TechData Sheet

Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4370

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Desiccant Dehumidification Systems Case Histories

Background

In the effort to save money on utility bills and provide better air quality, desiccant dehumidification systems are gaining greater acceptance as an attractive method to achieve these goals. In the past though, desiccants have had reliability problems primarily due to the material used for the desiccant. In the past an absorbent material such as lithium chloride was used for the desiccant. An absorbent material attracts moisture through a chemical interaction. This causes the absorbent material to undergo a change of state. A common example of absorption is table salt attracting moisture and becoming soft and mushy. When an absorbent material was used on a wheel in a desiccant dehumidifier, if the amount of moisture it absorbed was not closely controlled, the absorbent would start to flake off and get into the HVAC system. Because an absorbent can absorb up to 1,000 times its weight in moisture, the wheel could become so heavy that it would start to collapse and distort. This would cause premature bearing failure, seal failure and in extreme cases, a structural failure of the wheel itself. Because of these potential problems, the controls for these machines were very critical. For instance, if there was a failure of the drive belt or motor, the machine had to sense this and automatically shut off, otherwise the wheel would sit in one position and continually absorb moisture until the wheel was damaged.

Today, an adsorbent material, such as a silica gel, is used on desiccant wheels. Any material that adsorbs moisture uses a physical process to attract moisture. Silica has microscopic pores which attract moisture due to the difference in vapor pressure between the surface of the desiccant and the moisture in the air. This process does not change the state of the desiccant and will not attract the enormous amounts of moisture which absorbents can, therefore eliminating the problems exhibited by older dehumidifiers.

To determine if the newer machines provide energy savings, improved indoor air quality, and trouble-free, reliable service, 28 units at 15 facilities in 7 different cities were visited in January 1997. Local gas company representatives, building engineers, maintenance personnel, and building managers were interviewed during these visits. The majority of the units (19) were Engelhard/ICC, 7 were Munters and 2 were categorized as “other.”

Investigation Results

The investigation proved that desiccant dehumidifiers generally work well, and the few reliability problems that were encountered, were repaired under warranty. Two units had major problems that may be attributed to the fact that they were not wheel type desiccants; the desiccant was mounted on vertical cylinders. They were not manufactured by either Engelhard/ICC or Munters. Other problems with the HVAC systems may not have been due to the desiccant dehumidifiers.

For most of these applications, energy savings was not the primary goal, and consequently, most facilities did not go out of their way to measure any energy savings. The facilities that could make an accurate assessment of their energy savings were those that did a retrofit of a desiccant unit and nothing else, and those companies or organizations that had similar buildings without desiccant dehumidifiers. In every case accurately evaluated, desiccant dehumidifiers save money on energy bills. Of the 15 facilities visited, only 1 facility has not been able to recover the cost of the retrofit and has decided to forego use of desiccant dehumidifiers in the future. In most cases where the desiccant unit was part of the original design of the building, the tonnage of the remaining chillers used for sensible cooling could be reduced which resulted in a net savings for the original cost of the HVAC system.

One recurring problem was the lack of or inadequate training from the manufacturers. However, due to the relatively simple

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design of these machines, most operators and maintenance personnel are able to adequately train themselves using manufacturer-supplied literature.

Successful Installations

Installations that worked well with no complaints from building personnel are described below. Unless otherwise noted, all the Engelhard/ICC units have a desiccant wheel, a thermal wheel, an integral hot water heater and coils for regeneration, and a direct evaporative cooler on the regeneration side.

Smyrna Municipal Center, Office Building
Smyrna, Georgia

Features:

A 5,500 CFM Engelhard/ICC unit was installed in June 1995 at an initial cost of $28,000 plus $10,000 installation. The dehumidification system is separate from the rest of the HVAC system. The process side brings in 100% outside air. The regeneration side uses 100% return air from the building, exhausting it to the outside. A humidistat in the building turns the hot water heater on and off.

Maintenance:

Normal maintenance consists of changing the filters approximately every three months, checking and adjusting the drive belt tension if required. No unscheduled maintenance or reliability problems were reported.

Outcome:

Smyrna is very happy with the unit and are planning to install another desiccant dehumidifier in their new jail, currently under construction.

Columbia County Schools
Columbia County, Georgia

Features:

The Columbia County Schools installed three 3,000 CFM units on two new schools in September 1996. Each unit cost $25,000 and $5,000 for installation. They use 100% outside air for the process side.

These units were installed primarily to avoid humidity problems. A cost savings of approximately 10% has been realized in comparison to similar schools without desiccants.

Maintenance:

The school found that raising their thermostats from 69°F-70°F to 72°F-74°F was possible because dry air is more comfortable at higher temperatures than humid air.

Outcome:

Because of their satisfactory experience with these two schools, Columbia County Schools plan to install desiccant dehumidifiers in all their new schools.

Liz Claiborne Warehouse
Montgomery, Alabama

Features:

This is a 670,000 ft^2 warehouse with four 15,000 CFM Engelhard/ICC units mounted on the roof and a 4,000 CFM Engelhard/ICC unit mounted on the ground, completed in September 1993. All five units have post cooling and heating coils on the process side airstream downstream of the thermal wheel. On two of the roof-mounted units, the regeneration air is 100% return air from the building and is exhausted back to the inlet side of the process side. A damper varies the inlet of the process side from 100% outside air to 100% regeneration exhaust. This process allows for days when the other dehumidifiers adequately dehumidify the air (the regeneration exhaust is already dry) and it is undesirable to exhaust this dry air to the outside. The other roof-top units use 100% outside air on the process side. The regeneration air is 100% return air from the building and is exhausted to the outside. The 4,000 CFM unit can either draw process air from the buildings return air or from the outside. A damper controls from 0 to 100% outside air. The regeneration air inlet is 100% outside air and exhausts to the outside.

Maintenance:

Regular maintenance on these units involves a filter change approximately once a month. The units had a problem with premature drive belt breakage, but Engelhard/ICC installed heavier duty belts which eliminated the problem.

Outcome:

A first time cost savings of $400,000 was realized due to the size of the conventional cooling which was decreased from 1,600 tons in the orginal design to 650 tons. In addition, the facility saves over $100,000 a year in utility bills.

The Rinx, Ice Rink
Hauppauge, New York

Features:

This installation is a 9,000 CFM Munters unit installed in June 1996. The process inlet can bring in either outside air or return air. A damper has three settings to vary the outside air to return air ratio. The regeneration air is 100% outside air and is exhausted to the outside. The unit cost was $31,000 plus $24,000 for installation, replacing $50,000 worth of electric dehumidifiers.

Maintenance:

There have been no problems with this unit. Regular maintenance consists of a filter change approximately once a month.

Outcome:

Following installation, electric costs decreased by $36,000 per year while gas increased by $12,000 to $15,000, for a net savings of $21,000 to $24,000 per year. About 75% of the savings is due to less electrical cooling being required to maintain the ice sheet. This is because the electric

dehumidifiers could only maintain about 70% to 80% RH. This would cause moisture to condense on the ceiling and drip down onto the ice. Not only did this make poor quality ice, but the electric chillers had to work harder to freeze the moisture on the ice. The new desiccant dehumidifier maintains an RH of 55% and this is no longer a problem.

Park Hyatt Hotel
Washington, DC

Features:

This hotel has two 10,000 CFM Engelhard/ICC units on the roof which were installed in mid-1994 at a cost of $86,000 each. Installation costs varied; one at $52,000 and the other $44,000. One supplies 2/3s of the building and the other supplies the remaining 1/3 and both units are set up identically. The process side is 100% outside air with post cooling and heating coils. The heating coils are electric since the electric company offered a rebate to heat the hotel using electricity. The regeneration side uses 100% return air from the toilet exhaust and is exhausted to the outside. The HVAC system uses Landis controls connected to a PC in the engineering office.

Maintenance:

The only problems to date were a glycol leak and a gearbox failure on one of the drive motors. Both were repaired under warranty. Regular maintenance consists of changing the filters approximately every three months, checking the drive belt tension, and greasing the blower motor bearings.

Outcome:

It is not possible to determine whether the desiccant dehumidifiers are saving energy due to an ongoing energy conservation program the hotel is participating in. Several factors such as efficient lighting fixtures and variable frequency drive motors may have contributed to lower costs. The hotel is happy with the performance of the units.

Constar International, Manufacturing Plant
Baltimore, Maryland

Features:

Constar International manufactures plastic bottles such as those used for soft drinks. It is critical that the air inside the plant stays dry because if moisture gets into the molds it will cause defects in the final product. Two Munters desiccant dehumidifiers are in operation at this plant. The first is a 20,000 CFM unit installed in 1978, originally using electric heat for regeneration but was converted to gas heat by Trane 3 or 4 years ago in order to save on utility bills. The second is a 9,000 CFM unit that was installed approximately 1 1/2 years ago. Both units use 100% return air for the process side and 100% outside air for the regeneration side. It is suspected that the larger unit, because of its age, uses an absorbent for the desiccant but since it uses 100% return air it is never exposed to the higher humidity outside air and therefore has never had the problems associated with absorbent desiccants.

Maintenance:

Both units have their filters changed every two to three weeks and the blower motors are greased bimonthly. No cost or energy savings figures were available, although the company does say that the gas desiccants are much cheaper to operate than electric.

Outcome:

Prior to the installation of the newest Munters unit, Constar had two 9,000 CFM units (neither Munters or Engelhard/ICC) installed in 1993. Both had their desiccant arranged on a rotating vertical cylinder which had a chain drive at the bottom of the cylinder, causing problems from the start. The desiccant would flake off and drop down onto the drive chain and be carried by the chain into the drive motor gearbox, eventually destroying the gearbox. The loss of desiccant on the cylinder required constant replacement. Both of these units were removed from service approximately 1 1/2 years ago.

Willis-Knighton Health System
Shreveport, Louisiana

Features:

Willis-Knighton Health Systems operates two hospitals in the Shreveport area — Willis-Knighton Medical Center and Bossier Medical Center. Both use desiccant dehumidifiers for their operating rooms. Today, many doctors are requesting lower and lower operating room temperatures due to the increasing amounts of protective clothing they are required to wear. These temperatures may be as low as 62°F db which creates very high relative humidity in the operating room.

The Bossier Medical Center had two Munters units installed in a penthouse when the building was new in December 1995. One unit is 6,000 CFM at a cost of $18,000 and the other is 7,600 CFM, at a cost of $22,800. Both units are set up identically. The process air is 100% outside air. The air can either go through the desiccant wheel or be bypassed. A vane controlled by a humidistat determines how much air is bypassed. The air then passes through a heat pipe, and then a heating coil, and a cooling coil. The return air goes through the heat pipe and is then exhausted to the outside. A third airstream is used for the regeneration air which is 100% outside air. The building's boiler and a heat exchanger heat the air. The reason for three separate airstreams is to ensure no cross contamination between airstreams. The desiccant wheels on both of these units are intentionally undersize, both rated at 4,000 CFM. Standard size wheels are approximately twice the cost of the smaller wheels and deliver air that is too dry for the hospital's requirements resulting in more of the air being continually bypassed.

Maintenance:

These units have had no reliability problems and regular maintenance consists of changing the filters every two months (the exact interval is determined by a static pressure gauge

across the filters) and lubing the fan motor bearings every three months.

Features:

At the Willis-Knighton Medical Center, a 7,600 CFM retrofit unit was installed on the roof in June 1994. The set up is the same as the units at Bossier Medical Center. The only other method to obtain the proper temperature and humidity in the operating room is to cool the air to the dew point with chiller coils and continue to cool the air to condense out moisture and then reheat the air to the desired temperature. Due to the inefficiency of this method, the estimated payback time for the desiccant dehumidifier is 1.5 years.

Maintenance:

The routine maintenance on this unit is the same as the Bossier units.

Outcome:

This unit had a problem with the wheel less than a year after it was installed. The weld broke on the wheel where the flange (which rubs against the seals) is welded to the outer case, resulting in damage to the wheel. The wheel was replaced under warranty and no further problems have occurred. In addition, this unit also had an installation problem. The regeneration exhaust was directed back toward the hospital, and although the exhaust is not overly loud, it changed pitch, resulting in complaints from patients. The problem was solved by routing the exhaust ducting back up and over the top of the unit and away from the hospital.

ARKLA, Gas Company Office Building
Shreveport, Louisiana

Features:

This is a 13,000 CFM unit installed on the roof of a 15-story office building in November 1995 at a cost of $75,000 which included installation. The unit can vary 0% to 100% outside air to return air. The regeneration air is 100% outside air. It has a dual hot water supply for regeneration, using either hot water from the integral hot water heater or hot water from the building's boiler.

Maintenance:

This unit had a problem that was a combination of equipment failure and human error. With the dual water system, a manually-operated isolation valve is provided to allow drainage of the building's hot water system while the dehumidifier is still operating. An automatic sensor is also provided in the unit which will shut it down if the water level gets too low. One day, the building side of the water system was drained without shutting the valve and the sensor also failed. The hot water heater tubes were damaged and had to be replaced.

Outcome:

Although no specific energy savings are available, the company installed an engine-driven chiller at the same time and since the desiccant dehumidifier was handling the latent heat load, the engine-driven chiller was downsized from a 12-cylinder engine to an 8-cylinder engine resulting in a savings of $99,000.

Northeast Baptist Hospital
San Antonio, Texas

Features:

This hospital has a 7,300 CFM unit that was installed in July 1992, serving only the operating room. This unit uses 100% outside air. The process sends some of the air through a pre-cooling coil and the rest is bypassed, but the airstreams are rejoined to go through the desiccant wheel. The airstream is again split to go through the heat pipe, also partially bypassed until they are once again rejoined and go into the HVAC system. The exhaust goes directly to the outside without going back to the dehumidifier. The regeneration air is 100% outside air and goes through the heat pipe and a direct-fired gas burner before going through the desiccant wheel and being exhausted to the outside. The cost of the unit was not available.

Maintenance:

The unit has been trouble-free since installation and only routine maintenance has been performed, such as filter replacement and blower motor lubrication.

Outcome:

The main purpose of this unit was a retrofit installation intended to solve a humidity problem. For this reason, the hospital suspects it costs them a little bit extra to run the unit; the humidity problem, however, has been eliminated.

Unsuccessful Installations

The following list of installations are those that have not proved to be entirely satisfactory. However, all of the problems are suspected to be with the HVAC systems and not the desiccant units. The names of the companies and their locations have been omitted.

Food Store

Features:

This 8,000 CFM Engelhard/ICC unit was installed in 1992, at a cost of $65,000 not including installation. This food store chain has two other stores in the same area which have desiccant dehumidifiers which were installed in 1993 and 1994.

Maintenance:

The units operate well, and the only reliability problem was premature wear of the drive belts, which have been replaced with heavier duty belts.

Outcome:

Although the store is saving $8,000 a year in energy costs, the company does not feel it will be able to recover the cost of the units, and therefore, do not plan future installations. It should be noted that the company does recommend desiccant dehumidifiers if economics justify it.

Day Care Center

Features:

This is a 2,000 CFM Engelhard/ICC unit installed in a basement mechanical room. The desiccant unit itself operates well, and the only reliability problem was a bearing that was bad when the unit arrived which was replaced under warranty. The unit has greatly reduced the incidence of disease transmission between the children.

Outcome:

The center has experienced some sort of balance problem with the HVAC system and their unit. The return air consists of short ducts that extend through the false ceiling and are open on each end. The return air is then drawn through from the plenum formed above the false ceiling. In some of the rooms, however, cold air can be felt blowing back through the return air ducts. Even though the thermostat is turned up in these rooms, they remain uncomfortably cool, resulting in energy costs which are double the original estimates. These problems are not attributed to the desiccant dehumidifier.

Fast Food Restaurant

Features:

This 2,000 CFM Engelhard/ICC unit was installed in July 1994, located on a military base. It uses 100% outside air for the process air and 100% return air for regeneration and is a direct-fired unit utilizing propane for regeneration.

Outcome:

When it is working, it works well; however, it has not worked for approximately 4 or 5 months. The base engineers are responsible for operating and maintaining the unit but are unable to troubleshoot the problems. The manufacturer is unable to assist because the warranty has expired. The kitchen area is too hot in the summer, and too cold in the winter. A problem with the HVAC system may be causing the dehumidifier to shut down.

Conclusions

The newer desiccant dehumidifiers (vertical wheel type) have no problems with the wheels themselves. Minor problems with the rest of the unit have all been repaired under warranty. One recurring problem was drive belt breakage on some of the older Engelhard/ICC units, but has since been solved.

Although most of these installations were to resolve humidity problems, and not to save energy, if accurate calculations were performed, they did save energy. When the desiccant unit is incorporated in the original design of the building, the sensible cooling capacity can be reduced, resulting in a substantial first-time cost savings.

In order to ensure satisfactory installation of desiccant dehumidifiers, do the following:

1. Have the system designed by someone who has extensive experience with desiccant dehumidifiers.

2. Use only disc-type wheels that use an adsorption type material produced by a reliable manufacturer.

3. Ensure that operation and maintenance personnel have adequate training from the factory or purchase an extended service contract.

For more information on desiccant dehumidification systems contact:

NFESC Code 20 at (805) 982-1465, DSN 551-1465.

DEPARTMENT OF THE NAVY

COMMANDING OFFICER
NFESC
1100 23RD AVENUE
PORT HUENEME CA 93043-4370

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