Power Knot LLC

501 Valley Way
Milpitas CA 95035
USA
+1-408-889-8433
www.powerknot.com

Efficiency Gain at FUSD

Treatment of a Roof Top Packaged A/C Unit

1 Summary

Power Knot treated a four ton (14 kW) roof-top packaged air conditioning unit with a Synthetic Refrigerant Catalyst at the Mission Valley Elementary School in Fremont, California. After treatment, the efficiency of the unit increased by over 16%, resulting in savings in electricity cost and increasing the air conditioning cooling capacity for 32 students in their classroom.

2 Introduction

2.1 About the Mission Valley Elementary School

Mission Valley Elementary, one of 28 elementary schools within the Fremont Unified School District (FUSD) is located on the southeast side of San Francisco Bay in the beautiful city of Fremont which lies between San Jose and Oakland in Alameda County.

The school's population is over 750 students with class sizes of 1:20 in grades K-3 and 1:30 in grades 4-6. The school consists of a rich ethnic diversity of students.

2.2 The Problem

With a shrinking budget in the fiscal year 2010, the Fremont Unified School District is exploring various ways to reduce expenditures. Energy cost is one of the major expenses for the 48 schools in the Fremont district.

Attendance in the Fremont schools has been increasing for the past few years. This has driven up the cost for operating the schools from salaries and classroom supplies all the way to facilities and maintenance. The energy cost for classroom electricity and heating has also increased significantly over the years. FUSD is interested in deploying new energy saving solutions to help them reduce their energy cost.

2.3 The Solution

The Synthetic Refrigerant Catalyst from Power Knot improves energy efficiency of a cooling system and can saves customer's money. It is injected into the refrigeration circuit of the cooling system and improves heat transfer by eliminating the "oil fouling" that occurs in a cooling system.

Power Knot guarantees a minimum of 10% gain in efficiency after the proper application of the Synthetic Refrigerant Catalyst. In the case of FUSD, this can translate to greater cooling in the classroom with the same amount or a decrease in electricity usage.

Figure 1. View of rooftop unit with school playground in background

3 About the Cooling Equipment

The packaged air conditioning unit is located on the roof of the classroom. Each classroom is cooled by one such air conditioning unit. There are four roof-top AC units per building. Each AC unit has an economizer feature to allow outside fresh air to enter into the classroom.

The unit is shown in figure 1; details of the unit are listed in figure 2.

Manufacturer	York (Johnson Control)
Model	D1HG048N09925BDB
Serial number	NCHM028019
Installed	2000
Cooling capacity	4 tons (14 kW)
Compressor	Hermetic reciprocating
Refrigeration circuits	One
Refrigerant	R-22
Compressor oil	45 US fl oz. (1.3 litre)
Voltage	208 ~ 230 V, 60 Hz, 3-phase
Current	20 A

Figure 2. Specifications for the Air Conditioning System

This unit uses about 7.2 kW to operate. It runs about for about eight hours a day 110 days a year. With electricity cost at 17¢ per kWh, that amounts to an annual cost to operate of over $1075.

4 Test Procedure

4.1 Importance of Procedure

To measure the gains in efficiency, Power Knot used the method of measuring enthalpy. The enthalpy method entails measuring the wet bulb temperature of a direct exchange air conditioning system before and after the treatment of the Synthetic Refrigerant Catalyst.

As the air is heated or cooled, the a/c unit is heating or cooling the gases (sensible heat) and the water vapor (latent heat). The cooling process often removes water vapor from the air. Hence it is why we measure the wet bulb temperatures to include the moisture factor of calculating the energy required to cool the water in the air.

Figure 3. Showing the digital thermometer reading temperatures before and after the evaporator

4.2 Enthalpy measurement

At the Mission Valley Elementary School, we measured the wet bulb temperature on the roof-top AC unit in the air flow compartment area before and after the evaporator. From the wet bulb temperature we can calculate the enthalpy. The work done by an air conditioning unit is proportional to the difference in enthalpy between the supply air h_S and return air h_R:

$$\text{work done} \propto (h_R - h_S) \quad \text{(EQ 1)}$$

so

$$\text{work done} \propto \Delta h \quad \text{(EQ 2)}$$

Where $\Delta h = h_R - h_S$.

This proportionality is assured because the rate of flow of air through the space is constant, regardless of the output of the air conditioner.[1]

By treating this air conditioning system with the Synthetic Refrigeration Catalyst, we will measure the heat absorption before treatment (h_B) and heat absorption after treatment (h_A). If the flow of air remains constant before and after treatment (and that is a very reasonable assumption), the gain in efficiency is calculated as:

$$\text{gain in efficiency} = \frac{h_A - h_B}{h_B} \quad \text{(EQ 3)}$$

1. For details of the measurement of enthalpy, please refer to Power Knot's application note on this subject.

The enthalpy can be calculated at a specific time based on the wet bulb temperatures. This calculation of enthalpy is made using spot readings of the wet bulb temperatures.

4.3 Measuring Device

We measured the wet bulb temperatures using an Amprobe Model TMD-10 – Dual Thermometer.

5 Installation

We installed the Synthetic Refrigeration Catalyst into the low pressure port of the system using a hand pump as shown in figure 4.

The installation is performed while the system is running. This ensures the liquid cannot slug the compressor. It also results in no disturbance to the occupants of the space being cooled.

The installation takes only minutes and was completed at 13:45 on 2010-10-12.

We measured the enthalpy 15 minutes before that and 45 minutes after that. We allowed 45 minutes for the Synthetic Refrigeration Catalyst to take effect. On a small system like this, we would like to leave it at least an hour, but it was getting too close to the end of the school day to wait any longer.

Figure 4. Installing the Synthetic Refrigerant Catalyst

6 Energy Efficiency Improvements

The figures we measured for wet bulb temperature for the system before and after treatment are shown in figure 5. The table also shows the calculated enthalpy.

	Before Treatment		After Treatment	
	Wet bulb temperature	**Enthalpy**	**Wet bulb temperature**	**Enthalpy**
Before evaporator (return air)	59.1°F	26.40 BTU/lb	62.1	28.0 BTU/lb
After evaporator (supply air)	43.4°F	16.85 BTU/lb	43.5	16.85 BTU/lb
	h_B =	9.55 BTU/lb	h_A =	11.15 BTU/lb

Figure 5. Measurements before and after treatment with the Synthetic Refrigerant Catalyst

As can be seen, in about 45 minutes after treatment with the Synthetic Refrigerant Catalyst, we measured a greater delta temperature across the evaporator as compared to the delta temperature before the treatment. This means the air conditioning system is running more efficient and increased cooling capacity for the students in the classroom:

$$\text{gain in efficiency} = \frac{h_A - h_B}{h_B} = \frac{11.15 - 9.55}{9.55} = 16.8\% \quad \text{(EQ 4)}$$

7 Credits

Power Knot would like to thank the management and staff of the FUSD for their assistance and patience in support of this proof of performance. We visited the school on a very warm day to do this pilot and their maintenance personnel assisted us the whole time and allowed us to take photograph for this report.

8 Conclusion

Through the application of the Synthetic Refrigerant Catalyst, Power Knot guarantees a gain in the efficiency of a refrigeration system of at least 10%. This study has shown that treatment has increased efficiency by nearly 17%.

This increase in efficiency will ensure Fremont Unified School District saves energy by allowing the air conditioning unit to reach their cooling set points and shut off sooner to reduce electricity cost for their classroom.

As indicated in section 3 on page 2, the annual cost to operate this system is over $1000. The efficiency gain of nearly 17% equates to annual savings of about 1060 kWh or more than $180 every year.

This is an example of the benefits of the Synthetic Refrigerant Catalyst supplied and supported by Power Knot. For more information on the Synthetic Refrigerant Catalyst, please contact your local sales representative or send an e-mail to Power Knot at powerknot@powerknot.com.

Power Knot provides safe and economically sound solutions for businesses seeking to reduce energy costs and their carbon footprint through maximizing the efficiency of their cooling systems. Power Knot works with commercial, industrial, and military customers globally to reduce cooling system energy usage, improve energy efficiency, provide colder air, reduce maintenance expenses, and increase the lifetime of the systems. Their technologies are proven and available today, have been in reliable use for many years, and offer a payback period typically of less than two years. For more information, access www.powerknot.com.