



Patricia's Foods - Odessa, MO

## Packaged Rooftop Units with Modulating Temperature and Humidity Control

Patricia's Foods is a chain of supermarkets in Missouri which prides itself on providing a variety of quality items at competitive prices, with superior customer service. The over 20,000 items available in each store include a 100% satisfaction guarantee, with a 200% satisfaction guarantee on fresh meat, produce, bakery, and deli items. One of the ways Patricia's Foods offers exceptional customer service is with their "3-in-Line ... Too Much Time" policy. If a checkout line grows to 3 deep, a new checkout line will be opened until all checkout lanes are open.

Three years ago the Patricia's Foods in Odessa, MO moved to its current location, a 35,000 square foot space in an outdoor shopping complex along Interstate 70. When Patricia's Foods moved in, the HVAC system for the space consisted of the original 10 year old light commercial package rooftop units. The rooftop units had limited features and provided no space humidity control.

Jerry Metcalf, the owner of the Patricia's Foods stated, "After moving to the new location, we found the HVAC system's lack of humidity control was causing moisture to build up on the glass refrigeration cases.

We were also concerned about the efficiency of the HVAC system because of the high utility costs we were seeing."



Supermarkets present unique challenges for HVAC systems. First, a supermarket includes a variety of spaces which each have different temperature and humidity control requirements. The Odessa Patricia's Foods includes a grocery area, dairy and frozen foods area, bakery, deli with a dine in seating area, floral area, photo processing center, pharmacy, office space, and front vestibule with checkout stands.





Second, a supermarket is occupied for many hours of the day, almost everyday of the year, with occupancy levels varying throughout the day.

Third, the HVAC system must be sized to positively pressurize the building to prevent infiltration. If the building is not positively pressurized, the doors, which are constantly opening and closing, will permit infiltration of outside air, adding latent and sensible loads to the space.



Fourth, refrigeration and freezer systems in supermarkets reduce the sensible load, but not the latent load of the space. Thus, humidity control is often as important as temperature control in a supermarket.



### Fixed Capacity Temperature Control

Supermarkets and many other types of buildings commonly have space temperature and humidity fluctuations because of the use of single stage air conditioning equipment with on/off control. When an air conditioning unit's compressor turns on, it operates at full capacity. By providing cool air, the unit begins to cool the space and the temperature drifts downward toward, and then past, the setpoint. When the space temperature drops below the lower limit of the dead band, the compressor turns off.



After the compressor turns off, the sensible load causes the space temperature to drift up, past the setpoint, until the upper dead band is exceeded. When the upper



limit of the temperature dead band is exceeded, the compressor turns on and the process repeats. The space temperature fluctuates between the dead band limits.

During the off time of the compressor, when the space temperature is drifting up to the dead band, the supply fan continues to run, providing outside ventilation air to the space. Moisture in this outside air raises the humidity of the space. In addition, the space latent load, which can consist of beverage and cooking appliances, cleaning and washing appliances, and people, raises the humidity of the space. During the on time of the compressor, when the unit is providing cool air, the humidity of the space will be reduced, however, it is not being controlled.

Single stage air conditioning equipment is inefficient because the compressors are either on or off. Because a unit is typically sized for peak load operation the unit must average its compressor on time with its compressor off time to meet part load requirements.



This leads to additional energy usage when the compressor is cycled on. When an electrical motor starts, such as the motor that drives a compressor, there is an inrush of current. When an electrical motor is at rest, there is very little inductive resistance to current flow through the windings. As the motor starts to turn, this inductive resistance increases with the increase in RPM. This means that as power is applied to a motor at rest, there is a spike of

electrical current far greater in amplitude than the design amp draw of the motor. This temporarily increases the amp draw, each time the motor starts, and leads to decreased efficiency at part load operation when the compressor must cycle on and off. The increased amp draw results in increased power consumption without an increase in cooling capacity.

## Modulating Temperature and Humidity Control

The solution for lack of humidity control and high utility costs, provided by Terry Williams, Sales Representative with Custom Air & Power in Overland Park, KS, was nine constant volume, air-cooled condensers, packaged AAON rooftop units with modulating temperature and humidity control. Seven of the units include variable capacity scroll compressors, three include modulating humidity control, and all include the factory installed WattMaster - Orion Controls System. The packaged rooftop units provide about 46 tons of total cooling capacity. "Using variable capacity scroll compressors and modulating humidity control provides the store with a level of control and energy efficiency that is unmatched," Williams said, "and sizing the equipment to meet the store's current ventilation, heating, and cooling requirements results in a load reduction on refrigeration cases which reduces the store's energy usage."

The modulating temperature control option from AAON includes a variable capacity scroll compressor which provides modulating cooling capacity, not by cycling the compressor on and off, but by varying the volume of refrigerant that flows through the cooling system.

The compressor operates in two states, a loaded state and an unloaded state. During the loaded state, the compressor operates like a standard scroll compressor and delivers full capacity and mass flow.

During the unloaded state a solenoid valve at the compressor discharge opens and the top of the scroll separates from the bottom of the scroll, which removes the pumping output of the compressor. Thus, there is no capacity and no mass flow from the compressor. The length of time the compressor is in either the loaded or unloaded state is controlled by varying the duration of a pulse control signal.



Equipment with variable capacity scroll compressors can control supply air temperature and space temperature more accurately than equipment with standard compressors because the compressors can modulate their capacity almost instantaneously to match the load. This is because the pulse control signal has only a short duration.

Variable capacity scroll compressors are more reliable than standard scroll compressors because the compressor is cycled on and off less which results in a reduction in wear on the compressor motor and a reduction in the number of times the compressor motor must endure inrush currents.

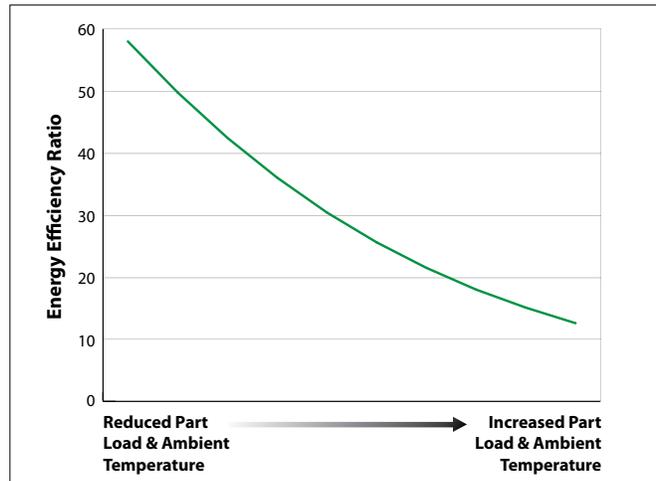
system, the amount of power consumed by the compressor decreases. Refrigerant gas is not compressed during the unloaded state of the compressor; therefore less compressor energy is required. Also, as the ambient temperature and space load are reduced the energy efficiency of the unit increases (See figure below).



The modulating humidity control option from AAON provides a dehumidification mode of operation, without the need for a call for cooling, based on the space humidity. During dehumidification, the compressors turn on, cooling the air to the dew point and condensing moisture in the air on the cooling coil, providing both sensible and latent cooling. The air is then heated to prevent overcooling of the space with a reheat coil containing hot refrigerant gas diverted from the condenser coil. Modulating valves divert the hot refrigerant gas from the condenser to the reheat coil, allowing the system to use the minimum amount of reheat needed and precisely control the supply air temperature. This allows the humidity of the space to be reduced without supply air temperature swings or overcooling of the space.



Modulating temperature and humidity control provides significant energy savings. As the output capacity of the compressor is reduced by the controls



4 Ton Constant Volume RTU with Variable Capacity Scroll Compressor

Since the installation of the AAON equipment with modulating temperature and humidity control Patricia's Foods has been able to precisely control both the temperature and humidity of the supermarket while saving energy. Moisture build up on the refrigeration cases has been eliminated. And Metcalf noted, "With the new HVAC equipment installed and running this past summer we were able to save approximately \$6,000 a month in utility bills."

Contact your local AAON sales representative for more information about the benefits modulating temperature and humidity control can provide you.

