Figure 5. Proper installation of tube plug.

2. Particulate deposits
3. Crystalline deposits
4. Macro fouling
5. Corrosion product
6. Obstructions

Radial designed blades to match tube dimensions

Not all tube cleaners are designed to precisely match the tube radius. Put a tube cleaner in the tube that is designed to the tube size specified on the condenser manufacturer's data sheet. Tube cleaners that are adjustable or designed for a range of tubes sizes will do one of two things – if too small, compromise the cleaning effectiveness or, if too large, risk the tube integrity.

Color coded for quick sizing

The periphery tubes and the air removal tubes in most cases have a different wall thickness than the main condensing section tubes. Having a color code allows the cleaning personnel to match the correct size cleaner to the specific tube.

Solutions for every condenser

The integrated platform of solutions presented has been successful in improving productivity, reliability and profitability for a broad range of condenser applications. Cleaning, testing and leak detection work together to lower cost, reduce downtime and improve overall efficiency. A single service provider offering all three services ensures the highest level of accountability and quality.

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Raise plant efficiency and lower production costs: Achieving total condenser performance

By George Saxon, Jr.

Achieving "Total Condenser Performance" means achieving the perfect balance of productivity, reliability and profitability from the effective integration of cleaning, nondestructive testing and leak detection technology. With this in mind, problems can be anticipated and condenser tubes can be maintained at optimum efficiency. The process identifies the status of condenser tubes, detects equipment fatigue that can cause inefficiency and cleans the tubes to improve flow and heat transfer. Used together, the platform can increase efficiency by as much as 4 percent and dramatically reduce CO_2 emissions.

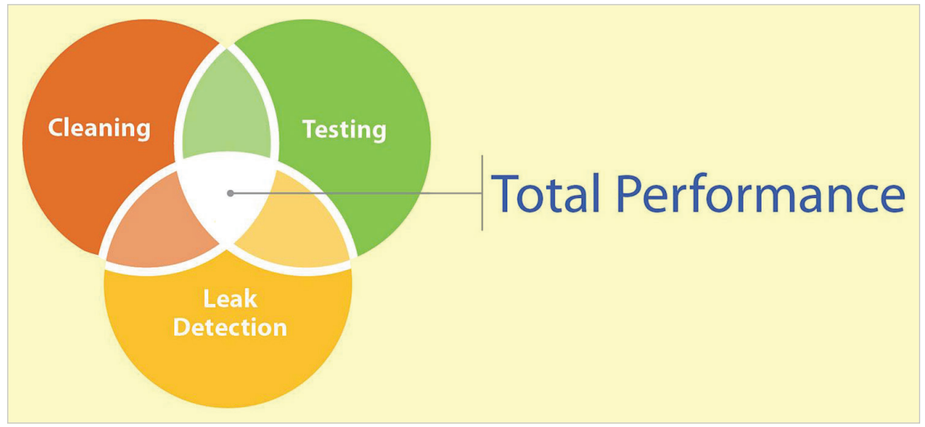

Figure 1. Venn Diagram representing total condenser performance

Certainly improvements in condenser performance can be achieved independently, either through effective cleaning, leak testing or nondestructive testing, but achieving *total performance* is about leveraging the power of the three to make remarkable improvements that can – and will – determine the difference between your plant selling megawatts or buying them, reducing CO_2 emissions or shutting the plant down. This article will show you just how to achieve the *total performance* goals.

Total condenser performance: The power of 3

The performance triad represents the unique integration of the three essential components. Testing, leak detection and tube cleaning providing a platform to reduce cost, downtime and inefficiency, which leads directly to greater profitability, productivity and reliability. Since condenser performance corresponds directly with plant heat rate and megawatt output, an investment in the approach discussed can yield immediate measurable improvements.

Catch problems before they lead to outages: Non-destructive testing

After proper cleaning, testing is the most effective way to reduce tube failure. Non-destructive testing can catch problems before they lead to outages, saving hundreds of thousands of dollars in unplanned downtime.

Identifying vulnerability to reduce downtime and unplanned outages

Knowing which tubes to plug or repair before they fail can save millions of dollars in downtime. Nondestructive testing, including Eddy Current Testing (ECT), Remote Field Testing (RFT), Internal Rotating Inspection (IRIS) and borescopic video examination, as performed with the proper equipment and qualified technicians, is paramount. Testing in accordance with guidelines set by the American Society of Nondestructive Testing (ASNT) ensure consistent, repeatable results. Defects can quickly be located in a variety of tube materials, including stainless, titanium and brass. Multiple frequencies should be used and an understanding of tube fouling mechanisms, as well as corrosion analysis, is beneficial in understanding the big picture. Figure 2 is an example of a tubesheet map, the "at-a-

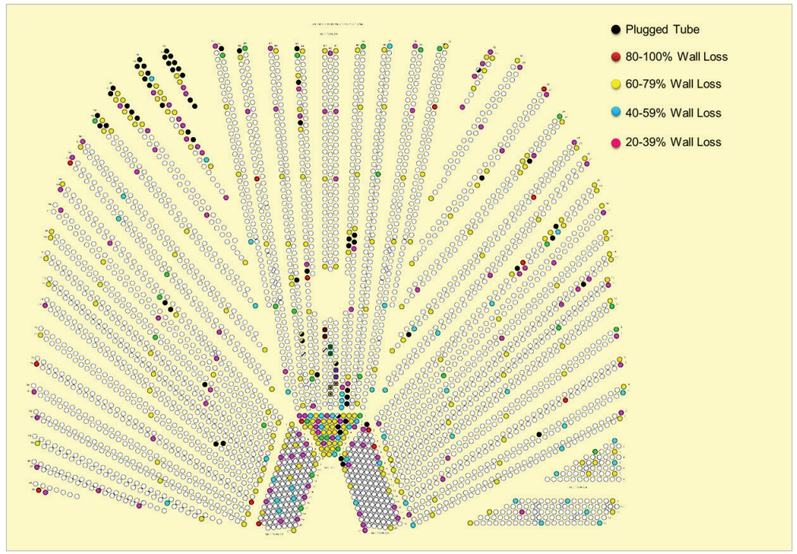

Figure 2. Tubesheet map, the graphic presentation of ECT results. A color-coded tubesheet map can help quickly identify problem areas.

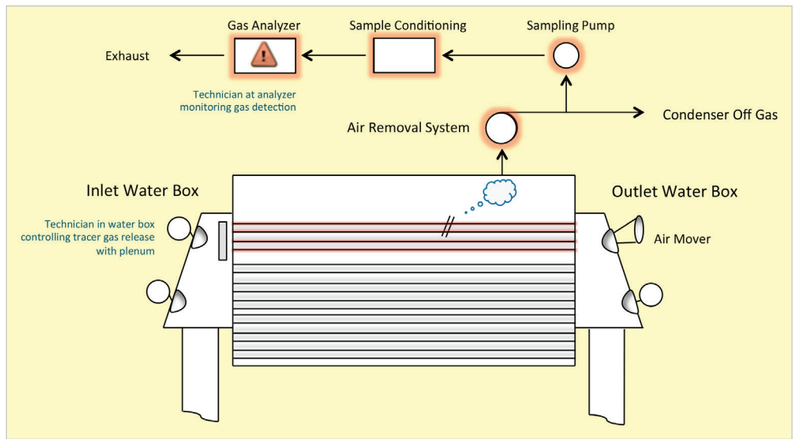

Figure 3. Tube leak inspection diagram

glance" summary of condenser tube condition. The overall condition of the condenser and developing trends are obvious.

The incorporation of good cleaning practices with nondestructive testing provides the best results, since clean tubes are easier to test and, among other things (such as good fill factor), there is a lower noise to signal ratio.

Effectively locate condenser air in-leakage and tube leakage: Leak detection

Leaks can cause corrosion and damage throughout the plant. Systematic surveys incorporating state-of-the-art systems ensure detection of the smallest leaks and maintain efficient operation year-round.

Helium and SF_6 tracer gas technology to improve efficiency

Using Helium or SF_6 tracer gases to systematically inspect the condenser and vacuum boundary for air in-leakage, or inside the condenser for tube leakage, will identify the location of undesired leaks to the condenser or water in-leakage from faulty condenser tubes. These leaks, if undetected, continue to degrade condenser performance and cause damage to other components. When cooling water contaminates the condensate, the water chemistry is negatively impacted and boiler tube failures and ultimately damage to turbine components can occur, costing the plant considerable amounts in reliability, availability and repair costs. Locating the leaks and taking the necessary remedial actions to restore efficiency and reliability to the condenser and plant will result in improved condenser performance. Figure 3 and 4 are a typical condenser tube in-leakage diagram, as well as a technician demonstrating the delivery of tracer gas through a plenum.

Once leaking condenser tubes are identified, the tubes should be adequately plugged by inserting tube plugs in both ends. A tube plug should be installed with confidence and should not move into or out of the leaking tubes. Plugs with innovative gripping and sealing designs perform the best. Tube plug evaluations rating pressure and vibration thresholds should be reviewed when selecting tube plugs. It is recommended to have a satisfactory quantity of tube plugs on hand to plug leaking tubes immediately. A quantity of plugs in the amount of 2 percent of the total number of condenser tubes should be stocked.

Common sources of water in-leakage include:

- Tube leaks
- Waterbox flanges
- Faulty tube plugs
- Leaking hotwell components
- Tube to tubesheet joints

When air in-leakage is identified the leak should be repaired and retested, confirming the new leak tight status.

Common sources of air in-leakage include:

- Penetrations to the condenser shell
- Vacuum pumps
- Rupture discs
- Flanges
- Shaft seals
- Bolt holes
- Manways
- Drains

Effectively clean the condenser: A good cleaning

Cleaning is fundamental to performance maintenance and achieving *total condenser performance*. By removing deposits on a regularly scheduled program, dramatic improvements in megawatt output and heat transfer can be achieved, while also reducing the likelihood of tube failures related to fouling and under-deposit corrosion. Turbine backpressure improvements are immediate when the appropriate tube cleaning tools are applied.

Effective cleaning to improve productivity and reliability

When cleaning, select tube cleaners that are designed and engineered to provide safe, effective cleaning for the conditions at your site. Be sure the tube cleaner has:

Figure 4. Technician delivering tracer gas through a plenum.

Fouling specific architecture

The tube cleaner should be suitable to the type of deposits in your condenser for your cooling water conditions and corrosion needs. Apply a tube cleaner that has proven to be effective under those circumstances. Plus, tube deposits have a variety of heat transfer conditions, so while a deposit might appear to be thin, it might have very poor heat transfer characteristics.

Spring-loaded blades effectively eliminating fouling

Carbon steel heat treated blades for standard applications; these features provide the body and the resistance to remove deposits that include all types of fouling:

1. Biofilms

As seen in the August 2013 issue of Energy-Tech *magazine*