Hy-Vee Store #1054

EnerFreeze Custom Rebate Evaluation

Hy-Vee Inc
Cedar Rapids, IA

Michaels No.: A8410AAN.FEX

November 2012

1. Executive Summary

This case study was completed through the Alliant Energy Custom Rebate program to evaluate energy savings resulting from EnerFreeze, a refrigeration system treatment that is designed to increase the efficiency of refrigeration systems. The product was installed in a medium temperature supermarket refrigeration circuit at the customer facility. The energy usage of the system was evaluated before and after product installation with the use of data obtained from metering specific parameters within the refrigeration system. The metered data, in conjunction with theoretical system performance calculations, show an estimated total annual kWh savings of 54,680 kWh and an estimated peak demand savings of 2.94 kW. This translates to an energy cost savings of $2,124 using the actual tariff rates in effect for this customer, and a Custom Rebate incentive of $3,185.

2. Background

A case study for the EnerFreeze refrigeration technology was completed for Hy-Vee as part of the Alliant Energy Custom Rebate program. The product was installed in the Johnson Avenue Hy-Vee store #1054 in Cedar Rapids, IA. The EnerFreeze product is produced by the Weatherly Companies based out of Bellevue, WA and is a treatment that is added to a refrigeration circuit and is designed to remove oil fouling from the coils, thereby increasing the heat transfer capabilities and efficiency of the system. The treatment was installed on medium temperature rack C in this particular store. Rack C consists of six compressors, connected to a condensing unit on the roof of the facility. Rack C serves medium temperature display cases and coolers throughout the store. The case temperatures range from 20 to 40 degrees and contain dairy, meat, deli, and produce. The savings were determined using pre- and post-installation metered data. The equipment specifications and design conditions were provided by the manufacturer and customer, respectively.

3. Metering

Pre-installation metering took place from 8/8/12 at 12:30pm to 8/29/12 at 10:00am. After the treatment was installed, the post-metering occurred from 8/29/12 at 11:00am to 10/4/12 at 12:00 pm. According to the vendor, the treatment can sometimes take up to a week to fully circulate through the whole refrigeration circuit. To ensure that the treatment had plenty of time to be fully integrated into the system, the first two weeks of post-installation data were not used for analysis.

The parameters that were metered for this analysis include: individual compressor amperages, rack power, condenser amperage, outdoor air temperature, store temperature, compressor room (mezzanine) temperature, and refrigeration suction, discharge and condensing temperatures. The data-loggers were installed per discussion with the refrigeration contractor and representatives from the Weatherly Company.

4. Analysis

The metered data provided data points over a range of temperatures that occurred during the metering period. Even though the pre- and post-installation metering happened right after each other, the average, minimum, and peak outdoor air temperatures were different. This means that the calculations had to be adjusted for each temperature range to account for the change in load and outdoor air temperature. The store temperatures remained fairly similar. The product load, number of door openings, and other factors in the store could have been different between the sets of data, but there is no way to include all of these different factors in to the calculations.

If the power usage of the compressor rack and condenser in the pre- and post-implementation case are compared directly, they show a decrease in runtime and energy usage. But, the average outdoor air temperature dropped 13 degrees F during that time. Also, comparing individual days in the pre- and post-installation cases was very inconclusive. Of the two best comparisons, one showed energy savings and one showed an energy penalty. Overall, of the seven closest matching days, four show energy savings and three show an energy penalty. So, direct daily temperature matchups were not used for analysis. It is likely that the loading in a grocery store is so variable and generally erratic that these types of day-to-day comparisons are not possible. The relative humidity of the outdoor air also changed between the pre- and post-installation metering periods, which would affect condenser efficiency and loading.

Instead, a temperature bin analysis was used to determine the energy usage over the range of metered temperatures and extended to include temperatures outside that range to determine usage for the entire year. A compressor kW versus outdoor air temperature curve was developed for both the pre- and post-installation data. These are shown below in Figure 1 and Figure 2.
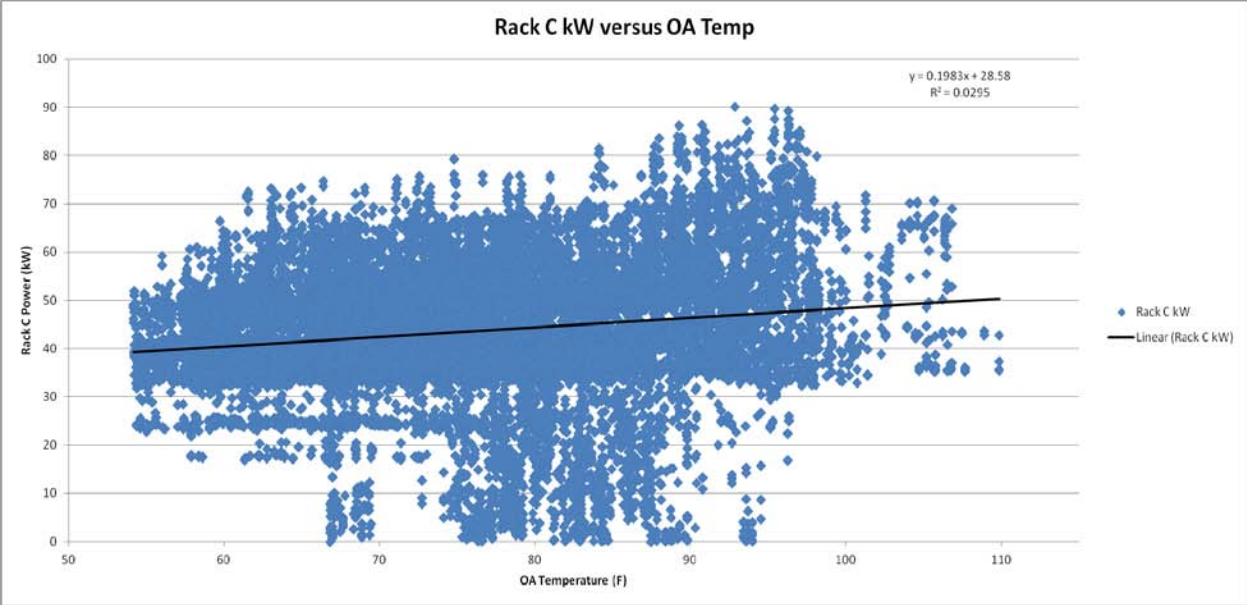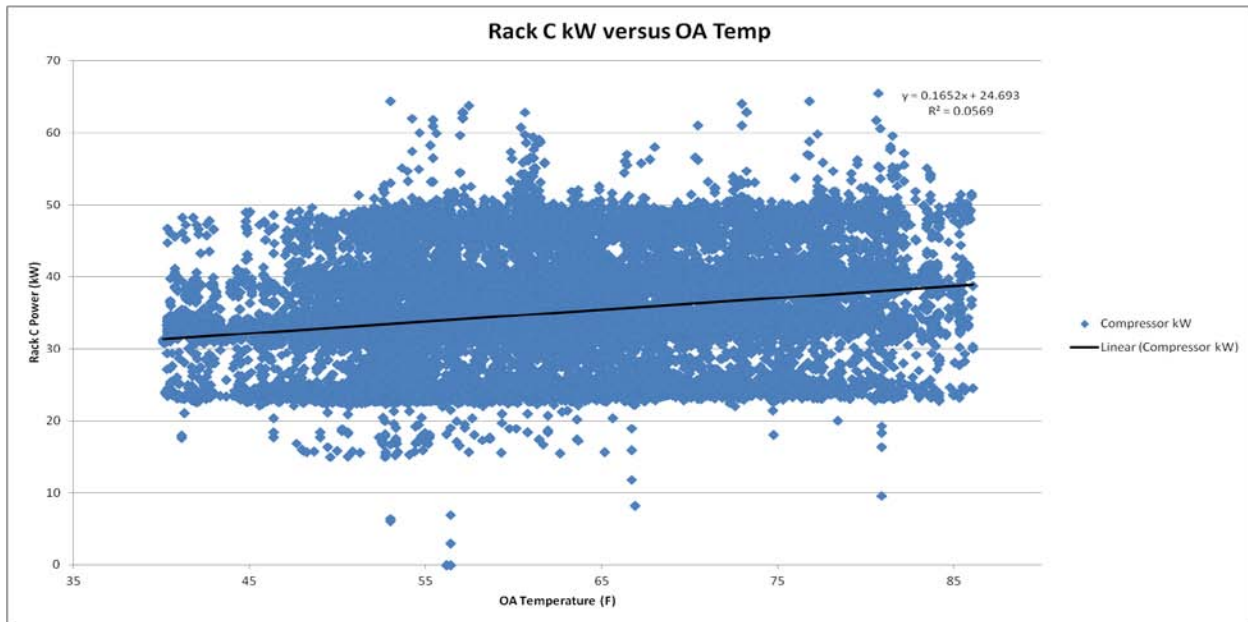

Figure 1: Pre installation rack kW versus outdoor air temperature

Figure 2: Post installation rack kW versus outdoor air temperature

The weighted average of the outdoor air temperature, condensing temperature, compressor rack kW, and condenser kW were shown over the metered temperature range for each set of metered data in the calculations. The bin hours produced a weighted average outdoor air temperature that matched very closely to the average temperature observed during each respective metering period. The loading profiles, average condensing temperatures, and heat of rejection for the condensers were all adjusted so that the calculations would match the weighted averages of the condensing temperature, compressor rack kW, and condenser kW generated by the metered data. Once the adjusted loading and average condensing temperatures were determined for the existing case, the same loading profile was carried over to the proposed case.

Because the EnerFreeze technology is designed to increase the heat transfer across the condenser coils in the system, the total heat of rejection was adjusted in the post installation case so that the condensing temperature and weighted average condenser kW would be more in line with what was shown in the metered data. This is because the minimum average condensing temperature and refrigeration load were assumed to remain constant between the existing and proposed systems. The theoretical condenser power usage in the proposed case was higher than seen in the metered data so the heat of rejection was the parameter that could be adjusted, and was also the parameter that would most be affected by the EnerFreeze product.

The annual compressor savings were determined by using the average kW curves generated from the metered data for pre- and post-installation. The exception to this is at the highest temperature bins in the post installation case, where the theoretical data was used. This was done because the condensing temperature begins to increase well above average at the higher temperature bins, which requires much more compressor energy. The compressor energy at these higher temperature bins is not expected to follow the same linear relationship to outdoor air as during the metering period, when the condensing temperature was not as high. The only time the outdoor air temperature reached the upper temperature bins was during the lead-in circulation time of the EnerFreeze product in the system. As discussed before, this lead-in time data was not used for analysis in order to make sure that the Enerfreeze product had been fully integrated into the system.

3

5. Results

The analysis over the entire temperature range of the system shows an annual energy savings of 54,680 kWh, which translates to a system kWh savings of about 14%. The technology also shows an estimated peak summer demand (kW) savings of 2.9 kW. Using the customer electrical tariff of 807/808 interruptible, the energy savings translate to an energy dollar savings of $2,124. This results in an estimated incentive of $3,185 through the Alliant Energy Custom Rebate program and a payback of 2.03 years, including the incentive amount and using the project cost of $7,500 as provided by the Weatherly Companies. The pre and post installation system energy usage and estimated savings are shown below in Table 1 and Table 2.

Table 1: Medium Temperature Rack C Refrigeration System Estimated Pre and Post Energy Usage

Pre and Post Energy Usage		
	Annual kWh	**Peak kW**
Pre Installation	383,062	101.39
Post Installation	328,382	98.45

Table 2: Project Savings Summary

Estimated Project Savings			
Annual Estimated kWh Savings	**Estimated Peak Demand Savings**	**Energy Cost Savings**	**Estimated Incentive**
54,680	2.94	$ 2,124	$ 3,185

It is important to note that these savings numbers presented in this report may not be applicable to all stores. The savings will depend on the loading of the refrigeration system, the age of the refrigeration system, and the amount of fouling present in the refrigeration circuit, among other factors. With only 6 weeks of post installation data, it is not possible to determine the longevity of the product, in terms of maintaining the energy savings. During the test period, the product is shown to provide increased heat transfer capabilities for the system due to reduced oil fouling, but due to the short-term nature of this test, it is not possible to determine persistence of savings.