

The Interpretation of Standard Deposit Analysis Results

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The formation of various types of scales, sludges and deposits in industrial or commercial cooling, boiler and process systems occurs quite frequently. The presence of these types of deposits can present some serious problems. Scaling of boiler tubes can lead to tube failure. Deposits in heat exchangers lead to restricted flow and loss of system efficiency. An analytical analysis of these deposits is performed for several reasons. The results of this analysis can be used to determine how the deposit can best be removed or to determine if the deposit is the result of corrosive attack or excessive mineral concentration.

The interpretation of a deposit analysis necessitates an understanding of the various stages of the analysis and why each are performed.

A sample as received in the laboratory may contain any or all of the following: water, hydrocarbon organic material (oil, grease, etc.), microbiological organic material (algae, slime, fungus, etc.) inorganic mineral deposits, and extraneous material (wood, glass, insects, etc.). Each of these components is treated separately during the analysis and reported separately in the results.

The analysis begins with a visual examination of the deposit noting physical characteristics such as color, texture, size, shape and form. During this visual inspection, any extraneous material is removed from the sample. The results of this visual inspection and the presence of any extraneous material is noted on the report form as "Visual Observations".

All samples are dried to remove excess or entrained water. Since most deposits are water formed, this result is not reported in the analysis results. The removal of excess moisture ensures accurate inorganic component results.

If oil or grease is suspected, the sample is treated with Trichlorotrifluoroethane in an extraction apparatus. Trichlorotrifluoroethane is used because it will dissolve most hydrocarbon organic material that will be encountered including oil, grease, tar and oxidized oils. Boiler deposits will seldom contain any Trichlorotrifluoroethane soluble material unless a

defoaming agent is used or, tannin or lignin is entrained within the deposit. The result of this portion of the analysis is reported as "Solvent Soluble Organics" under the organic analysis portion of the report form. In general, a result greater than five percent indicates the potential for a serious problem. Because of the environmental hazardous nature of Trichlorotrifluoroethane, the extraction is only performed if requested by the customer or if oil is suspected by the chemist.

The portion of the deposit remaining after the Trichlorotrifluoroethane extraction is then ignited in a furnace at 650°C to determine the Ash Content and Loss on Ignition of the deposit. This procedure removes all remaining organic material, including microbiological components, wood shavings or insect parts. This value is reported as a percent of the original sample as "Loss on Ignition". The portion of the sample that is left after ignition is the inorganic components of the deposit. This value is reported as a percent of the original sample as "Ash Content" on the report form.

This remaining portion of the sample is used to determine the inorganic metal and mineral composition of the deposit. This analysis consists of a series of acid digestions designed to reduce the sample to a liquid form. Subsequent spectrophotometric analysis of the liquid is used to determine the inorganic composition of the deposit. It is not uncommon for this portion of the analysis to not total 100%. There are many inorganic compounds which may be present in the deposit. A deposit analysis will identify those components which are most common in water formed deposits as well as any other components requested or deemed necessary by the customer or the chemist. These may include process or treatment components.

A standard deposit analysis includes identification and quantification of the following inorganic ions:

Calcium	as CaO
Iron	as Fe_2O_3
Copper	as CuO
Phosphate	as PO_4
*Carbonate	as CO_3

* Carbonate is not tested quantitatively. This portion of the analysis is performed qualitatively.

These inorganic ions, as well as any other inorganic ions can combine to form scale deposits. Calcium carbonate is the most common type of scale deposit in cooling and boiler systems. This type of deposit is most often caused by improper control of blowdown or bleedoff resulting in high levels of hardness and alkalinity. It is rare that a scale deposit will be composed exclusively of one type of scale. Often a deposit analysis will reflect varying concentrations of a number of scale compounds. Some of the most common types of scale found in water systems are:

COOLING SYSTEMS

Calcium carbonate	as $CaCO_3$
Calcium sulfate	as $CaSO_4$
Calcium phosphate	as $Ca_3(PO_4)_2$
Magnesium silicate	as $MgSiO_2$
Iron oxide	as Fe_2O_3

BOILER SYSTEMS

Calcium carbonate	as $CaCO_3$
Calcium hydroxyapatite	as $10CaO \cdot 3P_2O_5 \cdot H_2O$
Serpentine	as $3MgO \cdot 2SiO_2 \cdot 2H_2O$
Calcium phosphate	as $Ca_3(PO_4)_2$
Ferric phosphate	as $FePO_4$

The presence or absence of any type of scale is dependent upon the water quality, system type and operating parameters. Each deposit analysis must be interpreted on an individual basis.