Boiler tube scale deposit measurement reduces energy cost and improves availability

Does your mill/plant monitor boiler tube waterside deposition using Deposit Weight Density (DWD) testing? If so, from where do you take this tube sample? Are you taking the sample from the best location? Accurate nondestructive measurement provides the best method to maintain boiler capacity while minimizing costs.

Valmet nondestructive measurement of scale deposit

Valmet provides a new service to measure and record the thickness of internal boiler tube deposit layers in boiler waterwall tubing. The service uses ultrasonic technology and proprietary software to accurately measure the thickness of the deposit layer. Using this service allows for a more accurate chemical cleaning strategy - chemical cleaning cycles could be extended and the lifespan of your boiler can be improved. The technology can also monitor the removal of the deposit layer during the cleaning cycle.

There are numerous benefits to this approach, most notably the ability to measure tube scale deposit thickness with a direct correlation to the standard Deposit Weight Density (DWD) method. In addition, tube samples are taken only when and where they are needed. When scale growth is regularly monitored, corrective actions can be taken before corrosion risks increase.

Figure 1. Scale and corrosion as shown above are minimized with regular and accurate measurement and treatment.

The Valmet service can be used to monitor the effectiveness of cleanings and, if cleanings are improperly performed, can minimize the damage that could occur from excessive cleaning. Using the results from the ultrasonic testing, boiler operators can replace the tubes that have issues, rather than acid cleaning the entire boiler. Acid cleaning would result in longer downtime and could damage otherwise good tubes if improperly performed.

Typical boiler cleaning strategies

Some boilers are chemically cleaned at a regular interval of between five and ten years. Other strategies include the removal of sample tubes for DWD analysis, and based on the DWD results may be chemically cleaned. Meanwhile, the boiler water chemistry must be strictly controlled, as a delay of one or two years on a fouled boiler can result in major tube damage. The type of boiler (recovery vs. power) and how it is used also affect the cleaning strategy. Cleaning is often performed after a major upgrade or rebuild.

Factors affecting boiler cleaning strategies

Have there been water chemistry incidents between cleanings, either a major or several small incidents? Do your incident corrective actions include taking a tube sample at the next opportunity? What is the state of your water chemistry controls? Is the condensate return fouled? Is there makeup water contamination?

Has your treatment strategy changed, i.e. coordinated phosphate (PO4) to all-volatile (AVT)? Have you changed fuels or burner design, i.e. coal-to-gas conversion, changes high heat zone?

If chemical cleaning is improperly performed, the result is excessive cleaning time and tube wall thinning. Insufficient cleaning leads to corrosion damage and loss of heat transfer, which reduces tube cooling and could cause tube failure.

Tube sampling for DWD

The standard DWD test should not only provide a deposit loading indication, but also an analysis of chemical composition of the deposit in the tube. Optimally, the tube sample should come from the highest heat flux area and/or low flow area of the boiler. The change in the weight of the tube divided by the water-touched area where the deposit was removed produces the DWD result, in units of grams per square foot (g/ft²). The threshold for cleaning based on DWD analysis is at 25-30 g/ft².

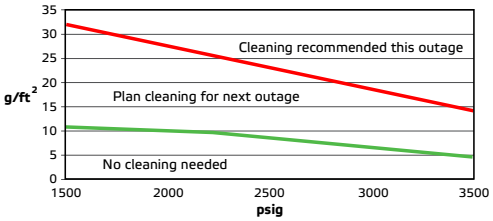

Figure 2. The cleaning threshold is >= 25 to 30 g/ft² DWD.

Source: previously published Valmet technical documents

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Boiler tube scale deposition costs money

Example: Annual operating costs increase due to high iron deposit layer measuring 0.1mm = 3.9 mils ~ 25 g/ft² (threshold), which causes ~0.5% energy loss. At 1000 MMBTU/hr heat input and a fuel cost of $2.50/MMBTU, the resulting annual cost of lost energy is $100,000. An indirect indicator of scale or deposit formation is flue gas temperature. If the flue gas temperature rises (with boiler load and excess air held constant), the effect may be due to scale in the tubes. Effective and well timed boiler tube scale deposit measurement and remediation can save significant money over time.

Valmet's measurement process

The technology combines ultrasonic testing hardware and software to measure and record thicknesses of the internal deposit layer. The measurements are made using the change in wave forms through the material. This requires a cleaned smooth inspection surface, and the minimum detectable scale is < ~1 mil.

Transducer probes are prepared beforehand using the inspection tube size as a reference. The probe needs to be profiled to match the tube. Boiler tubes are prepared by cleaning an area of one square inch near the crown area in a way which does not damage the metal surface itself. A wire wheel and buffing pad are used to polish the surface without removing any base metal. The scale thickness measurement is then performed by analyzing the reflection of longitudinal ultrasonic waves from different layers of the material.

Figure 3. Probes are profiled to match the boiler tube, then connected to the ultrasonic testing equipment for accurate measurement.

Deposit thickness can be calculated directly from the distance of separate waves reflected from different interfaces and from sound propagation speed in the scale. With a deposit the waves reflected from the deposit and water/air interface widen noticeably. The waves are combined (B1+D1). B1+D1 is gain adjusted and compared to the known metal material wave. The change in wave width (Dt) is the scale thickness. Calibration is by checking the zero point from a scale free tube. If a tube sample containing scale is available, the measurement can be fine-tuned.

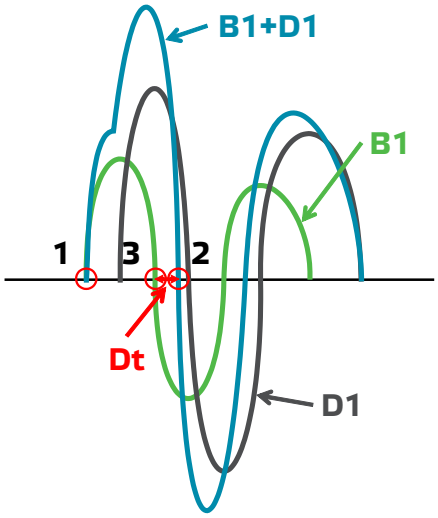

Figure 4. The change in wave width (Dt) corresponds to the material thickness.

Technology enhances chemical cleaning

Equipment may be used to monitor the effectiveness of ongoing cleaning. This minimizes the potential for tube damage due to excessive cleaning. Also, the cleaning time may be optimized in order to improve boiler availability.

Figure 5. Graphic displays of the ultrasonic wave shape allow Valmet operators to accurately present the scale thicknesses in a comprehensive report.

Benefits of Valmet measurement of your boilers

The Valmet service measures tube scale deposit thickness with direct correlation to the standard Deposit Weight Density (DWD) method using an advanced ultrasonic testing method.

Internal scales in furnace tubes can be measured in hundreds of points, as compared to one point for standard DWD analysis.

Tube samples are taken only when needed and where needed.

When scale growth is monitored frequently, corrective actions can be carried out in time (before corrosion risks increase).

The impacts of water treatment become clearly visible: water treatment can be optimized so that acid cleaning intervals can be extended, thus reducing cost.

On-line monitoring of acid cleaning means the acid treatment phase can be extended or terminated as needed. Cleaning results can be verified (vs. guarantees).

The measurement results can be used to replace a few problem tubes instead of acid cleaning the entire boiler.

Contact Mike Ward 980 228-6659 mike.ward@valmet.com or your Valmet representative to learn how boiler tube scale deposit measurement by nondestructive ultrasonic testing can benefit your operation.

Source: previously published Valmet technical documents

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