

# biofuels

## international

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## Biofuel leaders to gather in Berlin

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## A \$500 million problem

**Why cooling capacity is so important for ethanol production**

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The startling impact of cooling capacity on ethanol production

# A \$500 million problem flying under the radar

**E**thanol production in the United States has increased steadily over the last five years as plants have invested in new equipment and technologies. However, in four out of the last five summers, this steady uptrend has been briefly interrupted (see Figure 1). Each summer the average set-back from the overarching trend is a production loss of 250 million gallons of ethanol. Considering current market prices for ethanol and other co-products, such as distiller's grains and corn oil, the value of this lost production approaches \$500 million (approximately €428 million) per year.

## Why is this Happening?

While US regulations restrict the use of E15 and higher ethanol blends of gasoline in the summer months, this reduction in usage is generally offset by increased summer driving.

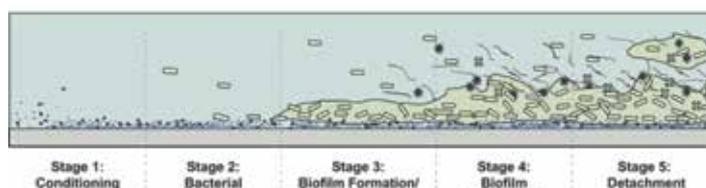


Figure 2 – Five stages of biofilm growth

Additionally, plants do not normally perform maintenance shutdowns during the summer. Consequently, one cause surfaces as the likely culprit – cooling capacity.

So how has this issue gone unnoticed? Actually, a better question is, how has this production loss been accepted as the norm? The answer lies within the industry. Corn ethanol is a very young industry, and plants are minimally staffed. As a result, most resources are focused on making ethanol, with very little time and in-house expertise to spend on utilities such as cooling. Many plant operators are young and lack experience or training on

plant utilities. Contrast this with mature industries, for example oil refining or power generation, whose employees have decades of optimisation behind them and are well-trained and experienced utility systems experts.

Consequently, the prevailing assumption in US ethanol plants is that bottlenecks will occur because it is too hard to keep the process cool during hot weather. Many plants have added production capacity but left the cooling capacity the same. Unfortunately, the lack of attention to cooling operations has resulted in significant operational issues. The largest operational issue affecting cooling capacity is in fact quite avoidable, and that is biofilm.

## The cause and effect of biofilm

Biofilm in cooling systems forms on cooling tower fill, piping and heat exchanger surfaces when bacteria in the water begin to adhere to a surface and multiply. As the bacterial film grows, it entrains nutrients and debris in the water, forming an ever-

thicker layer that becomes increasingly challenging to control (see Figure 2). Removal of biofilm requires mechanical cleaning or penetrating chemistries. Walk past many ethanol plant cooling towers and the presence of bacterial activity is obvious, with slime or algae present in the tower sump or fill.

Biofilm is all too common because of three factors. First, most ethanol plants are located in cornfields where ample airborne dirt and debris get sucked into the cooling water through the cooling tower, thus providing deposits that are ideal for bacterial attachment, a source of bacteria, and nutrients. Second, discharge or food safety regulations limit the types of chemicals that can be used to control bacteria and biofilm. Although bleach is often used, it only kills free-floating bacteria – it does not control biofilm. Third, very little attention is paid to the cooling water side of heat exchangers. Process surfaces have regular cleaning procedures, and even when the cooling sides of heat exchangers are inspected, biofilms may appear innocuous because, unlike hard scale deposits, they are easily washed away.

Biofilm contains a lot of water and therefore is an effective insulator. In fact, biofilm is much more heat insulating than typical mineral scales (see Figure 3). In a heat exchanger, a mere 20



Figure 1 – Weekly ethanol production in the Midwest United States (1000 barrels/day). Red lines show production during the last five summers. Production bottlenecks occurred in four of the five summers

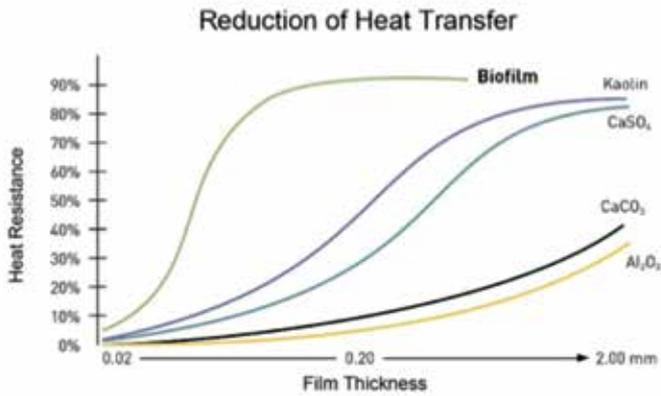


Figure 3 – Biofilm heat transfer loss comparison

microns of biofilm (think the thickness of the glue on scotch tape) can impede heat transfer by up to seven%. In cooling tower fill, biofilm reduces the ability of water to evaporate effectively, which is the mechanism for ultimately rejecting heat from the process. The net effect is an inability to cool sufficiently such critical processes as mash, fermentation, and distillation. During hot and humid weather, cooling tower effectiveness is already limited. Add in the detrimental effect of biofilm, and plant operators must slow the process, resulting in an aggregate five% reduction in summertime ethanol production.

**New technologies to control biofilm**

Mature industries have had the time and the resources to employ various best practices to control biofilm in cooling systems. These best practices include:

- Filtration systems that continuously remove airborne dirt and debris
- Chemicals that effectively penetrate and disperse biofilm
- Monitoring and control systems that optimise the use of chemical treatments

Ethanol producers must train their employees to become more aware of the issue of biofilm and these simple best practices. However,

the unique challenges of the ethanol industry require cutting-edge monitoring and control systems that provide performance-based monitoring and control.

A range of performance-based monitoring and control systems designed to target various aspects of water treatment is available. These systems not only dose chemicals to recommended levels, but also monitor continuously the critical performance criteria in real time so chemistries can be dosed dynamically, delivering 24/7 protection. Additionally, these systems allow early detection of and rapid response to operational issues.

Examples of these systems include Solenis' OnGuard 2-plus control system and OnGuard 3B analyzer. While the control system provides a

broad approach to continuous monitoring of scale, corrosion, and bacterial fouling, the analyzer focuses solely on monitoring biofilm. It does this by taking a side stream of cooling tower water and running it through a target cell and ultrasound array. The surface of the target cell is programmed to the specific temperature and flow characteristics of the plant's critical heat exchanger. Ultrasound is fired at the target cell surface and the measured reflection of the ultrasound allows for real time detection of biofilm down to five microns of accuracy (see Figure 4).

system realised a \$1.5 million (approximately €1.3 million) revenue improvement as a result of controlling biofilm. The plant also realised \$40,000 (approximately €34,000) cost savings by reducing its use of chillers during the summer by 90%.

**A logical path forward**

Ethanol producers must evaluate the performance of their current cooling water treatment programme and the condition of their cooling systems. A programme to remediate any biofilm issues, followed by a comparison of



Additionally, it can differentiate between other foulants, such as scale or oil, for example.

The analyzer has been employed at multiple ethanol plants in the United States and the initial results have been extraordinary. One ethanol plant that had just installed a new cooling tower

cooling system performance and production in the cleaned system versus the prior dirty system, will provide an estimate of potential capacity improvement. Investment in cooling infrastructure (cooling towers, heat exchangers, or pumps) may be needed to address any remaining summer capacity issues; however, these are significant capital investments. Meanwhile, a chemical treatment programme that leverages performance-based monitoring and control can be implemented quickly without capital outlay, likely delivering immediate profit improvements. This, along with education on cooling system operations, is a logical first step. ●



Figure 4 – Biofilm on target cell surface

**For more information:**

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Biofilm monitoring and  
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