Emerging Technology Program

1009: Commercial and Industrial Air Curtains

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

The Nicor Gas Emerging Technology Program (ETP), a part of the utility's ongoing energySMART Energy Efficiency Program (EEP), assesses new or underutilized technologies that have the potential to provide natural gas savings for the 2.2 million Nicor Gas customers in Northern Illinois. The Gas Technology Institute (GTI) implements the ETP for Nicor Gas. This report summarizes the findings from an evaluation of air curtains and their potential to provide a new energy efficiency measure to Nicor Gas commercial and industrial (C&I) customers.

Background

Commercial and industrial facilities have traditionally utilized overhead doors in shipping/receiving areas to create a barrier between the conditioned indoor air and outdoor air. In colder climates, the opening of the overhead doors creates a scenario for sudden, high heat loss to lower temperature outdoor environments. This results in an increase in heating energy use, and often dictates an increase in heating equipment capacity, to help overcome those losses and maintain better control of the temperature indoors.

Documentation of third party testing or even modeling of the heat loss mitigation by air curtains in shipping/receiving overhead door applications appears to be very limited, although other air curtain applications appear to better documented. Those other applications encompass doorways into cold storage rooms, such as in grocery warehouses, and customer (pedestrian) entrances/exits in retail stores, as an alternative to vestibules.

Based on these resources, air curtain technology has the potential to significantly reduce these heating losses through an open doorway. Industry literature and research studies by third parties show that the installation of properly applied air curtains can reduce the airflow through the open doorway, and in turn the heat loss, by as much as 75%.

Results

This pilot assessment evaluated air curtains as a method of decreasing gas heating consumption by reducing heat loss through overhead doors when open to the outdoors. Air curtains operate when the door is open and blow a sheet of air downward to the floor to prevent the heated indoor air from being displaced by an inrush of cold outdoor air.

ETP executed the field-based pilot of this technology at three industrial supply warehouses in the Chicago area over approximately five months. All three were branch locations of a single supply company, which utilize a grade level dock door to load customer vehicles. Pertinent site data is found in Table 1. Each store was retrofitted with an air curtain on the overhead door in the warehouse space. Heating equipment runtime (gas consumption) along with overhead door activity (open time) was recorded without air curtain operation for approximately two months and then with air curtain operation for approximately three months, providing comparison data to estimate energy savings.

Table 1: Site Data

Location	Arlington Heights, IL	Franklin Park, IL	Morton Grove, IL
Door Size	10 ft. wide 10 ft. high	10 ft. wide 12 ft. high	8 ft. wide 10 ft. high
Affected Heating System Capacity	200 MBH	400 MBH	300 MBH

The following relevant data was collected:

1. Heating system gas valve firing time
2. Air curtain runtime (coincident with door opening periods)
3. Indoor air temperature at three locations evenly spaced from the doorway
4. Outdoor air temperature
5. Wind speed and direction

The gas valve firing time was used with the nameplate input rating of the heating systems to determine gas consumption. The air curtain run time in conjunction with a one-time measurement of the voltage and amperage was used to determine electric usage for the three phase air curtain at Franklin Park. The air curtain run time in conjunction with nameplate voltage and amperage was used to determine electric usage of the single phase air curtains at Morton Grove and Arlington Heights.

The monitoring period began at each site with the air curtains off. This would provide baseline data from which the savings provided by air curtains would be calculated. The data acquisition system (DAS) recorded the gas valve on the affected heating system as it opened and closed. A current switch was installed to establish the air curtain operation and door open time periods.

Three space temperatures were measured, one near the door and two others at equally spaced distances from the door. This data provided verification that the air curtains were effectively operating. Outside air temperature, wind direction and speed were recorded as well.

Baseline data was taken at 30 second intervals until the door was opened. While the door was open, metering was performed at 3 second intervals. This allowed for the thermal decay of the indoor temperatures to be noticeable and help validate proper air curtain operation and savings.

In order to normalize the difference between baseline operation and air curtain operation, the gas use was compared to the amount of door open time and heating degree days (HDD) on a daily basis. A ratio of gas use to HDD and door open time in seconds was created (Btu/HDD-sec). The difference between the baseline and air curtain operation ratio of gas use to HDD and door open time represented the savings from the operation of the air curtains. Incremental gas savings from the installation of air curtains was calculated based on the difference between these ratios.

Wind speed and direction data was collected on-site. Due to the built-up environment at the host sites, i.e. effect of other nearby buildings, there were dramatic variations in the dataset involving wind speed and direction. No meaningful statistical correlation of wind speed and direction could be developed in conjunction with the balance of the dataset.

Unfortunately, at two of the sites in Morton Grove and Franklin Park, the heating equipment was of inadequate capacity and ran continuously during building operating hours over much of the heating season. As a result, no significant cycling of the heating equipment occurred to form the

basis for gas savings with air curtain operation versus without. The third remaining site in Arlington Heights, was equipped with adequate heating capacity and had sufficient cycling to provide a basis for gas savings.

Based on the air curtain operation at the Arlington Heights site, gas heating consumption was reduced 42.5% resulting in an annualized savings of 427 therms, along with 259 kWh in net electricity savings over a year. That yielded an annual energy cost savings of $378, with gas and electricity costs of $0.8405/therm and $0.0752/kWh, respectively, per the 2014 pricing assumptions of the Nicor Gas Energy Efficiency Program (EEP). Based on a total installed cost of $13,662 for the air curtain ($7,660 for equipment and $6,002 for installation), which is indicative of representative industry costs, a simple payback of 36.1 years is estimated.

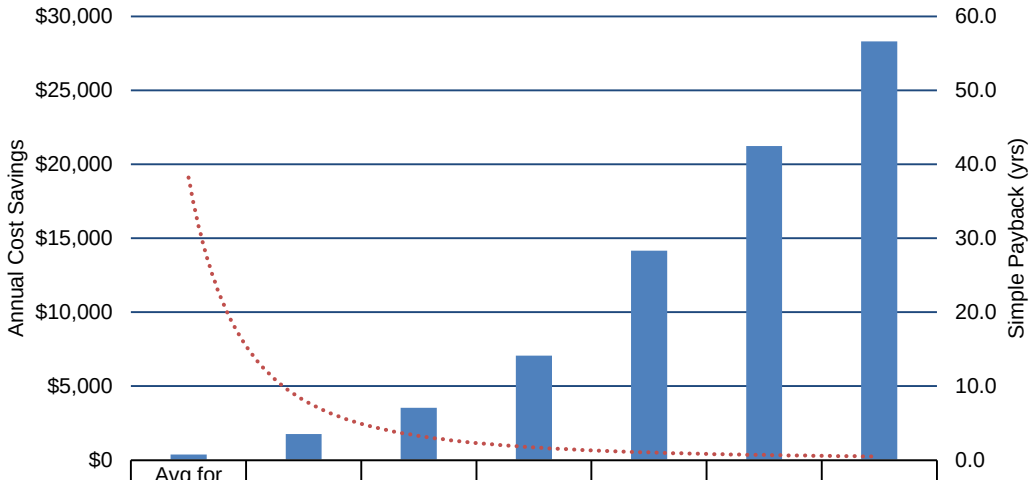
However, these resulting economics for the pilot assessment were the outcome of a relatively low amount of door use – about ½ hour per day; five days a week. As the amount of time that the door is open increases, paybacks drop proportionately. Simple paybacks drop to 3.9 years with door open time of three hours per day over five days a week, or 15 hours total per week.

Table 2 shows economics normalized to the National Climatic Data Center (NCDC) 30 year (1971-2000) average HDD65 of 6,498 for O'Hare International Airport rather than for the observed 2013/2014 heating season only.

Table 2: Annual Operating and Payback Economics for 30 Year Average Weather

	Arlington Heights
Annual Natural Gas Savings (therms)	383
Annual Natural Gas Cost Savings	$321.72
Annual Natural Gas Savings (%)	42.5%
Annual Electric Savings (kWh)	226.4
Annual Electric Cost Savings	$17.03
Annual Total Cost Savings	$338.75
Natural Gas Savings of Door Area (therms/ft^2)	3.83
Installed Cost	$13,662.03
Simple Payback (years)	40.3

Door open time is a key factor in energy savings and payback economics. The average door open time at the Arlington Heights site was 0.32 hours/day. Figure 1 shows energy savings and simple paybacks resulting from various, higher door open times up to 24 hours of door open time per day. Payback decreases proportionately with longer door open times. Based on air curtain industry literature [Marley Engineered Products. 2008. Leading Edge: A Marley Engineered Products Brand, Design and Applications Guide: Air Curtains, http://www.marleymep.com.], the dataset at the Arlington Heights site may be on the lower end of door open time experienced in the marketplace. Although this pilot demonstrated heating savings, the door open time, along with door size, will need to be a major consideration in the structuring of any energy efficiency program measure looking to maximize therm savings.



	Avg for Data Set - 0.32 hours/ day	1.5 hours/ day	3 hours/ day	6 hours/ day	12 hours/ day	18 hours/ day	24 hours/ day
Cost Savings	$377	$1,769	$3,538	$7,076	$14,153	$21,229	$28,305
Simple Payback (yrs)	36.2	7.7	3.9	1.9	1.0	0.6	0.5
Gas Savings (therms)	425	1,975	3,949	7,899	15,797	23,696	31,594
Gas Savings per Door Area (therms/ft^2)	4.25	19.75	39.49	78.99	157.97	236.96	315.94
Electric Savings (kWh)	257.8	1,453.3	2,906.7	5,813.4	11,626.7	17,440.1	23,253.4

Hours per Day of Door Open Time (Weekdays Only)

Figure 1: Cost Savings & Simple Payback at Varying Door Open Times

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