



Energy
Efficiency
Program

Emerging Technology Program

#1137: Hydronic Heating Plumbing System Flushing

Final Public Pilot Project Report

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Executive Summary

Introduction

As part of the Nicor Gas Energy Efficiency Program, the Emerging Technology Program (ETP) assesses new technologies that have the potential to realize natural gas savings for the 2.3 million Nicor Gas customers in Northern Illinois. GTI Energy provides program implementation for the Nicor Gas ETP. This report summarizes the findings of field evaluations for flushing hydronic heating systems using two types of established industrial chemical descalers. Also summarized are the potential energy efficiency savings applicable to Nicor Gas commercial and residential customers, from restoring an obsolete hydronic heating system to a like-new condition.

Background

Space heating systems like steam and hot water radiators are often fouled with contaminants resulting in surface scaling and sludge formation. Buildup of sludge and an oxide layer reduces the efficiency of these systems due to corrosion and poor heat transfer. They also reduce the active radiator area resulting in cold areas on the equipment. There are two alternatives to restoring the piping system to optimum operation—chemically flushing the entire piping system or replacing the entire system.

The process of chemically cleaning and removing the deposits from hydronic heating systems is called 'flushing'. Presence of sludge on the inside of radiator piping impedes heat transfer and reduces flow rate of heating fluid.

This is evident by a simple 'touch test' performed when the radiator is operating at full capacity, where the surface of the pipes without clogs will be hot to touch and cold where the pipes are clogged. A more accurate estimation would be to measure the hot water flow rate across the radiator and the return temperature from the loop. A fouled piping system will have a higher return temperature and a lower flow rate leading to lower effective heating efficiencies. Chemically de-scaling the pipes is expected to restore them to near original condition and increase the efficiency of the hydronic system. The market for this technology represents approximately 10% of residential housing and 30% of commercial spaces in the U.S., or about 120 million radiators.

Potential Savings

Potential savings from restoring clogged radiators to like-new condition are multifold:

1. Improved heat transfer between the steam/hot water, radiator surface and the conditioned space.
2. Extended equipment life due to reduction in hot and cold spots.

3. Fuel savings due to increased combustion efficiency assuming constant steam/hot water production before and after flushing.

Field Demonstration

This Nicor Gas ETP pilot field study was done at a multi-story office building in Rockford, Illinois. The goal was to investigate the effectiveness of chemical descalers on smaller hydronic heating equipment like radiators. The building had more than 150 two-pipe steam radiators located in office spaces, lobbies, hallways and stairwells. A central boiler circulated the low-pressure steam in a loop to all the radiators. The supplied steam was at 5psig.

Many sites like this one that have fouled radiators are unaware of the cause of the decline in their efficiencies. In many cases, commercial buildings resort to installing supplemental heating systems to satisfy the heating loads. For example, the selected site installed packaged rooftop units (RTUs) which provide supplemental heating to the building. They have multiple radiators in place which are not being used. If the radiators are restored to optimal operating conditions, the need for the RTU heating will be eliminated.



Figure 1 Steam Boiler serving the hydronic heating radiators

Results

Chemical descaling was first tested on the clogged radiators using an industry established biodegradable descaler. However, the solution was ineffective on the scaling due to the primary source of scales being rust, loose metal flakes and other deposits.

Secondly, a stronger acidic chemical descaler from another vendor was used for the procedure. The results were inconsistent – either the loose metal flakes did not react with the chemicals and remained in the radiator pipes or the chemical solution ate away the metal leaving the pipe structure vulnerable.

Flushing was found to be inconsistent and ineffective for scaled cast iron radiator systems. The ideal cost-effective path to restore a clogged radiator system is by replacing it with a new unit. This avoids any possible inconsistencies associated with a radiator-flushing procedure (e.g., less-than-expected savings, failure to return the pipe system to like-new condition, inability to treat a system due to its interlinking with separate domestic hot water systems). This offers benefits during heating seasons for natural gas, is applicable to both residential and commercial applications, and considers hot water or steam as the source of thermal energy (seeing as both heat transfer mediums can theoretically act as the intermediary from which contaminants precipitate).

Table 1 Annual Normalized Gas Savings per Surface Area (therms/ft²)

HVAC System Type		1 - Rockford	2 - Chicago	3 - Springfield	4 - Belleville	5 - Marion
Hot Water Radiator	Standard Scaling	0.115	0.113	0.102	0.091	0.094
	Heavy Scaling	0.337	0.332	0.301	0.269	0.278
Steam Radiator	Standard Scaling	0.170	0.168	0.152	0.136	0.140
	Heavy Scaling	0.501	0.493	0.447	0.400	0.413

Implications for Energy Efficiency Programs

This pilot investigated the most cost-effective process to restore clogged hydronic heating radiator equipment to optimum efficiency. Most facilities tend not to replace their old radiators and often add a means of secondary heating. Hydronic Heating Flushing is aimed to incentivize the replacement of the old radiators or delay it. Markets that could be addressed with this technology include all buildings heated by hot water or steam radiators, such as residential, office buildings, dormitories, multifamily buildings, and senior living. Many pre-1970 residential and multi-family homes near the Chicago periphery can benefit from this technology. Additionally, many public sector building types heated by radiators can benefit from this technology.

Nicor Gas and GTI Energy have drafted a technical workpaper based on the pilot results with the intent to incorporate this measure into the 2020/21 cycle of Illinois Technical Resource Manual (TRM) measure additions. The measure is geared to target the retrofit market in the commercial and residential sector with old radiator systems.