NORR
An Ingenium Group Company

Final Report

Toronto District School Board
Reverse Flow® Pilot Project
Sir Oliver Mowat C.I., Scarborough

NORR Project No. 04044

September 7, 2007

Executive Summary

NORR Architects and Engineers was retained by the TDSB Energy Management group to evaluate the application of Reverse Flow® heat recover system at a typical school. In addition to the providing design and construction review, NORR's role was to evaluate the performance of the Reverse Flow unit on the roof of Sir Oliver Mowat CI over the course of an operational year.

Significant Dates through the Monitoring Period:

- December 13, 2005 Start Date for Data Acquisition
- February 24 – March 8 – Broken Fan Belt on AHU
- April 25 – April 30 – Lost Data
- May 29 – August 19 – Deleted trend logs and incorrect trend logs
- September 17 – November 20 – Lost Data
- December 16, 2006 – Stop Date for Data Acquisition
- January 19, 2007 – Draft Final Report issued to TDSB
- March 1, 2007 – Start Date for Verification of Data Repeatability
- May 31, 2007 – Stop Date for Verification of Data Repeatability

While there were gaps in the data collection, the data collected allowed for the creation of a model of the equipment performance at this particular installation.

The equipment performed as promised by the supplier and annual savings based on the heat recovery confirmed the suppliers literature.

Based on the 2006 Data NORR has calculated that the annual savings expected at this installation are typically $30,800. With the cost of construction corrected to omit the monitoring costs the simple payback for this installation is 5.85 years.

In order to confirm the model, NORR collected data for an additional 3 month period from March 2007 thru May 2007. The data collected in 2007 was graphed against the data from the previous year.

The consolidated 2006 & 2007 data analysis projects an annual savings expected at this installation to be typically $30.200. With the cost of construction corrected to omit the monitoring costs the simple payback for this installation is 6 years.

With the strong linearity of the data and the further confirmation of the data from the supplemental monitoring from 2007 NORR is confident in the projected energy savings for years moving forward.

NORR believes that this project successfully demonstrates that the Reverse Flow technology performs as published and that real-life energy savings match the predicted performance.

Introduction

NORR Architects and Engineers has been retained by the TDSB Energy Management group to evaluate the application of Reverse Flow® at a typical school. NORR's role is to evaluate the performance of the Reverse Flow unit on the roof of Sir Oliver Mowat CI, provided over the course of an operational year.

Reverse Flow®

Reverse Flow is an energy recovery system consisting of a pair of aluminium cartridge assemblies and damper arrangement. The Reverse Flow is connected to both the relief (or exhaust) ductwork and the fresh air intake for the HVAC unit.

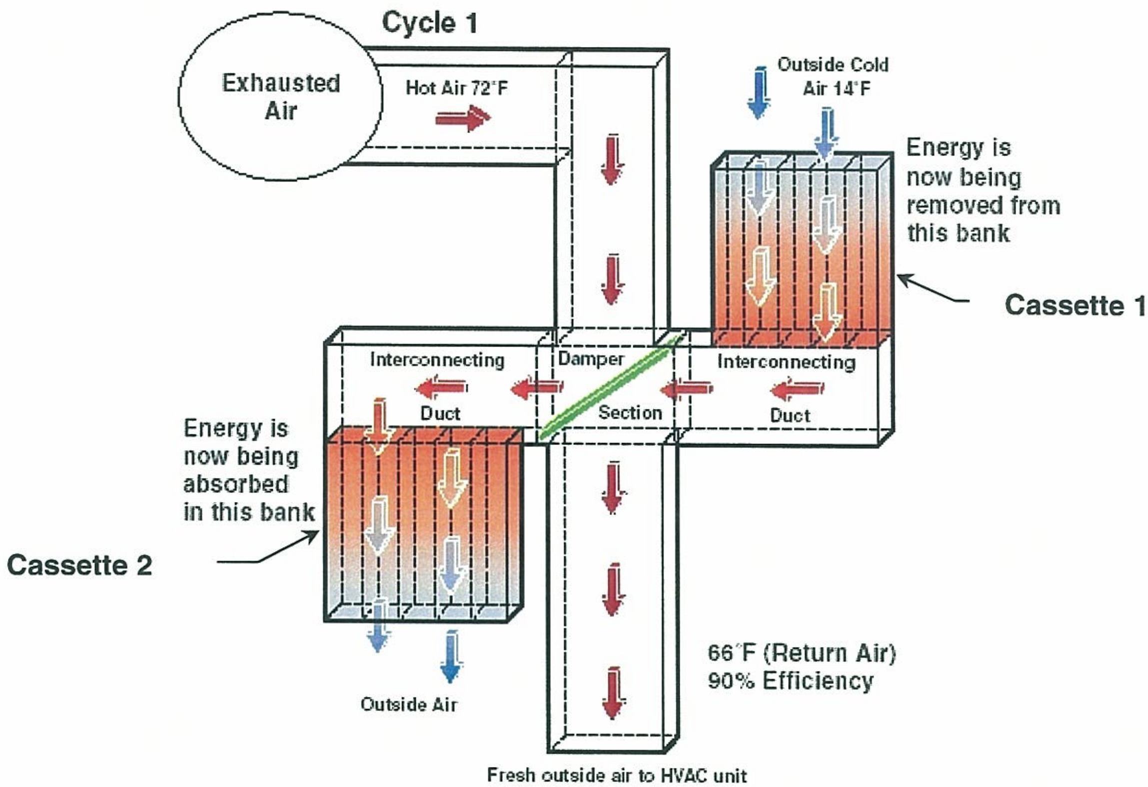

Figure 1 - Reverse Flow Cycle 1

In operational mode the damper will oscillate from position 1 to position 2 approximately every 70 seconds (adjustable). In Cycle 1 the damper is in position 1 and the fresh air is drawn through the charged cassette (Cassette 1). This air directed into the HVAC unit by the damper. The cassette is essentially a large mass of aluminium. As the air passes through the warm cartridge, heat and moisture is exchanged with the incoming air. In the winter, the warm cartridge will heat up the fresh make-up air reducing the burden on the boiler. At the same time relief air is exhausted through the other cassette. Cassette 2 is cold from the previous cycle and therefore is heated up by the relief air. Furthermore, moisture from the moist indoor air will condense on the surface of the cartridge.

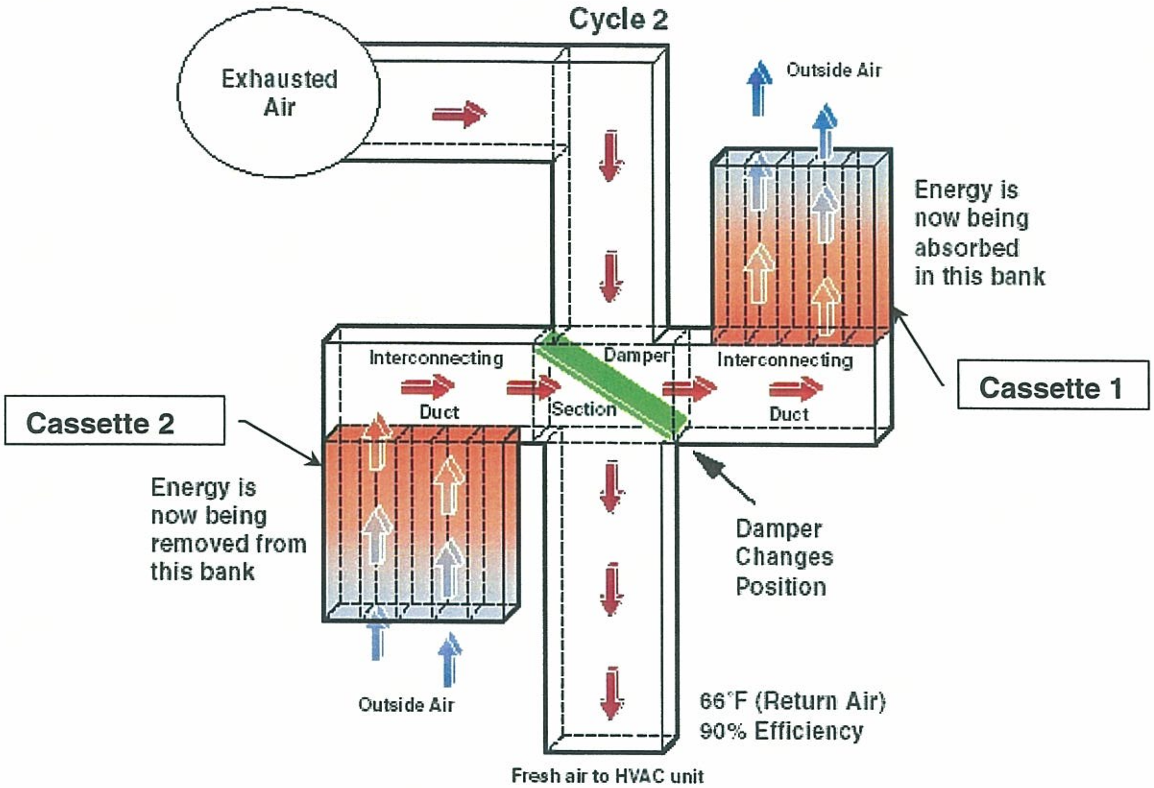

Figure 2 - Reverse Flow Cycle 2

After a set period the damper switches to position 2 and the direction of airflow through the cartridges is reversed. Cassette 1 is now cooler from the previous Cycle 1 operation and Cassette 2 is warmer. Incoming air passes through warm cassette in the reverse of the process indicated in Cycle 1.

The period of the oscillation determines how long the warm moist air is passed through the cold cassette. A longer period means that more water will condense and be drained away. A shorter period would cause the water to condense, but it would not accumulate enough to drain away & therefore when the airflow direction is reversed that moisture will be recovered.

In addition to the damper oscillation the temperature difference between the two airstreams is critical. A small difference between the two airstreams means that very little heat will be recovered. However, this also means that very little energy is required to reheat this air to the desired temperature and therefore is not a concern.

Site Selection

Sir Oliver Mowat CI was selected as an appropriate site for the installation of this technology. The school has a pool which is ventilated with a separate HVAC unit located in a mechanical penthouse.

The Reverse Flow unit is well suited for application of at a pool location for humidification control . The airflow of warm damp air from the pool through the cold cassette causes the water vapor to condense. The longer the period between damper operation, the more water will condense on the cassette, which will eventually drain off. The amount of dehumidification is limited by the amount of heat stored in the cassette. However not all the water drips off the cassette and when the damper position is switched, the cold dry air is preheated and absorbs some of the condensed water from the cassette. This is important for humidity control in a pool application, as by supplying dry air to the pool area it encourages more rapid evaporation of water from the pool.

The disadvantage of this site is that there is no year-round conditioning of the pool air. That is, there is no mechanical cooling of the pool environment in the summer operation.

Existing HVAC Systems – AHU-09

AHU 09 serves the pool at Sir Oliver Mowat. The unit is located in a second floor mechanical room located above the change rooms. Roughly 10,000 cfm of supply air is discharged through the wall of the mechanical penthouse into the high ceiling of the pool area. The air is distributed around the pool deck via a network of ducts. Return grilles are located both at a high level and at lower level closer to the deck. The return fan returns 10,000 cfm back to the mechanical penthouse. The return air is relieved to outside or returned to be mixed with incoming fresh air. The current setpoint is fixed at 80% fresh air. Relief air is discharged through the exhaust/relief louvre on the south side of the mechanical room. Fresh air is drawn from a louvre on the north side of the mechanical room.

The unit itself is comprised of a return fan, mixing box, V-bank filter section, HW heating coil and supply fan.

Unit Operation

The Reverse Flow unit essentially is controlled by the BMS for ON/OFF operation only.

The unit will operate in two distinct modes. In operational mode, when outdoor air temperature is low enough, the unit will be in "*Heat Recovery Mode*" with the damper oscillating to control space humidity and recover the heat.

The second mode is the "Free Cooling Mode". In this mode, the damper period is extended to approximately two hours. Fresh air is brought into the pool without heat recovery. The long period of damper operation allows the unit to reverse the air flow through the cassettes periodically to take advantage of the "self cleaning" properties of the reverse flow arrangement. "Free Cooling Mode" is a misnomer in this installation as it is not free cooling but heat recovery is not required since the outdoor air temperature is greater than the indoor air temperature.

Data Logging & Calculations

A series of trendlogs automatically recorded four data points every 15 minutes since the start of the monitoring period. The trendlogs recorded the outdoor air temperature, airflow, air temperature after the reverse flow unit and the unit