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Case Study - 60 HP Low Pressure Steam Boiler - Scale

Case study updated on January 30, 2014



- Installer:** *HydroFLOW* Midwest - Master Distributor in the USA Upper Midwest.
- Customer:** Commercial trucking company from Rosemount, Minnesota. Please contact Bjorn Pearson, Manager at *HydroFLOW* Midwest, for customer information. Phone: 952-377-8860 Email: info@hydroflowmidwest.com.
- Application:** 60 horse power low pressure natural gas steam boiler (steam is used during the truck wash process).
- Installed Unit:** One *HydroFLOW* 45i on the water line feeding the steam boiler. Note: The system does not have a condensate return or deaeration (DA) tank.
- Water Source:** Well water with calcium carbonate hardness of over 200 PPM. A water softener reduces the hardness to roughly 30 PPM.
- Chemicals:** Water softener and BWT-250 "Complete Boiler Treatment".
- Timeline:** August 1, 2013 to January 28, 2014 (6 month evaluation).
- Background:** Due to excessive scale accumulation, even with softening and chemical usage, the head of maintenance decided to evaluate *HydroFLOW's* ability to descale the steam boiler and prevent further scale formation.

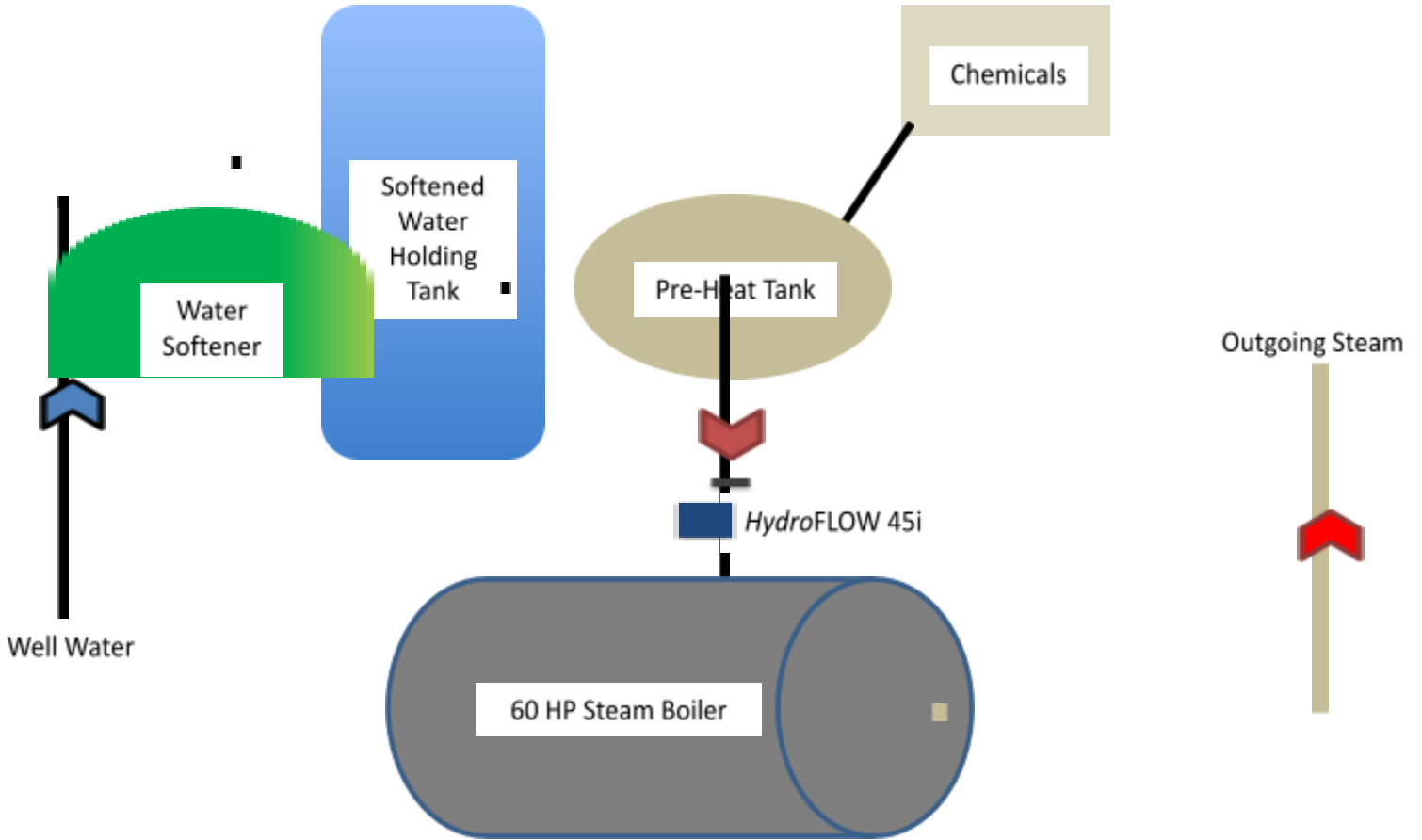
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Goal: Gradually remove scale deposits from the steam boiler's tubes without the need for an acid clean.

System Configuration:



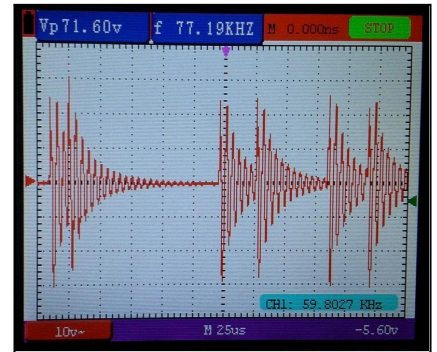
Water Softener



Pre-heat tank and chemicals



HydroFLOW 45i



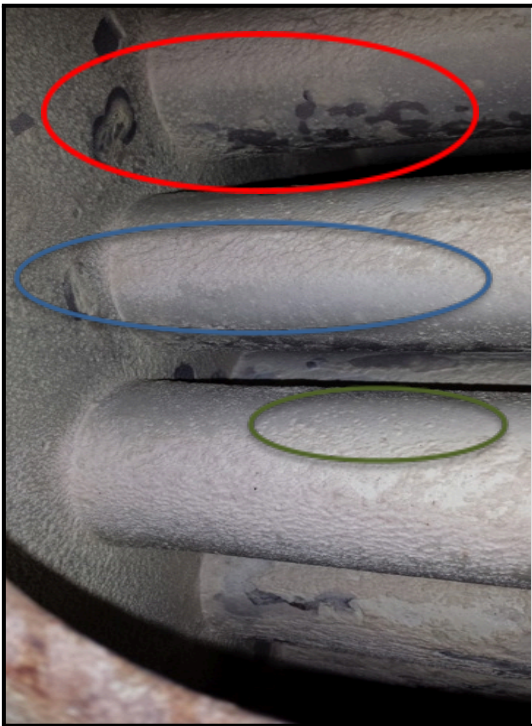
Hydropath signal

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Before and after pictures: Flakes and layers of scale are gradually being removed and existing scale is very brittle.



August 1, 2013



January 28, 2014 (6 months later)

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August 1, 2013



January 28, 2014 (6 months later)

Scale debris which settled at the bottom of the steam boiler consists of brittle flakes and white paste. The sample was removed through the bottom inspection port on January 28, 2014.



Results:

- ☐ Immediately following installation the maintenance supervisor increased blow down from once to twice per day. Increasing the blow down accelerated the removal of scale deposits and helped prevent any plugging issues. Upon completion of the cleaning process, the blow down regimen will be decreased.



- ❑ Stack temperature has dropped from 296° F to 272° F in 6 months, which demonstrates an 8% increase in heat transfer efficiency. The efficiency is expected to further increase as scale continues to be removed from the system.
- ❑ The removal of scale can be greatly accelerated if the steam boiler will be fed with unsoftened water, however, the water softener was not turned off as it serves the entire truck wash system and there is no bypass for the boiler feed.
- ❑ Chemicals are yet to be reduced. Note: Following a water analysis by a *HydroFLOW* representative, a significant reduction in chemical usage may be achieved. See below Steam Boiler Q&A and Water Test Requirements documents for additional information.

Return on Investment Calculation:

Steam Boiler Description				Hydro FLOW Solution			
Boiler Status	Existing	Remaining Life, yrs	30	Hydro FLOW Model	45i	Installed Price	\$5,500
Unscheduled Downtime to Replace Boiler, hrs			0	Payback Period	Months		Months
Est Boiler Replacement Cost (incl. installation), \$			\$60,000	Cash Flow Breakeven	5.8	Simple Payback	4.1
Boiler Production Capacity	Boiler Output (Horsepower)			Financial Return (ROI)	%		%
Boiler Output (Horsepower)	60			Internal Rate of Return	216%	Simple Return	296%
Cost, \$ /Therm	\$ 0.69	Scale Thickness, in.	1/8	Total Ownership Cost Savings			
Equipment Replacement				Financial Life Cycle Period for Analysis, yrs			
Piping, yrs	30.0	Tubes, yrs	30.0		Current	Hydro FLOW	Savings
Cost Incl Labor, \$	\$5,000	Cost Incl Labor, \$	\$30,000	Capital Equipment	\$ 95,000	\$ 5,500	\$ 89,500
Offline, hrs	48	Offline, hrs	48	Operating	\$ 4,130,450	\$ 3,746,812	\$ 383,638
System Parameters				Downtime	\$ 9,600	\$ -	\$ 9,600
Annual Hours of Operation, hrs (1 yr = 8,760)	8,420			Total	\$ 4,235,050	\$ 3,752,312	\$ 482,738
Revenue Lost When Boiler Is Offline, \$/hr	\$ 100			Cost of Capital	10%	NPV of Savings	\$ 120,210
				Average Annual Savings			
				\$ 16,275			

Low Pressure Steam Boiler Questions & Answers

What are the basic guidelines for steam boiler applications?

- ❑ Customer to provide *HydroFLOW* USA with DA/condensate tank feed water analysis, current chemical usage data and picture documentation of the steam boiler’s tubes and internal cavity.
- ❑ Install a *HydroFLOW* water conditioner before each boiler and condensate tank.
- ❑ Continue with the regular chemical regimen. An ROI of roughly 6 months will be achieved thanks to heat transfer efficiency gain, which is attributed to lessened fuel consumption due to scale removal.
- ❑ Water softener should be bypassed and chemicals should be reduced ONLY after the initial 3 month inspection proves the *HydroFLOW* device is operating properly. *HydroFLOW* USA will work with customer to determine which chemicals can be reduced.
- ❑ Periodic inspections should be conducted in order to locate a problem, and correct it, before it becomes severe.

How is it possible to know if the water conditioner is having a positive effect?

- ❑ A visual inspection of the steam boiler’s tubes and internal cavity should be performed in 3 month intervals. The purpose of the inspections is to verify that the water conditioner is removing and/or preventing lime scale accumulation.

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- ☒ As lime scale deposits will begin to remove; stack temperature is expected to gradually drop due to lessened fuel consumption. In new or recently cleaned boilers; stack temperature is expected not to significantly increase.
- ☒ If applicable, a gas/fuel meter feeding the steam boiler can be monitored in order to verify lessened fuel consumption.

Note: It is very important to obtain photo documentation of the steam boiler’s baseline conditions prior to the installation and during each inspection. The purging of lime scale can last up to one year if the existing lime scale deposits inside the steam boiler are extreme.

Possible negative effects?

Negative effects are not expected but the following side effects may occur:

- ☒ Removal of lime scale flakes could accumulate in the bottom of the steam boiler’s cavity and should be discarded if they impede the steam boiler’s operation.
- ☒ During the initial months of operation, lime scale debris may begin to clog the pump screen of the condensate tank or accumulate inside the condensate tank itself. The accumulation of debris will gradually decrease and eventually stop over time.
- ☒ Blown-down water may be reddish with rust and include lime scale particles that are being removed. Over time, the water will become clearer.

After installation, should the standard blow-down schedule be maintained?

The blow-down schedule should be increased by 50% during the initial purging stage of 3 ~ 6 months in order to assist in the removal of lime scale. Customer should consider implementing automatic blow-down in all steam boilers and introduce standardized boiler blow-down and maintenance procedures.

Is periodic water testing necessary?

Yes, refer to the “HydroFLOW Water Test Requirements for Steam Boilers” document.

What routine maintenance does the water conditioner require?

The water conditioner has no moving parts and typically lasts well over 10 years if maintained properly and installed with an adequate surge protection device. Weekly preventative maintenance inspections should include a visual check to ensure the mounting hardware is fastened securely, the red and green lights are glowing brightly, the ferrite ring is intact, the polymer screws are tight and the unit is clean.

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Water Test Requirements

Make-up water test requirements (from city or well) - water sample to be taken before the water softener and chemical injector.

- **Total Hardness in PPM (parts per million)^[1]**
- **Hardness as Calcium Carbonate (CaCO₃) in PPM**
- **Magnesium (Mg) in PPM**
- **Silica or Silicon Dioxide (SiO₂) in PPM**
- **Iron (Fe) in PPM^[2]**
- **Chloride (Cl) in PPM**
- **Dissolved Oxygen^[3]**
- **pH^[4]**
- **Alkalinity**
- **Conductivity**
- **Ferrous metal corrosion rate in MPY (mils per year)**

[1] Following proper installation of the *HydroFLOW* water conditioner on the steam boiler's incoming water line; the water softener should be bypassed and the use of scale inhibiting and anticorrosive chemicals can be discontinued.

[2] *HydroFLOW* water conditioners have no effect on iron. Consult with your chemical provider if iron levels are over 0.1 PPM (for low pressure steam boilers) or 0.05 - 0.02 PPM (for medium to high pressure steam boiler).

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[3] *HydroFLOW* water conditioners have no effect on dissolved oxygen. A deaerator and/or oxygen scavenger chemicals may be required if the oxygen level is over 0.04 PPM (for low pressure steam boilers) or 0.007 PPM (for medium to high pressure steam boilers).

[4] Low pH (acidic water) may be harmful for steam boilers. Consult with your chemical provider if the pH is below 7.5.

Blow-down water test requirements.

- **pH**^[1]

- **Conductivity**^[2]

- **Ferrous metal corrosion rate in MPY (mils per year)**^[3]

[1] It is recommended to contain a pH level of over 9. Chemicals may be required and blow-down may need to be reduced in order to increase the level of pH.

[2] *HydroFLOW* water conditioners are designed to work at high conductivity levels. It is recommended to follow the steam boiler's manufacturer instructions (typically 3,000 $\mu\text{S}/\text{cm}$). It is recommended to increase blow-down by 50% during the initial purging stage of 3 ~ 6 months in order to assist in the removal of limescale. As conductivity levels stabilize, the blow-down schedule can be reduced according to water testing parameters.

[3] Typically, although the actual corrosion rate is reducing, the measured corrosion rates (i.e. the amount of iron in the water) will increase following the installation of a *HydroFLOW* water conditioner due to the system being purged of existing limescale and corrosion deposits. Gradually, the measured corrosion rate will decrease and stabilize at roughly 30% less than what is was prior to the installation of the water conditioner.