HUMIDITROL® DEHUMIDIFICATION SYSTEM
Constant and Variable Volume Applications

APPLICATION AND DESIGN GUIDELINES

Form No. 485106
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This document pertains to the Lennox line of Energence™ 3-50 ton constant air volume (CAV) and variable air volume (VAV) packaged units.

HUMIDITROL DEHUMIDIFICATION SYSTEM OVERVIEW:

The Humiditrol dehumidification system allows a Lennox constant air volume packaged unit to provide the following benefits:

- Independent control of both the temperature and humidity levels of the enclosed space.
- Increased dehumidification capability without overcooling the enclosed space.
- Reduced energy consumption by using hot gas reheat from the active compressors (compared to auxiliary reheat systems).

For additional information, sequence of operation and performance data, please reference the Energence packaged unit Engineering Handbook bulletins.

CONSTANT AIR VOLUME UNITS AND POTENTIAL DEHUMIDIFICATION ISSUES:

Many constant air volume units feature a single zone system configuration where mechanical cooling demands do not remain constant throughout the year. This is especially common during the shoulder months when the outdoor air has a moderate temperature and high humidity level.

During this time frame the sensible cooling load in the single occupied zone is relatively light and the unit can satisfy the temperature requirement by operating in either mechanical cooling or fresh outdoor air cooling mode. While this may satisfy the temperature demands, the humidity levels typically remain higher than desired because mechanical cooling does not run long enough to effectively remove moisture from the air stream.

Furthermore, even though the unit does not have a cooling demand, the packaged rooftop unit will still continue operating the supply fan to bring in unconditioned outdoor air during the occupied time period to meet fresh outdoor air requirements. This can result in very high moisture levels in the occupied space, especially if the outdoor air has a mild temperature and high relative humidity level.

Some constant air volume units with single zone configurations attempt to solve the humidity problem by using one of several different methods. These methods include either setting the thermostat lower, or adding additional reheat capability when the mechanical cooling mode is in operation. Unfortunately both these solutions provide less than optimal results.

Setting the thermostat lower often creates a temperature problem in addition to the already present humidity problem. These systems tend to overcool the occupied space in an attempt to remove more moisture. Adding additional reheat capability during mechanical cooling, such as hot water or electric reheat, may not conform to local codes and increases operating costs.

CONSTANT AIR VOLUME UNITS FEATURING THE HUMIDITROL DEHUMIDIFCIATION SYSTEM:

Constant air volume units featuring the Humiditrol dehumidification system can accurately control both the temperature and humidity levels of a space by measuring and controlling these functions separately. Units featuring this advanced technology have the capability to operate in three separate modes.

- Full dehumidification only
  - Remove moisture
  - Return approximately neutral temperature air to the occupied space.

- Full dehumidification and partial cooling
  - Remove moisture
  - Return partially conditioned air to the occupied space.

- Full cooling
  - Remove moisture
  - Return conditioned air to the occupied space.

Example:

Notice in the illustration below that while Lennox's multi-stage constant air volume unit without the Humiditrol system has an excellent sensible to total (S/T) ratio in part load operation (0.52), the unit is still providing almost 50% sensible cooling (12 tons). [Recommended control for this operation is through a multi-stage thermostat or Direct Digital Controller (DDC)].

Adding the Humiditrol dehumidification system allows the unit to deliver a S/T ratio of 0.19. This is a dramatic reduction in sensible cooling and provides excellent dehumidification capability while maintaining almost neutral air temperature. This allows the unit to now provide 11 tons of latent capacity (dehumidification) with only 3 tons of sensible cooling. This dramatically reduces the possibility of over cooling the occupied space.

Unit Data:		
Unit type	Lennox Constant Air Volume	Lennox Constant Air Volume with Humiditrol Dehumidification System
Coil type	Face split	Face split
Part Load Performance Data (two compressors operating):		
S/T Ratio	0.52	0.19
Total Capacity Btuh (Tons)	286,600 (24)	165,400 (14)
Sensible capacity Btuh (Tons)	149,032 (12)	31,426 (3)
Latent capacity Btuh (Tons)	137,568 (11)	133,974 (11)

Assumptions:

- Unit = LGH480H4*
- Part load performance, only two compressors are in operation
- Outdoor air = 65° F DB
- Entering evaporator air = 75° F DB and 67° F WB
- Entering evaporator dew point = 63° F
- Entering evaporator RH = 67%
- Supply air volume = 16,000 CFM

VARIABLE AIR VOLUME UNITS COMPATIBILITY ISSUES:

Unlike constant air volume units, many variable air volume units do not benefit from the addition of the Humiditrol dehumidification system. The primary reasons are:

1. By design, VAV units deliver a constant discharge supply air temperature (typically 55° F) to meet diverse cooling demands in multiple zones. Humiditrol and other hot-gas reheat systems will raise the discharge temperature to 70° F or above. Raising discharge supply air temperature will prevent the unit from satisfying the cooling demand in some zones.
2. VAV units typically operate in traditional multiple zone systems with almost constant S/T ratios. Zones that require independent humidity control may not be suitable for VAV units.

Unlike most constant air volume units, variable air volume units feature discharge air temperature control, which allows the units to deliver typically 55° F discharge supply air temperature, at design or part-load conditions. A variable air volume unit accomplishes this by staging the compressors as the air volume changes based on zone demands. Humiditrol and other hot-gas reheat systems will reheat the conditioned air to 70° F or more to provide discharge air that has a lower relative humidity, but not temperature, than the space. This is a result of the space requiring much more latent than sensible cooling. VAV systems are designed with controls that work in environments where space conditions are maintained by varying the volume, and not temperature, of supplied cooled air (i.e. less than 70° F). It is important to note that Lennox does offer the capability to operate constant air volume units using discharge air temperature control. For additional information please consult your local Lennox field sales representative.

In most cases utilizing VAV applications, such as office environments, the S/T ratio required by the space usually will not vary too much from the S/T ratio of the RTU. Also, the S/T ratio stays relatively constant, meaning that sensible and latent loads often increase or decrease in the same proportion. For areas of the building where the sensible load is much higher than the latent load, or vice versa, or where there are large temperature or humidity changes, these areas need to be zoned separately from the VAV system for independent control by a separate system to ensure proper conditioning of all spaces. For example, computer server rooms (high S/T ratio) and kitchen areas (low S/T ratio) should have separate systems from office areas because they have different load profile than the office space.

VAV units are also designed to operate in cooling mode at all times (when outside air temperature is above 55F). This ensures that the fresh outdoor air, air that may have a high latent content, coming into the unit to meet the outdoor air requirements will receive constant dehumidification. As we examined in the constant air volume case above, many constant air volume units do not receive a constant call for mechanical cooling, therefore the fresh outdoor air coming into the building will pass directly into the occupied space without any dehumidification. A VAV unit on the other hand, is providing conditioned (including dehumidification) air to the space at all times during operation.

The example below shows how a VAV unit will remove humidity from both return and fresh air to deliver dehumidified 55° F supply discharge to the space.

Example:

- Unit: VAV packaged unit, LGH480H4V – Design Conditions
- Zoning system: VAV system with multiple zones and basic VAV terminal units
- Scenario: Summer (high outdoor air temperature and humidity)
- Outdoor air conditions: 85° F and 70% RH, 3200 CFM (20% air volume for mixed return air)
- Unit discharge air temp: VAV unit will deliver 55° F discharge supply air at the unit with 52.4° F wb
- Space conditions: 72.5° F and 44% RH, 12,800 CFM (80% air volume for mixed return air)

The outside air has a humidity ratio of 127.9 gr/lb and the return air has a 52.4 gr/lb ratio at the conditions above. With a 80/20 mix of return and outside air, respectively, the mixed air humidity ratio is 67.5 gr/lb before entering the evaporator coil of the LGH480 VAV unit. After conditioning, the discharge air delivered to the space has a humidity ratio of only 56.8 gr/lb, a 15.9% drop in humidity.

During part load conditions, VAV zone dampers will begin to close to meet the reduced zone cooling requirement through air volume reduction. The VAV unit, under part load conditions will make use of its staging or unloading capability in an attempt to continuously condition (including dehumidification) the air and maintain the target supply air temperature.

Report Date: Wednesday, October 26, 2005
Project Information:
Altitude: 0 (Feet)
Barometric Pressure: 29.921 (in.Hg)
Atmospheric Pressure: 14.696 (psia)

1. Outside Air

STATE POINT DATA

Air Flow (Standard) (cfm)	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (%)	Humidity Ratio (gr/lb)	Specific Volume (cu.ft./lb)	Enthalpy (Btu/lb)	Dew Point (°F)	Density (lb/cu.ft.)	Vapor Pressure (in.Hg)	Absolute Humidity (gr/cu.ft.)
3,200	85.000	76.990	70.0	127.9	14.129	40.471	74.1205	0.0707	0.8502	9.051

2. Return Air

STATE POINT DATA

Air Flow (Standard) (cfm)	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (%)	Humidity Ratio (gr/lb)	Specific Volume (cu.ft./lb)	Enthalpy (Btu/lb)	Dew Point (°F)	Density (lb/cu.ft.)	Vapor Pressure (in.Hg)	Absolute Humidity (gr/cu.ft.)
12,800	72.500	58.824	44.0	52.4	13.572	25.580	49.3788	0.0736	0.3543	3.859

3. Mixed Return Air

STATE POINT DATA

Air Flow (Standard) (cfm)	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (%)	Humidity Ratio (gr/lb)	Specific Volume (cu.ft./lb)	Enthalpy (Btu/lb)	Dew Point (°F)	Density (lb/cu.ft.)	Vapor Pressure (in.Hg)	Absolute Humidity (gr/cu.ft.)
16,000	75.000	63.087	51.9	67.5	13.683	28.549	56.1732	0.0730	0.4549	4.932

4. Supply Air

STATE POINT DATA

Air Flow (Standard) (cfm)	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (%)	Humidity Ratio (gr/lb)	Specific Volume (cu.ft./lb)	Enthalpy (Btu/lb)	Dew Point (°F)	Density (lb/cu.ft.)	Vapor Pressure (in.Hg)	Absolute Humidity (gr/cu.ft.)
16,000	55.000	52.989	88.0	56.8	13.139	22.000	51.5097	0.0760	0.3835	4.319