Boiler Scale: National Impact

Definition: the accumulation of minerals and impurities on the water side of a boiler's heating surface

Calcium (Ca)	Phosphate (PO_4)
Magnesium (Mg)	Sulfate (SO_4)
Bicarbonate (HCO_3)	Silicate (SiO_2)
Carbonate (CO_3)	Iron (Fe)

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Scale in a Boiler Causes…

1) Damage or Failure of Boiler = downtime & loss of production, and costly repairs

2) Efficiency Loss

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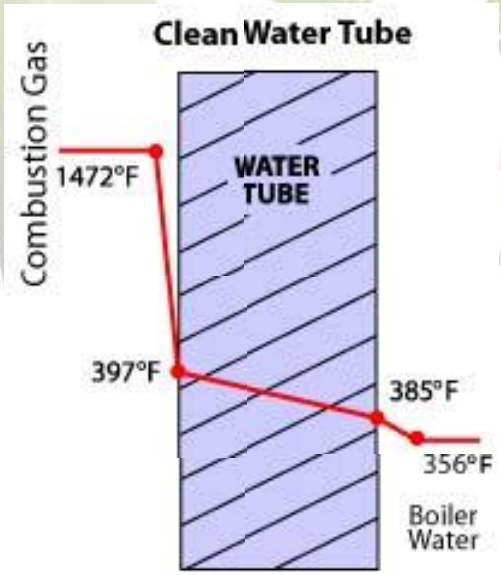
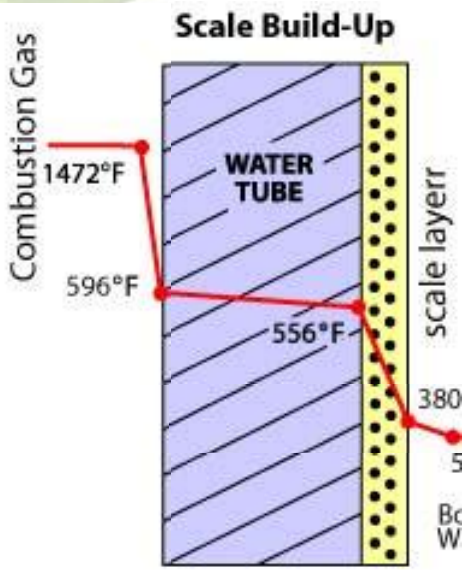
Scale = Insulation

Thermal Conductivity W/(m*K)

Silicate Scale	**0.35**	
Carbonate Scale	**0.60**	**Mild Steel 52.50**
Sulfate Scale	**1.45**	

An eggshell thickness (1/32”) of scale reduces efficiency 2-7%





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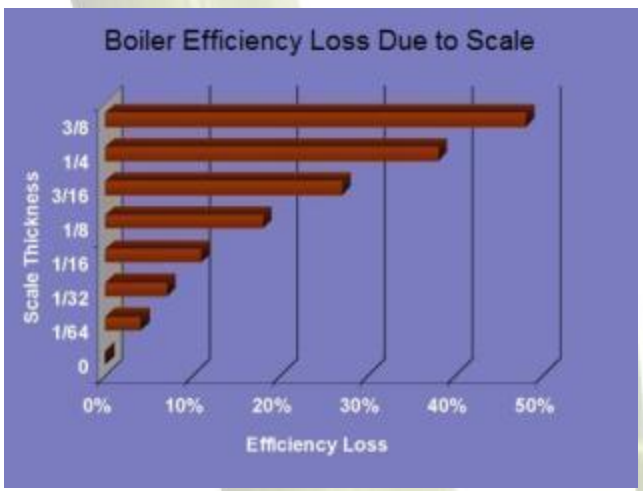
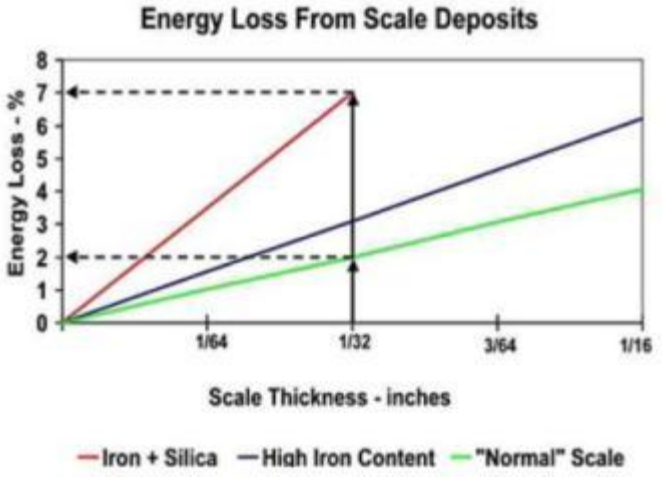
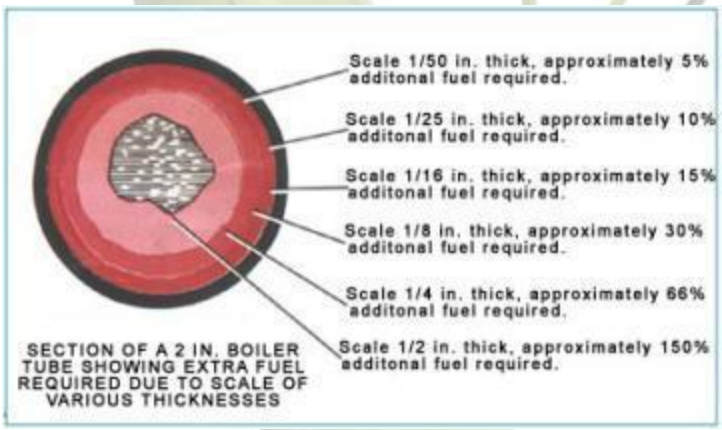
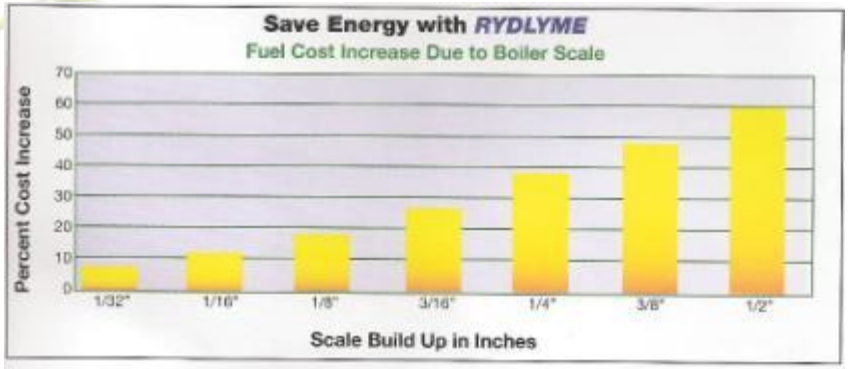
Average Efficiency loss per 1/32”?





Thickness of Scale	Increase in fuel consumption due to this scale
1.) 0.05 mm (1/64")	4%
2.) 1 mm 1/32")	7%
3.) 2 mm (1/16")	11%
4.) 3.65 mm (1/8")	18%
5.) 6.25 mm (1/4")	38%
6.) 12.7 mm (1/2")	60%
7.) 19.5 mm (3/4")	80%
8.) 25.4 mm (1")	Over 90%





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Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech. For additional information on industrial energy efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.

Efficiency Loss from Scale Conservative Standard

Energy Loss Due to Scale Deposits*

Scale Thickness, inches	Fuel Loss, % of Total Use		
	Scale Type		
	"Normal"	High Iron	Iron Plus Silica
1/64	1.0	1.6	3.5
1/32	2.0	3.1	7.0
3/64	3.0	4.7	–
1/16	3.9	6.2	–

Note: "Normal" scale is usually encountered in low-pressure applications. The high iron and iron plus silica scale composition results from high-pressure service conditions.
*Extracted from National Institute of Standards and Technology, Handbook 115, Supplement 1.

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BOILER WATER TREATMENT AND RELATED COSTS OF BOILER OPERATION: AN EVALUATION OF BOILERS IN THE LOUISIANA SUGAR INDUSTRY

James A. Cuddihy, Jr., Walter J. Simoneaux, Robert N. Falgout, and James S. Rauh
Midland Research Laboratories, Inc., 10850 Mid America Avenue
Lenexa, KS 66219

ABSTRACT

If one considers the importance that steam plays in the production of sugar, the boilers should be considered one of the highest priorities in a sugar factory. In fact, some have said that a sugar factory boiler is the heart of the factory. But, do sugar factory personnel place a high priority on the condition of the boiler? To answer this question, a study was conducted on 43 sugar factory boilers in Louisiana at the end of the 2003 crop. Video borescope equipment was used to examine the internal condition of 222 different tubes and to document their condition. Additional data from analyzing boiler water and feedwater during the crop was evaluated to show the impact of boiler conditions and operating practices on the operating efficiencies of the factories. Based on the severity of conditions found, in terms of deposition and scaling, calculations were made to demonstrate how this impacts factory profits when supplemental fuels are required to achieve firing rates required for efficient factory operation. A discussion of how these adverse conditions occur and why the water treatment program is of utmost importance is also presented.

Table 2. Factory borescope summary for eight factories with 222 tubes[1] examined in 43 boilers.

Factory	Clean Tube	Slightly Scaled	Moderately Scaled 1/32"	Heavily Scaled 1/16"+	Chipped Scaling	Pitting Corrosion	Under Deposit Corrosion
A	3	4	10		2	1	3
B	6	10	12	9	3	7	7
C		3	8	16	7		15
D	3	15	1			2	3
E	1	1		18	3	1	1
F		5	12	19	2	26	4
G	2	1	7	25	7	11	20
H	9	12	5	5		6	5
Total	24	51	55	92	24	54	58
Average	10.8%	23.0%	24.8%	41.4%	10.8%	24.3%	26.1%

[1]Any given tube could have more than one condition observed.

RESULTS AND DISCUSSION

This summary reveals that two thirds of the tubes inspected have scale with a thickness of 1/32" or greater, and one half of the tubes exhibited some type of corrosion. Deposit thickness was estimated during video borescope visual observation using previous experience. Nearly one quarter of all tubes inspected had only a slight amount of scale and only about ten percent of the tubes inspected were found to be clean and free from corrosion.

Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech. For additional information on industrial energy efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.

Average Efficiency Loss Nationwide Conservative Estimate

Energy Loss Due to Scale Deposits*

Scale Thickness, inches	Fuel Loss, % of Total Use		
	Scale Type		
	"Normal"	High Iron	Iron Plus Silica
1/64	1.0	1.6	3.5
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3/64	3.0	4.7	–
1/16	3.9	6.2	–

Note: "Normal" scale is usually encountered in low-pressure applications. The high iron and iron plus silica scale composition results from high-pressure service conditions.
*Extracted from National Institute of Standards and Technology, Handbook 115, Supplement

"About 66% of Operating Boilers Lose 3.1% Efficiency Due to Scale"

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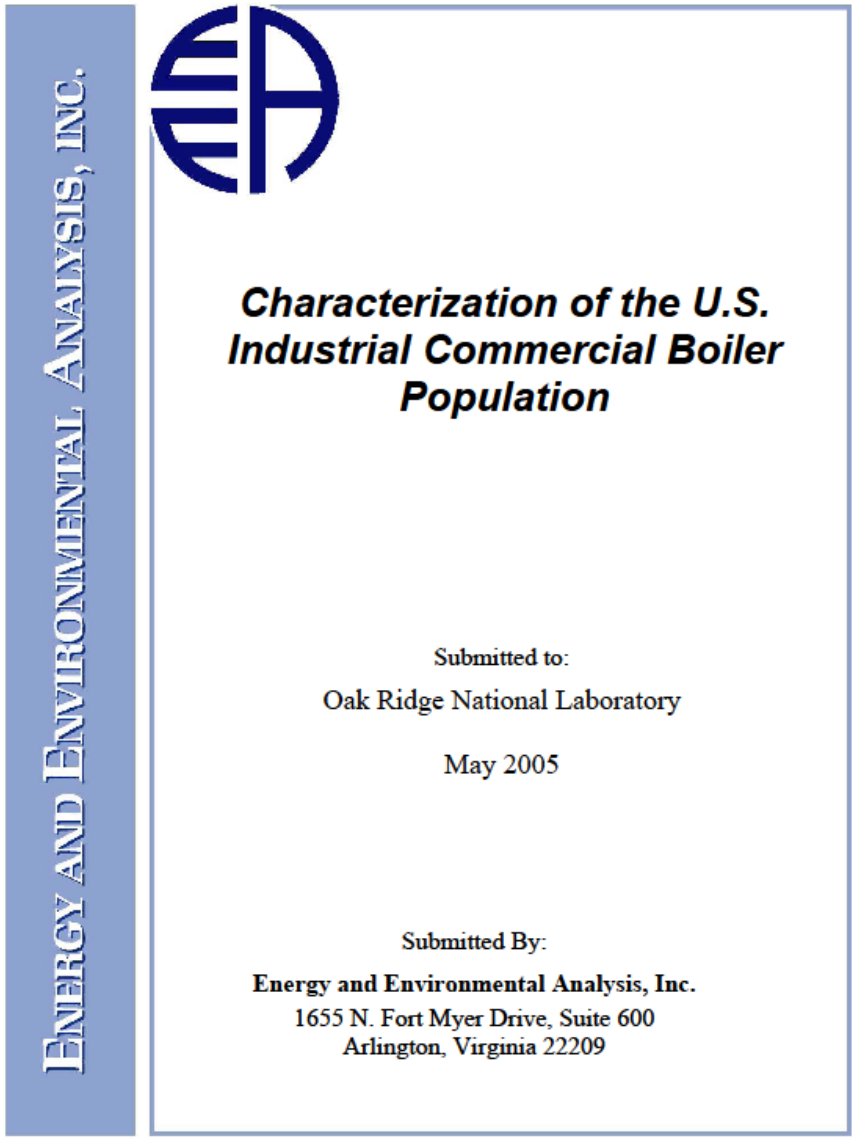

Total Industrial and Commercial Boiler Fuel Input (U.S)

2,714,397 MMBtu/hr
(x 24 hrs)
65,145,528 MMBtu/day
(x 365 days)

23,788,117,720 MMBtu/yr

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Cost to Our Nation…

23,778,117,720 MMBtu/yr
(x .66 hrs)
15,700,157,695 MMBtu/yr
(x .031)
486,704,888 MMBtu/day Loss
(x $10 for therms)

$4,867,048,885/yr

4,867,048,885 Therms
(/200)

24,335,244 Tons CO_2

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CHEM-AQUA

High Cost of Scale Deposits in a Steam Boiler

Boiler Load	Scale Thickness		
	1/64"	1/32"	1/16"
250 HP	$19,743	$40,294	$84,089
1000 HP	$78,971	$161,177	$336,355
60,000 lb/hr	$137,410	$280,448	$585,258

Fuel Cost = $10.00/MCF with a High Iron Scale Deposit

- Technical Bulletin 1-020
- Boiler Systems

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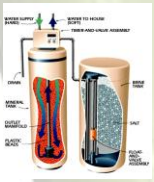
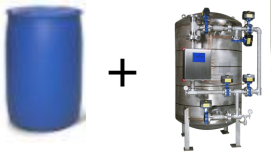
Scale Prevention



1) Eliminate Minerals and Impurities from Entering System via Make-up Water (proper system design with water softeners/RO systems)

2) Use Chemical Sludge Conditioners and Dispersants (part of water treatment contracts with 3rd party)

3) Blowdown & Daily Testing to prevent excessive concentration of solids (routine/daily maintenance)



4) Eliminate Iron and Copper Oxides from returning condensate (chemical condensate treatment & possibly addition of a condensate polisher)

5) Detect and Eliminate Process Contamination (detection is the key)

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Detection: Hardness in Make-up Water

Miura's Colormetry Unit

Automatically Detect Trace Water Hardness 24/7

- Samples Feedwater every 30-60 minutes
- Detects hardness below 1ppm
- Automatically increases surface blowdown when hardness is detected
- Interfaces with BL Controller & M.O.M.
- Easily replaceable cartridges
- Alarm Output for integration with Building Automation System
- Cost Range for Automatic Hardness Detectors = $2,000-$6,000

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Detection: Scale Present in Boiler

Miura's BL Controller

(normal)

(caution)

+

Built-in Boiler System

- Some Boilers have "Scale Detection" Sensor
- Thermocouples attached to tubes measure and trend metal temperatures
- When temperature increases beyond normal range, boiler alarms

Custom System

- Install thermocouples on flue gas and or boiler tube surfaces
- Trend monthly/weekly temperatures and look for rises
- Alert maintenance personnel ASAP

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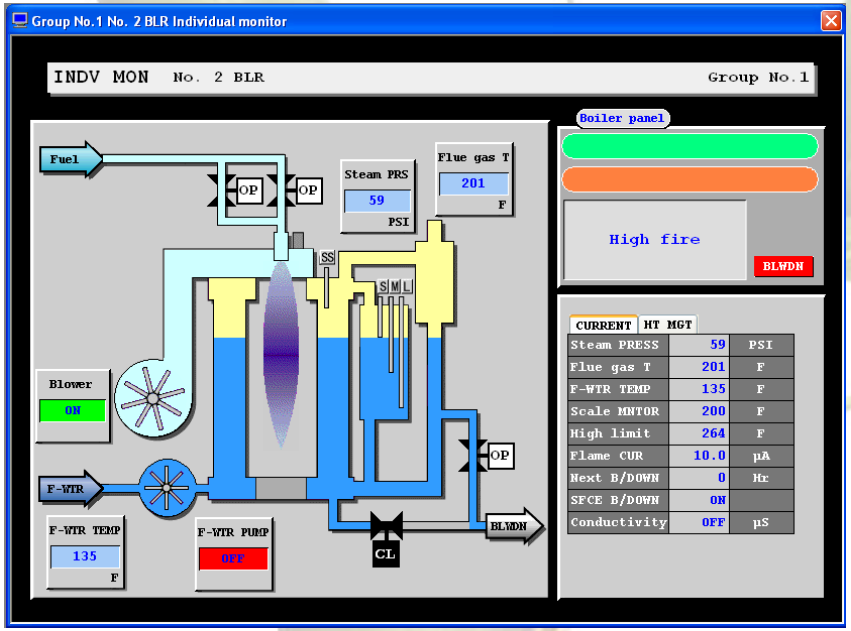
Remote Monitoring by Manufacturer

Miura's M.O.M. System



- Maintenance Budgets and Staffing are at an all time Low
- Ask you boiler manufacturer is they offer online monitoring and support

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MIURA BOILER

MONTHLY REPORT

CUSTOMER NAME: XYZ Company

BOILER MODEL: LX-200SG

SERIAL NUMBER: ####xxxx

REPORT DATE: 9/1/2007

REPORT ISSUED: 9/4/2007

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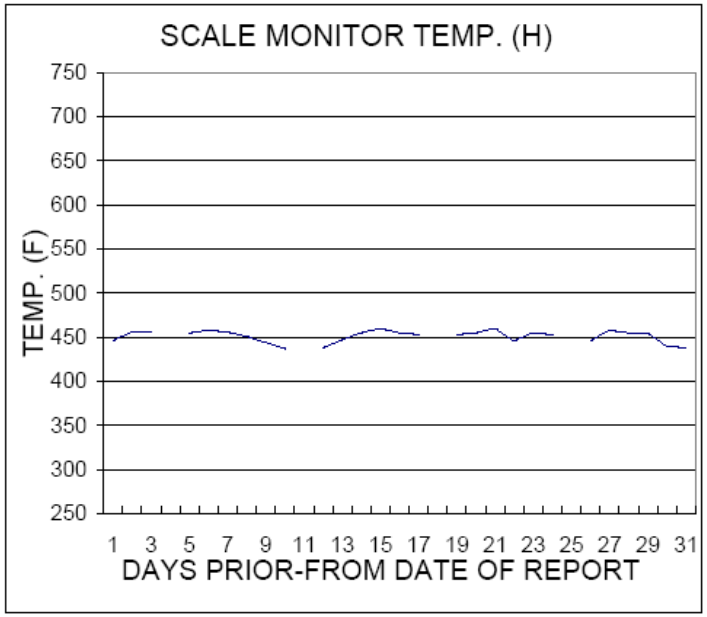
ATLANTA, GA
USA 30339

TEL: 770-916-1695
FAX: 770-916-1858

MIURA MONTHLY REPORT

MAINTENANCE DATA (MAX)			
ITEM	LAST MO.	THIS MO.	DIFF.
SCALE MONITOR F	456	460	4
FLUE GAS TEMP. F	316	327	11
CONDUCTIVITY x100	31	31	0
FLAME SIGNAL(MIN)	5	5	0
AMBIENT TEMP. F	120	131	11



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Cost to Our Nation…

$4,867,048,885/yr

24,335,244 Tons CO_2

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