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THE EFFECT OF

SYSTEM CLEANING WITH FERNOX CLEANER F3 ON A RESIDENTIAL HYDRONIC HEATING SYSTEM

Date of Testing: August 8, 2025
Location: Minneapolis, MN

Abstract

A trial was conducted to evaluate the impact of system cleaning using Fernox Cleaner F3 on the efficiency of a residential hydronic heating system. Testing was performed in an occupied residential property without modifications to the boiler or system configuration. Results showed a **20.4% reduction in time to reach boiler high limit temperature** and an **average increase of 13.2°F (13.8%) in baseboard emitter output** after cleaning. These findings suggest that system cleaning can significantly improve heating performance and may contribute to energy savings.

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1. Introduction

The efficiency of residential heating systems is influenced by more than the boiler's combustion performance. Key factors include emitter efficiency, system water quality, circulation rates, insulation, ventilation, and environmental conditions. Many of these are interdependent, making controlled efficiency studies difficult.

This trial simplifies the evaluation by focusing on measurable parameters before and after cleaning, including:

- Combustion characteristics
- Time required to reach the boiler's high limit temperature
- Baseboard emitter temperature output
- System water analysis, before and after cleaning

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2. Objective

The purpose of this trial was to assess the performance of a residential hydronic heating system before and after cleaning with Fernox Cleaner F3, using the boiler circulator for distribution. The goal was to identify measurable improvements in system operation that could indicate potential energy savings.

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3. Trial Parameters

Property:

- 3-bedroom home with attached 2-car garage, built in 1961
- Approximately 1,800 ft² of living space

Heating System:

- **Boiler**: Burnham P-204AH-WNI
  - Installation: 1997
  - Power: 96,000 Btuh input, installed 1997
  - Serial No: 17389003
  - Circulator: Grundfos UP1558FC, three-speed pump (non-ECM)
- **Emitters**:
    - Main level: 81 ft of ¾” copper baseboard with aluminum fin
    - Basement: Modine S160 unit heater
- **System configuration**: Single-pipe supply and return, emitters in series
- **Materials**: Primarily copper with minimal iron near boiler

Testing was conducted with stable internal and external conditions to minimize environmental effects.

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4. Methodology

4.1 Pre-Cleaning Testing

- **Combustion Analysis**: Measurement of O_2, CO, and stack temperature
- **System Warm-Up**: Stopwatch measurement from cold start to boiler high limit (180 °F)
- **Emitter Output**: Infrared (IR) photos of three baseboard sections (Living Room, Kitchen, Dining Room) using TopDon TC002C (iPhone 15)
- **Water Analysis**: A sample of system water was analyzed using laboratory equipment (i.e. ICP-AES, Autotitrator, IC etc…)

4.2 Cleaning Procedure

- Fernox Cleaner F3 introduced into the system
- The boiler gas supply was isolated but the circulator used for distribution during cleaning
- Post-cleaning flushing continued until system conductivity was within 10% of fill water
- Fernox Protector F1 was introduced after flushing

4.3 Post-Cleaning Testing

All pre-cleaning procedures were repeated after cleaning under the same test conditions.

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5. Results

5.1 Combustion Analysis

Combustion		
	Pre-Flushing	Post-Flushing
CO	5ppm	5ppm
CO2	8.8	8.7
O2	5.50%	5.60%
NO	117p	111ppm
NO2	8ppm	9ppm
Nox	127ppm	120ppm
Stack Temp	410°F	395°F

- Stack temperature reduced by 15 °F after cleaning.

5.2 Boiler High Limit

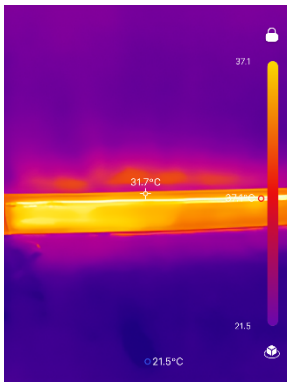
70°F - 180°F				
	Pre-Flushing	Post-Flushing	Time Diff	Time Diff%
Minutes	20.12	16.02	4.10	20.4%

- Time to reach 180 °F reduced by 4 minutes 10 seconds (20.4%).

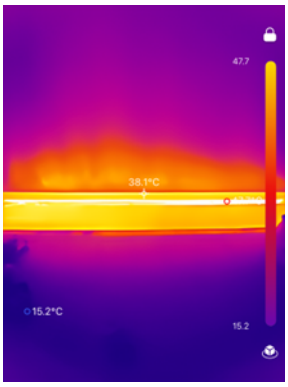
5.3 Baseboard Emitter Output

Living Room Baseboard

Pre



Post

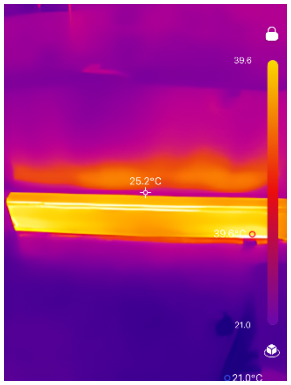


	Pre			Post		Diff ΔT	Δ%
Living Room Baseboard	31.7°C	89.06°F		38.1°C	100.58°F	11.52	12.9%

After the system was cleaned and flushed the living room baseboard output temperature increased by +11°F.

Kitchen Baseboard

Pre



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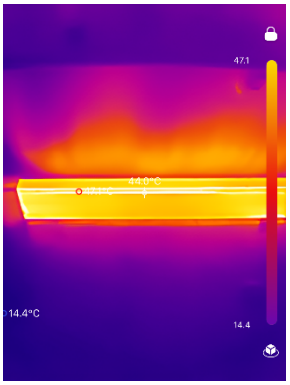
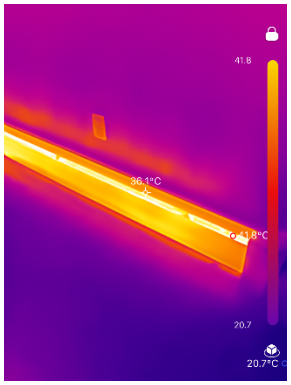


	Pre			Post		Diff ΔT	Δ%
Kitchen Baseboard	39.6°C	103.28°F		44°C	111.2°F	7.92	7.7%

After the system was cleaned and flushed the kitchen baseboard output increased +7°F.

Dining Room Baseboard

Pre



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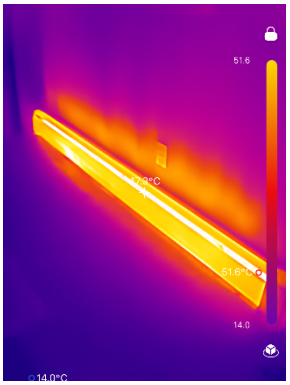

	Pre			Post		Diff ΔT	Δ%
Dining Baseboard	36.1°C	96.98°F		47.3°C	117.14°F	20.16	20.8%

After the system was cleaned and flushed the dining room baseboard output increased +20°F.

Summary

Location	Pre-Cleaning Temp	Post-Cleaning Temp	Change
Living Room	Baseline	+11°F	↑ 11°F
Kitchen	Baseline	+7°F	↑ 7°F
Dining Room	Baseline	+20°F	↑ 20°F

The average increase across emitters: **+13.2 °F (13.8%)**

5.4 Water Analysis

		Pre-Flush Date: 7/17/2025			Post-Flushing Date: 8/28/2025	
Test	Recommended Level	Mains Water Results	Sample Result		Mains Water Results	Sample Result
Apperance	0 (2max)	0	2		0	0
pH	6.6 - 8.5	7.8	9		7.6	8
Conductivity uS/cm	More than mains water	410	406		410	1305
M-Alkalinity as CaCO3 mg/L	300 mg/L > mains	190	221		202	1202
Total Hardness as CACO3 mg/L	50 to 200 mg/L	0	0		0	3
Hardness Desposition	Less than 30%		0			0
Calcium mg/L	For Information	0	0.2		0	1.2
Magnesium mg/L	For Information	0	0		0	0.2
Chloride mg/L	Less than 125 mg/L	24.1	20.8		23.3	26.8
Excess Chloride mg/L	less than 50 mg/L		0			3.5
Lithium mg/L	For Information	0	0		0	0
Sodium mg/L	Depends on treatment	103.09	103.2		98.36	255.5
Potassium mg/L	< 125 mg/L	21.5	1.1		0.3	2.9
Aluminium mg/L	< 3 mg/L	0	0		0	0
Iron mg/L	< 80 mg/L	2	2		0	9
Copper mg/L	< 3 mg/L	0	1		0	0
Phosphorus mg/L	< 80 mg/L	0.04	0		0.04	13.4
Boron mg/L	Depneds on treatment	0.02	0.1		0.01	0.3
Molybdenum mg/L	Depends on treatment	0.12	0.8		0	183.4
Nitrate mg/L	For Information		0.4			0.7
Nitrite mg/L	For Information		0			0
Sulphates	For Information		0			6.6
Refractive indext	Depends on treatment		0			0
Monopropylene Glycol %	> 25%		0			0

- **Pre-cleaning**: Water appeared turbid; pH indicated corrosive conditions; little/ no Fernox inhibitor present.
- **Post-cleaning**: Water clear with no sediment; pH stabilized at optimum level. Optimum levels of water treatment species present (e.g. molybdenum). System is in compliance with Fernox recommendations.

7. Discussion

Cleaning with Fernox Cleaner F3 improved overall system performance in measurable ways:

- Lower stack temperature and faster system warm-up suggests more efficient heat transfer
- Significant emitter temperature increases demonstrate better heat delivery into the living space.

These results provide strong evidence that cleaning with Fernox Cleaner F3 can enhance system efficiency and reduce system energy consumption.

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8. Conclusion

This study demonstrates that cleaning a residential hydronic heating system with Fernox Cleaner F3:

- Improves heat transfer and delivery
- Reduces warm-up time by over 20%
- Increases emitter output by an average of 13.8%

Such improvements contribute to reduced energy usage and enhanced comfort for homeowners.
