Emerging Technology Program

#1092: Commercial Foodservice Modulating Valve

Public Project Report – Executive Summary

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Full Report

The following executive summary is made publicly available by Nicor Gas as part of their Emerging Technology Program (ETP). The detailed Nicor Gas ETP report is available to qualified state and utility run energy efficiency programs upon request. Please contact the Nicor Gas ETP administrator at NicorGasETP@gastechnology.org to find out how to access the full report.

Executive Summary

Introduction

As a part of the Nicor Gas energySMART energy efficiency program, the Emerging Technology Program (ETP) assesses new technologies that have the potential to realize natural gas savings for the 2.2 million Nicor Gas customers in Northern Illinois. These customers include a mix of commercial, industrial and residential accounts. The Gas Technology Institute (GTI) provides program implementation for the Nicor Gas ETP. This report summarizes the laboratory findings to evaluate a modulating valve retrofit and its potential to provide energy efficiency to Nicor Gas commercial customers.

Background

The Nicor Gas ETP piloted the modulating valve technology in a past field evaluation where it was applied to commercial clothes dryers. In that application, the technology showed an average savings of 14% of annual natural gas use. The manufacturer recently began applying their modulating valve technology to ovens and fryers in the commercial foodservice sector. The manufacturer indicated they found 15-20% gas savings with the modulating retrofit on fryers and ovens, which is similar to the 13.8% savings found with clothes dryers earlier in the Nicor Gas ETP. GTI used PG&E Foodservice Technology Center data in conjunction with the Energy Star savings tool[1] to estimate the annual natural gas usage for a fryer and oven, which is 1,581 and 800 therms, respectively. Given the manufacturer's initial savings claims, this translates to an estimate of roughly 120-320 therms saved annually, depending on the equipment being modified and the usage at the specific restaurant or foodservice facility. In this scenario, the technology would have a 3.4-year payback in a mature market when the initial installed cost is projected to be $600 (currently at $825) with annual gas savings estimated at 237 therms (15% savings on annual fryer usage of 1,581 therms). A gas price of $0.75/therm was used for this calculation.

Results

Three test runs were conducted at GTI laboratories in Des Plaines, Illinois on baseline equipment and three additional runs completed after the modulating valve had been installed on both the fryer and oven. GTI evaluated the retrofit modulating valve on a Pitco Frialator AG14S fryer and Blodgett DFG100 oven in a laboratory setting. All of the tests were completed at 50% of the full load called for in the standard test procedures. Results showed little impact on efficiency for the oven; the results were within the error potential of the test (see below table). The fryer showed an actual decrease in efficiency of 12%, but the error margins are high enough on the test that if the baseline is 2.9% lower and the modulating 1.9% higher they could almost have the same efficiency. The production capacity for 50% full load was much better than results at 100% full load. At 50% load the

[1] Energy Star Website: US EPA and DOE Savings Calculator for Energy Star Certified Commercial Kitchen Equipment, http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx, accessed March 16, 2015

modulating technology performed on par with the baseline. However, the modulating technology performs 20% better at 50% than at a full load. A full-load test was conducted with the Northwest Energy Efficiency Alliance (NEEA) at a GTI laboratory facility, but results are not publically available at this time. Even at full-load testing, cooking efficiency and production capacity do not result in any improvements.

	Cooking Efficiency (%)	**Production Capacity (lb/hr)**
Oven Results		
Baseline	35.6% ± 0.5%	44.7 ± 4.4
Modulating	35.4% ± 1.2%	45.4 ± 1.8
% Improvement	-0.6%	1.5%
Fryer Results		
Baseline	48.3% ± 2.9%	39.7 ± 2.0
Modulating	42.3% ± 1.9%	36.9 ± 0.5
% Improvement	-12.4%	-7.1%

The modulating valve technology used on commercial clothes dryers uses a temperature sensor in the flue to determine when the lower firing rates should be used in addition to toggling the firing rate back and forth during normal operation. The control can be set to run in the low fire once a certain adjustable temperature is reached. In a commercial foodservice (CFS) appliance use, the modulating valve does not cycle around temperature but only switches back and forth on a timed schedule between high and low fire during normal burner operation. It is possible that the cycling around a temperature, as with the dryer application, is what drives the large percentage of the dryer savings.

It should also be noted that clothes dryers and commercial foodservice equipment operate in a different manner. Dryer operators tend to operate a dryer for a set amount of time and the clothes are removed upon shut-off. Depending on the load and moisture content, the load may require the entire drying cycle on the high firing rate to dry, or the load may be dry or nearly dry before the cycle terminates, thereby benefiting from the reduced firing rate. The operation differs in the CFS environment where the food is being cooked to a specific cook point and removed immediately upon having reached that point to avoid overcooking. The ASTM test procedures require the exact same amount of cooking to be done by monitoring moisture content and weight for French fries in the fryer or the temperature of potatoes in ovens. A large percentage of savings from the clothes dryer application may be attributable to saving energy during that over-drying time (e.g. when the cycle is not complete yet, but the clothes are already dry). In foodservice, the same opportunity does not exist. It is possible that in real world usage a fryer or oven operator might cook a food product for the same time and not notice a small difference in doneness of the food, which would more than likely result in energy savings with the technology. *However, when the food is cooked to the same doneness it appears that there are no measurable energy savings in a fryer or oven at a full load or 50% load cook testing.* The slight decrease in efficiency at 50% load testing with the fryer may be

attributed to a slightly longer cook time needed and potentially higher energy losses out of the open vat fryer during the longer cook time.

Although this testing does not show similarly significant savings as the clothes dryer application, it does not necessarily mean that modulating burner technology will not work well in foodservice applications. GTI believes it is possible that the simple control scheme of toggling back and forth without any feedback could be leaving potential energy and performance savings on the table. Controlling the modulation around a setpoint as is done with dryers, has the potential for both higher energy savings and better temperature control. Modulation with temperature control could be used to eliminate any overshoot in recovering from a load drop on a fryer. In addition, if the modulation is controlled by the fryer or oven control settings, the high fire could be used for preheat to eliminate slow preheat issues. This control scheme would be the most effective by integrating it with the equipment controls around the setpoint.