well as the heat transfer equipment.
- Acid producing bacteria and sulfate-reducing bacteria can thrive in biofilms causing severe corrosion problems.
- Since the extracellular component of biofilms protects the organisms from the environment, several conventional microbiocides are not effective in removing biofilms. As a result, conventional monitoring of planktonic counts before and after the feed of a microbiocide has no relationship to the amount of biofilm or sessile bacteria present in the system.

Treatment Considerations

Knowing the nature of biofilms helps in developing an effective treatment program to destroy them. Biofilms can be controlled using microbiocides, biodispersants and by limiting nutrients. However, it may be necessary to use a combination of more than one approach or use higher concentrations of microbiocide for effective control.

Oxidizing microbiocides such as chlorine, bromine, ozone or chlorine dioxide can be effective in penetrating biofilms, but will typically require a high residual for a sufficient period of time. Low free residuals of 0.1 – 0.2 ppm of chlorine or bromine on a continuous basis will not be as effective of an intermittent dose of 1+ ppm for several hours. Too high a halogen residual may result in aggressive corrosion in the system. The oxidizing biocides do have the ability to destroy the extracellular polymers as well as the organisms in the biofilm.

The use of a biodispersant in conjunction with an oxidizing biocide will reduce the residual and time required accomplishing the end result. The biodispersant breaks down the biofilm enabling the microbiocide to have access to the organisms resulting in more effective results.

Particularly effective in alkaline systems are Towerbrom, Chlorinated/Brominated Hydantoins and the liquid bromine products.

Non-oxidizing biocides are also effective in controlling biofilms. Glutaraldehyde, isothiazolin (one) and THPS are products of choice. If the non-oxidizing biocide also has biodispersant properties, it can be effective when used alone. This is especially true of the cationic biocides such as THPS. If the non-oxidizing biocide does not have these properties, more effective results may be obtained when used in conjunction with a biodispersant.

For a moderate to severe biofilm problem, it will be necessary to feed the non-oxidizer frequently from several times a week to daily. Alternating non-oxidizing microbiocides will also be more effective for broad-spectrum control. The use of alternating oxidizing and non-oxidizing biocides is very effective in controlling biofilms.

The use of biodispersants is very effective as a complement to any microbiological control program. The biodispersants penetrate the biofilm and loosen its structure. This exposes the organisms to the microbiocide and releases the organisms to the water where they can be effectively controlled. It is recommended that the biodispersant be fed prior to the addition of the microbiocide on a slug basis. A typical application would involve the addition of the biodispersant one to four hours prior to the addition of the microbiocide. For systems with a high nutrient loading, a continuous feed of the biodispersant is recommended.

Monitoring a system for biofouling control cannot be done using the conventional plate counts, dip slides, ATP monitoring of the bulk water. Monitoring the efficiency of the equipment is a good tool as well as biofouling monitors.

Conclusions

Controlling biofilms is an important part of any water treatment program. Biofilms can result in loss of efficiency, excess energy use and premature failure of equipment. An effective microbiological program should always include an effective treatment of biofilms.