A WoodwardBizMedia Publication

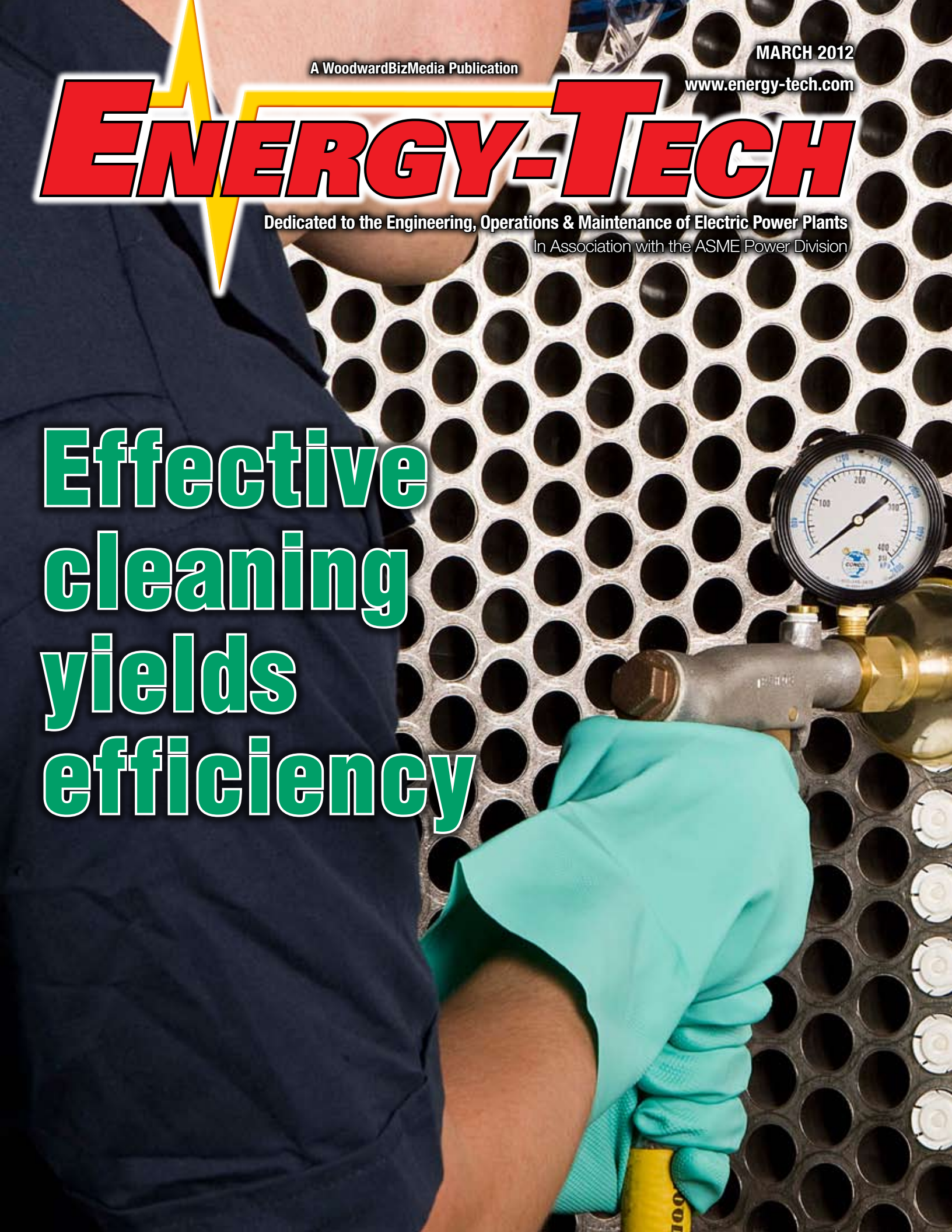
MARCH 2012

www.energy-tech.com

ENERGY-TECH

Dedicated to the Engineering, Operations & Maintenance of Electric Power Plants

In Association with the ASME Power Division



Effective cleaning yields efficiency

Effective condenser cleaning begins with an effective tube cleaner

By George Saxon, Jr.

By utilizing the most evolved cleaning technology available, it's possible to achieve great condenser performance and an immediate return on investment. Struggling with condenser tube fouling and corrosion is unnecessary, especially when the proper tools are readily available and accessible. It seems the struggle has to do more with how to approach the specific condition and assess the available tools. Of significance regarding cleaning is the challenge associated with selecting the proper tools and equipment to yield the best result. Cleaning the condenser can be a rewarding experience and add value to the operations, or it can be an exercise in futility if it has been performed with the wrong, or ineffective, tools and technology. Effectively cleaning these components requires a good basic knowledge of state-of-the-art condenser cleaning equipment and tube cleaners and your site-specific conditions. Here are some basic principles that can help you in this process.

Basic principles

Fouling occurs in the condenser as a result of particulates, minerals, organisms and debris in cooling water supplies. When the tubes foul, it is often a result of the constituents in the water and the cooling water supply, as well as the system itself. The fouling is temperature and flow affected. Low flow allows the particulates and minerals to fall out of the cooling water and attach to some organic slime or organism developing on the tube surface. As the cooling water temperatures rise, certain minerals will begin to crystallize since temperature is inversely related to the solubility of the common elements found in cooling water. So there you have it – fouling!

Common condenser tube deposits are categorized by type and include:

- Biofilm or microfouling organisms
- Particulate
- Crystallization
- Corrosion product
- Macrofouling, debris and shellfish

While condenser tubes will foul with one predominate deposit type, in almost all cases there are aspects of each fouling type present, which is why it's important to select a cleaning technology that addresses your site specific conditions. Cleaning technology for a biofilm when there is a crystallized deposit is useless.

A variety of tube cleaners are available for the tube cleaning maintenance market today. Manufacturer's such as Conco Systems Inc. have designed and developed a comprehensive line of tube cleaners to address the types of fouling identified above. Each of the tube cleaners are dramatically different in effectiveness, depending on the type of fouling or deposits present and the tube materials in place. What is unique and of importance is the ability to understand the tube cleaner's effective range. Another distinct and important maintenance matter is the proper sizing of the tube cleaner. Tube cleaners designed to fit the tube specification at your plant are absolutely essential, adjustable tube cleaners give way to erroneous sizing and inconsistent cleaning action.

Figure 4 highlights the distinctions to look for when selecting any type of tube cleaner, whether brushes, plastic or the Conco all-purpose tube cleaner. Eleven different tube cleaners designed for dealing with deposits ranging from thin biofilms to thick calcium carbonate scale all incorporate the TruFit™ features, achieving the most effective cleaning. When used in conjunction with the ProSeries Tube Cleaning System (Figure 5) available water is elevated to 300 psi at 36 gpm, propelling these tube cleaners to travel through the tubes at 10'-20' per second, leaving a clean tube surface behind, ideal for good heat transfer.

Figure 1. The heat exchanger cleaning process.

Titanium, stainless and copper tube materials foul differently, their surface conditions vary and so does their composition. In addition to fouling type, another important aspect to consider is the tube material since it affects effective removal of corrosion product, as well as protection from under-deposit corrosion and pitting. While titanium and superferritic stainless steels are impervious to corrosion, they have no copper content. Copper content fends off microbiological organisms, so there is biofilm attracting particulate deposits and mineral deposits. When it's affected by temperature, scaling will occur. So while one might enjoy a longer incubation period before fouling occurs on these smooth tube surfaces, when fouling does show up, be prepared to clean aggressively. Utilizing plastic pigs or nylon brushes might be satisfactory initially, but in the long term, metal cleaners will most likely be required.

As copper tubes oxidize, a sacrificial process for protection against microbiological deposits and biofilms begins and they generate a porous oxide layer that needs to be removed to continue to maintain the tube in its best condition. Copper based alloys have been known to provide a long, useful life when properly cleaned. Regardless of the tube material, keep the tubes clean, assess the condition and choose the best cleaner.

Elements of effective cleaning

Effective cleaning is easily achieved when one takes the time to perform a proper assessment first. Such assessments include, but are not limited to, visual inspections, deposit sampling and boroscopic inspection. The 2010 ASME Performance Test Code 12.2 for Steam Surface Condensers included a simplified fouling test. The fouling test is designed to help resolve disputes about performance degradations associated with the presence of deposits. There are basically three key elements – inspection, sampling and cleaning. Selecting the appropriate tube cleaner based on fundamentally sound technique and applying the same is the key to achieving a successful cleaning.

Figure 2. Debris and tower fill

Figure 3. Mud and silt, particulate deposit as removed

Costs of poor performance

Condenser fouling is usually the culprit for poor condenser performance. Simply stated, the deposits present negatively impact heat transfer and limit the capacity of the condenser. The rise in turbine backpressure from condenser tube fouling can be the indicator to consider improving the effectiveness of your cleaning program. Assume this, a rise in backpressure of 0.3˝ hg, is equivalent to approximately 10 percent cleanliness factor (HEI method), that 10 percent change in condenser performance on a 10,000 btu/KWhr heat rate correlates directly with 1 percent of MW output. So look at these examples and see the savings for yourself with respect to a 20 percent improvement. Note there are 8,760 hours in a year, in this case a 70 percent capacity factor is used and sale price of $60 MWh.

Heat Rate

- Assume 0.3 hg condenser backpressure is equivalent to 10 percent improvement in condenser performance
- Each 10 percent improvement in the condenser correlates to 1 percent improvement in HR (10,000 btu/kWh) or MW output

Example 1:
0.6 hg = 20% CF = 2% HR = 2 MW

MW loss

- 8,760 hrs/yr
- Capacity Factor
- Price per MWh
- MW

Example 2:
8,760 x 0.70 x $60 x 2 MW = $ 735,840

Example 3:
8,760 x 0.70 x $60 x 3 MW = $1,103,760

Underdeposit corrosion and tube failures

Deposits left on the tube surface can result not only in loss of efficiency, but also in losses to availability and reliability. Consider that deposits left on the tube surfaces can result in corrosion and tube failure. Or that if a tube leak occurs for some other mechanical reason, that these contaminates can make their way into the condensate. So when there is a tube failure, deposits permeate the tube wall and enter the condensate, chemistry calls for the condenser to shut down, and there is a forced outage. The leak is found through the use of tracer gas the tube plugged and the unit is restored to service. Keep in mind that those contaminates are now on their way to the boiler and turbine! The known delay time for that condenser tube failure consequence to hit the boiler and cause more damage is approximately 6 months. The cost of that boiler or turbine repair will be much greater than the cost to clean the condenser effectively. These boiler failures and turbine damage also are good reasons for effective cleaning maintenance on the condenser.

Frequency of cleaning

The frequency of cleaning is largely dependent on economics and the maintenance schedule. The condenser also can be cleaned during partial load conditions. As a rule of thumb, cleaning of the condenser should take place during each scheduled overhaul. If an overhaul is not scheduled and performance indicators suggest there is fouling in the tubes, then be on standby to take remedial action for any other mini-outage or forced outage. If you are in a period of reduced load, shut down one side to clean, then switch to the other side. Cleaning of the condenser should be done at a minimum of once a year and as frequently as when the economic impact of fouling exceeds the cost to clean. Keep an eye on the performance indicators.

Cleaning budget

Budget for the cleaning and don't give it up, regardless of how big the competing issues are. The return on investment for effective cleaning is big and realized quickly. Managers from other areas of the plant want your money for a more expensive project, with a lower return. Tell them to forget it, rate your plant projects based on outgoing cash and rate of return. The condenser cleaning project, done properly, will yield returns in excess of 750 percent or more, and that's a good reason to do it. Payback begins as soon as the unit returns to service, it will be within a month or two, not a year or two. Implement your program and enjoy the return, and don't forget to tell the boss how much money you saved him. Comments on emissions reductions you achieved also count as good information to share.

Figure 4. TruFit Tube cleaner

Program assessment

Take a minute and assess your program, look at the dashboard of performance statistics such as condenser backpressure, cleanliness factor, terminal temperature differential and MW output and see where you stand. In addition, give rise to the number of condenser tube failures or forced outages as related to the condenser that have occurred. Most likely there is room for improvement, try achieving more effective condenser cleaning and you won't be disappointed.

Maintenance really does matter, especially when cleaning condensers and heat exchangers. Results from this maintenance activity include improved plant performance, increased MW output, improved availability and reliability and reduced forced outages.

Figure 5. ProSeries Tube Cleaning System

George Saxon, Jr. is president of International Markets at Conco Systems Inc., chairman of Conco Systems, Pty Ltd in Australia, managing director of Conco Systems SPRL in Belgium and a director of Conco Industrial Services Corp., www.concosystems.com. He has been one of the principal members of Conco Systems since 1982 and his responsibilities include business development, marketing and international business. Saxon has a bachelor's degree from California University of Pennsylvania and an MBA from Duquesne University. George is an active member of the ASME Power Division and serves as the vice chair on the ASME Power Division's Executive Committee. He also has served on Technical Advisory Committees for the Electric Power Research Institute (EPRI) and is a former member of the American Society of Non-Destructive Testing (ASNT). You may contact him by e-mailing editorial@woodwardbizmedia.com.