<技術解說>

Chelation – The In-Service Approach to Boiler Cleaning

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PRIOR TO THE DEVELOPMENT OF full solubilizing internal boiler treatment programs using chelants such as EDTA (ethylenediaminetetraacetic acid), plant personnel had been accustomed to the necessity of acid cleaning the water sides of boilers. Frequency of cleaning varied from months to years depending on the quality of water, treatment program used, and the rate of scale buildup. Cleaning usually involved an outside contractor and a boiler shutdown of 3 or 4 days.

Today, a multifaceted treatment program combined with constant testing can elminate the need for cleaning. One effective treatment program, called Chelation involves external water treatment, using a softener or demineralizer, coupled with a chelant like EDTA. Chelants form soluble compounds with the harmful contaminants (calcium, magnesium, iron, and copper) in the boiler feedwater. These compounds are then removed by continuous blowdown.

Treatment programs should be supplemented by organic dispersants, which attack the substances that do not chelate, and keep particles from combining and depositing as scale in the boiler.

In systems that do not lend themselves to this type of boiler treatment program, EDTA can be used as an inservice cleaner;boiler shutdown is thus eliminated.

Inservice cleaning with EDTA offers many advantages over the old acid approach : less plant downtime; improved boiler efficiency as a result of the scale removal capabilities of the chelant; simplified boiler inspection because the unit is clean; less possibility of localized corrosion from acid inhibitor breakdown; acid waste disposal problems are eliminated;and generally lower cost.

Scale Removal—The amount of chelant needed in the boiler feedwater is based upon a chemical analysis of the water. After this figure has been determined, an additional amount of the chelant is added. The extra chelant serves two purposes: (1) as insurance against unusual buildup caused by an unanticipated

BOILER CORROSION DATA

PHOSPHATE TREATMENT

Exposure Time (days)	Boiler Number	Corrosion Buildup (Mils/yr) STEAM SPACE	MUD DRUM	STEAM DRUM (BELOW WATER LEVEL)
453	2	0.3	—	0.5
263	1	2.0	1.0	1.0
203	3	2.0	—	1.0
203	3	2.0	—	2.0
394	1	0.2	—	4.1
340	7	0.2	0.5	0.3
399	2	0.02	0.05	0.01
399	2	0.5	—	0.04
380	1	0.1	0.5	3.0
369	7	0.2	—	0.5
Average 334		0.9	0.5	1.4

EDTA TREATMENT

Exposure Time (days)	Boiler Number	Corrosion Buildup (Mils/yr) STEAM SPACE	MUD DRUM	STEAM DRUM (BELOW WATER LEVEL)
184	7	0.5	0.5	0.4
184	7	0.5	—	0.2
274	3	0.1	0.7	0.5
274	3	0.2	—	0.9
254	5	0.1	0.1	0.8
254	5	0.1	—	0.9
526	1	0.1	0.7	0.3
526	1	0.2	—	1.1
674	2	0.6	0.4	0.2
674	2	0.04	—	0.7
677	6	0.8	0.7	0.1
677	6	0.5	—	0.7
500	7	0.1	0.02	0.1
500	7	0.1	—	0.3
Average 441		0.3	0.4	0.4

change in the water content, and (2) to slowly act on and remove any existing buildup. Chelant is introduced into the system in the feedwater header, after the feedwater pump. For best results, the feedwater should be tested during each work shift.

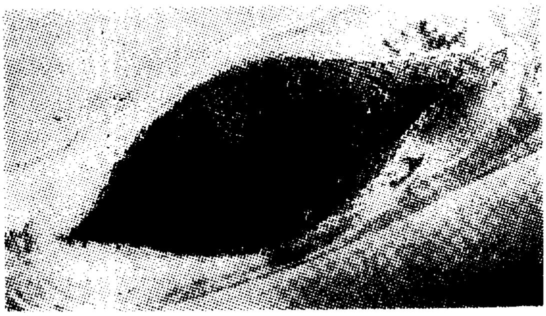

Fig. 1. Boiler deposits on generating tubes may become severe enough to cause gradual overheating, finallyresulting in failure, unless a program such as chelation is used.

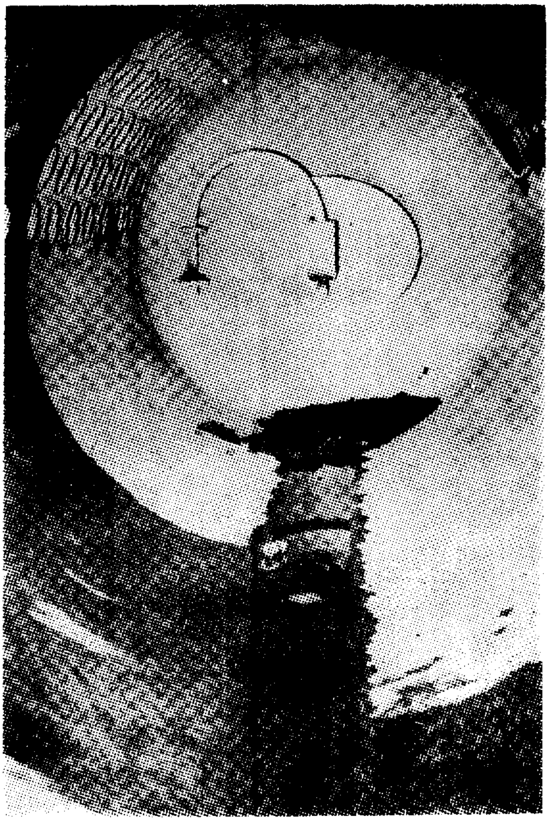

Fig. 2. When plant switched from phosphate to chelant clean-up program, the improvement was quite dramatic. Note scale in rear removed after chelant cleaning (light area).

Precise control of the scale removal rate is essential to prevent sloughing off of large chunks which could block lines. Extensive field tests have shown that the excess chelant should be introduced so that it takes about 90 days to solubilize and remove normal boiler deposit mixtures of calcium hydroxyapetite, magnesium silicate, iron oxide, and copper oxide. The controlled removal rate eliminates the danger of tube blockage or overheating, **Fig. 1.**

"When plant switched from phosphate to chelant clean-up program, the improvement was quite dramatic."

Although a chelant removes iron scale, it will not corrode the boiler provided its introduction to the system is carefully controlled, and an accurate chemical test has been made to determine the demand on the chelant for solubilizing .

A uniform corrosion rate of 1 mil per year throughout the wetted boiler surface would require more EDTA to chelate the iron oxide form than is present, as an excess, in a normal treatment program. The table gives the corrosion rate for boilers using phosphate and EDTA treatment. Note that in each area the EDTA did the better job of inhibiting corrosion.

Effectiveness—The list of successful chelant cleanup applications are numerous but the following examples indicate the program's effectiveness and benefits.

A western sugar plant had a yearly production season of approximately 4 months. During this time, an average of 350,000 lb of steam per hour was produced, and 95 percent condensate returns were obtained. Process leaks and the occasional use of raw water as makeup produced a dense, highly adherent scale under a phosphate treatment program.

This scale had the following compositions and necessitated yearly turbining of the boiler tubes with cutters to minimize the thickness:

Silica as SiO_2	2 percent
Iron Oxide as Fe_2O_5	14 percent
Loss on Ignition	1 percent
Phosphate as P_2O_5	11 percent
Calcium as CaO	12 percent
Magnesium as MgO	1 percent
Copper as CuO	59 percent

The problem had become so severe that a complete acid cleaning was being considered. However, a chelant cleanup was utilized and the acid cleaning delayed until the results of chelant cleaning could be evaluated at the end of the following production season. At that time the boiler was essentially "bare" metal clean, with an insignificant, light, powdery deposit in various areas, **Fig. 2** The boiler is now being maintained on a normal chelant program to prevent a recurrence.

In the Pacific Northwest, a large paper mill was experiencing severe deposition in its recovery and power boilers. This was primarily because of organically bound colloidal iron in the makeup water. The problem had become so severe, under a phosphate treatment program, that the boilers were inspected every 6 months and acid cleaned yearly.

A primary analysis of the scale from one of the recovery units indicated the following composition (most boilers had at least 1/8 in. of similar scale over all heating surfaces):

Tricalcium Phosphate	15 percent
Magnesium Silicate	5 percent
Loss on Ignition	16 percent
Iron Oxide	62 percent
Copper Oxide	2 percent

With chelation, the tricalcium phosphate and magnesium silicate are being preferentially removed, which is to be expected with a porous deposit. In other words, the problem hasbeen solved. **End**

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