"How To Get Comfortable With Dehumidification"

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ABSTRACT

Residential consumers are educated to think about their comfort conditioning system as air conditioners and furnaces. Over the past several years the technology of products and controls has been changing. Homes have progressively gotten tighter, new construction and up grading. Equipment capabilities and performance have changed. The ability to control to more precise conditions and for more components of air treatment highlights the need to educate the consumer on the potential available today with adjunct components of the comfort conditioning system.

Air conditioners are typically selected for one set of design conditions. In many situations the latent and sensible loads are not the consideration, only total load and first cost. The design conditions are exceeded only 2 1/2% of the time. Therefore, the equipment is typically oversized a majority of the time and not matched properly to the latent load. Air conditioners are constrained by their physical performance of the components, such as the coils and compressor. As a result, the equipment can not track the wide variety of sensible and latent conditions. The increased use of "set-up" thermostat controls diminish the control of humidity. Air conditioner thermostats sense and respond only to the temperature condition, not to the humidity level.

The use of a separate whole house dehumidification system can allow for separate control of the humidity and temperature. The humidity control level is independent of the cooling set point. As a result, the cooling set point can be raised (less air conditioner run time) and comfort enhanced or improved. Moisture removed is automatically expelled to the outdoors with a desiccant based system. The whole house can be treated rather than a spot area. Indoor air quality concerns, such as odors, mold and mildew, can be improved by the use of a desiccant based dehumidification unit.

1. Extracted in part from Borg Warner Air Conditioning training materials (1970).

WHAT IS COMFORT CONDITIONING?[1]

Research and experience clearly prove that to have a comfortable and healthful atmosphere, five properties or characteristics of the air must be treated:

1. Temperature (Cooling or Heating)
2. Moisture Content (Dehumidifying or Humidifying)
3. Movement of the Air (Circulation)
4. Cleanliness of the Air (Filtering)
5. Ventilation (Introduction of outside air)

Temperature

The need of heating when it is cold and cooling when it is hot does not require elaborate explanation. It is necessary to keep the surrounding air temperature at a point where the flow of heat either to or from the body is sufficient to provide comfortable conditions.

The temperature of the air is usually indicated by feelings of "cold", "hot", "cool", and "warm". These terms are relative and an ordinary thermometer is used to measure or express these feelings more accurately. The ordinary thermometer is commonly spoken of as a "dry bulb thermometer".

Moisture Content

The moisture content of the air is indicated by a "muggy" feeling or a feeling of "dryness" - uncomfortable in spite of the temperature. To measure this feeling and express it in more specific terms, a "wet bulb thermometer" is used. This is nothing more than an ordinary thermometer with a sock or cotton wick placed around the bulb. By wetting this sock and passing air over it, moisture will be evaporated until it balances with the moisture content of the air. The heat absorbed in evaporating this moisture will lower the actual numerical reading on the thermometer (i.e., wet bulb temperature).

By observing both the dry bulb temperature and the wet bulb temperature, we have an indication or measure of "relative humidity". Relative humidity, expressed in percentage, is the amount of moisture that the air can hold at the same dry bulb temperature.

A study of relative humidity and its effect on an individual's comfort clearly indicates that the moisture content of the air in a conditioned space must be controlled in all seasons.

Humidification.

Relative humidities (less than 25%) where the moisture content of the air is low causes nasal passages, throat, and other mucous membranes to become dry. This drying effect on the body caused by low relative humidity increases the susceptibility to colds and other diseases of the respiratory tract. Excessive drying of the atmosphere also has a detrimental effect on pianos, furniture, books, leather goods, draperies, etc.

Dehumidification.

To be comfortable in summer, one must be subjected to lower room temperatures as well as lower relative humidities. The necessity for dehumidification arises from the fact that perspiration discharged to the skin surface must be evaporated if it is to produce any cooling effect on the body. The rate of evaporation is dependent upon the ability of the surrounding air to absorb the moisture. If the relative humidity is too high to absorb moisture at a fairly rapid rate, the individual suffers a clammy sensation. If cooling is accomplished without any reduction in humidity, the individuals are certain to have a cold, clammy feeling.

Movement of the Air

The benefits of proper temperature and humidity can only be transmitted to the human body by the correct movement of air over it. Therefore, air must be distributed or circulated uniformly throughout a conditioned space. No air conditioning system is better than its air distribution system.

The oppressive feeling that is produced in a space with little air motion is caused by the film of air surrounding the body becoming saturated with body heat and moisture. Cooling by convection and evaporation is therefore minimized. A gentle steady air motion eliminates the dead air film and permits the body heat to be more readily transferred to the air, thus helping to create comfort.

Cleanliness of the Air

The importance of supplying clean, filtered air to a space does not require any detailed explanation. The necessity for careful cleaning of the air is obvious when one considers the amount of impurities it contains.

We breathe approximately 36 pounds of air each day. Clean air is important to both our health and comfort just as is clean water and food.

Ventilation

Odors, smoke and impurities accumulated in most spaces should be diluted by bringing in outside air. Tighter construction has reduced the amount of infiltration. Opening windows allows for the introduction of additional pollutants, odors, and pollen. Mechanically processing or treating the air becomes more and more critical. Residentially, controlled mechanical ventilation is becoming more and more prevalent.

COMFORT ZONE

No specific combination of temperature and humidity can be specified to meet everyone's idea of comfort. Relative humidity and its effect on an individuals comfort clearly indicates that the moisture content of the air in a conditioned space must be controlled in all seasons.

A combined index of temperature and humidity is defined in the ASHRAE Fundamentals (1) book as the effective temperature (ET). This basically means that a multitude of conditions with the same index provides the same physiological response. However, this methodology has certain givens, such as air velocities, clothing, and activity. Therefore, a universally quantified boundary of conditions can not be established. A standard set of conditions for winter and summer have been established to define a standard effective temperature (SET) as illustrated in Figure 1. ASHRAE defines this SET as "...the equivalent air temperature of an isothermal environment at 50% rh in which a subject, while wearing clothing standardized for the activity concerned, has the same heat stress (skin temperature t_{sk}) and thermoregulatory strain (skin wettedness w) as in the actual environment." In other words, the same physiological effect can occur in two different environments that have the same SET index rating.

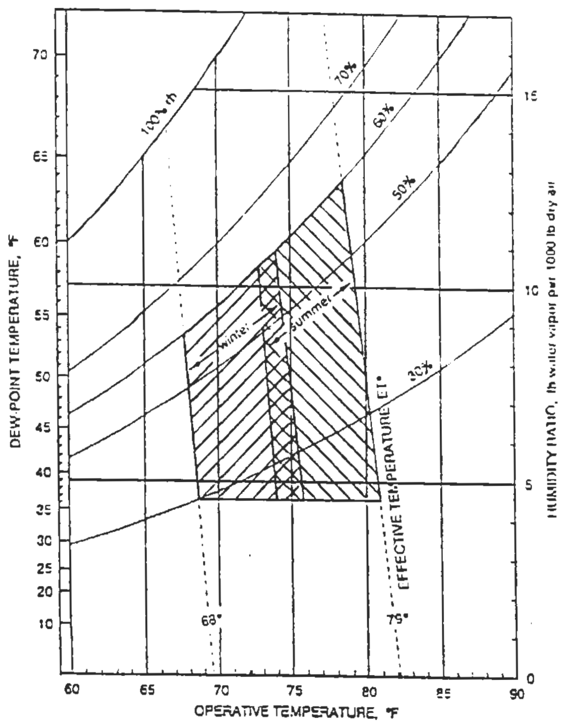

Figure 1 ASHRAE Comfort Zones

Comfort also extends beyond temperature and humidity. The conditions should also not foster the growth of any substances, such as mold and mildew, that would adversely affect allergy symptoms. The five characteristics of a comfort system also includes cleanliness of the air. Filtering is the first and most logical component. However, it is also beneficial if allergens, such as dust mites, can also be minimized. Controlling the humidity level can provide benefits in these areas of comfort. Desiccants also have the ability to adsorb some volatile organic compounds (VOC's), such as cigarette smoke (2).

BACKGROUND

During the cooling season, the space conditioning system performs two functions: temperature control (sensible cooling) and humidity removal (latent cooling). Sensible cooling is needed to compensate for the heat produced in the space and also transmitted through the building envelope and to cool the infiltration air. Latent cooling is required to dehumidify the infiltration air and the moisture introduced into the space from people, cooking, bathing, etc. The sensible and latent loads together comprise the total cooling load.

Central air conditioning cooling systems (vapor compression refrigeration cycle) have several shortcomings. Air conditioning cooling systems achieve humidity control by cooling the supply air to the point of saturation. Their capability is constrained by the physical performance of the coil design. This includes the refrigerant temperature, tube size and spacing, along with fin spacing and design. Air velocity and effective coil face area are also typically set parameters.

Air conditioners are designed to a specific point; therefore, they have a relatively fixed sensible to latent capability. As the manufacturers have striven for higher system efficiencies the evaporator temperature has been raised. As a result the latent capability of the system has gone down.

The ratio of sensible and latent loads constantly varies in a conditioned space. Under some conditions (morning and evening hours, rainy or cloudy weather, etc.) the latent load may be higher. In other words, the latent and sensible conditions can have an infinite variety of combinations; however, the air conditioner system can only vary within a narrow set of operating parameters. As a result an air conditioner may not be able to handle the latent load variety, especially the extremes.

Air conditioning systems are controlled only in response to space temperature. A rise in humidity will not activate the cooling unit. This can cause discomfort for the space occupants. Over the past several years some humidity sensing controls have been added to air conditioners. These devices typically reduce the air volume by up to 15% in order to remove more moisture. However, in order for these controls to function the air conditioner must first be running. Again, if the temperature is satisfied at the thermostat this feature does not contribute the benefit expected.

The cooling unit should be selected to match the capacity to the calculated load. However, the calculated load is only a single point that typically occurs or is exceeded 2 to 2.5% of the time. Unit selection should also be based on sensible and latent loads and system performance against these loads. Unfortunately this seldom gets done. The result is generally oversized units that do not get enough run time for desirable humidity control. Wider swings in temperature can also result due to the cycling pattern of the system.

In high humidity regions or during periods when humidity is high, lower than normal thermostat settings are often used in an attempt to remove enough moisture to maintain comfort conditions or solve a humidity problem. To reach the lower set point the air conditioner will run longer. This is, however, a very inefficient way to try to maintain acceptable indoor humidity levels. It also results in an environment that is generally colder than necessary for occupant comfort.

The use of set-up thermostats is increasing, primarily to save operating cost (energy consumption). This translates to less run time for the air conditioner, which also means less opportunity to control humidity. When allowing the temperature to rise for a period of time the humidity is also increasing. This increased humidity level will reabsorb into the furnishings, such as rugs, furniture, and draperies. When the cooling set point is returned to the normal occupied setting, the space temperature is reduced. However, the cooling system has less capability to remove the moisture in the space. Coupled with the fact that the cooling system only responds to temperature, the humidity level may never be brought to an acceptable level.

A set-up thermostat inherently increases over sizing of the air conditioner. This occurs since the inside set point is raised, therefore lowering the delta or temperature difference the system must work against. This increased over sizing means less capability to maintain comfort due to shorter run times or on cycles. In other words, the air conditioner will come on and cool the space much faster to the higher cooling set point and will turn off quicker.

Table 1 presents some data to illustrate some of these points. A location of Houston was chosen with an outside design temperature of 94° F. A design load of 48,000 Btuh was established at an indoor design temperature of 72° F. For this analysis a set-up temperature of 80° F was selected.

The cooling load is listed against outdoor temperatures from 65° up to 105° F. The set-up cooling load range is also tabulated from 75° to 105° F. Representative air conditioner capability is listed for a standard 10 SEER 4 ton system. Capacity increases as the outdoor temperature drops. The percentage of oversizing is tabulated for the normal temperature as well as the set-up temperature setting.

To illustrate the impact this has, the bin hours for Houston have also been included. This data illustrates that the bulk of the hours occur below 80° F. At 80° the normal design point has the air conditioner oversized at 128% and during the set-up period 493%. Therefore, cycling will occur more and humidity control is diminished.

Figure 2 illustrates this data graphically.

Table 1 Houston Cooling Load vs. Air Conditioner Characteristics

Location: Houston	Outdoor	Indoor Normal	Indoor Set-Up
Design Conditions:	94	72	80
Design Load:		48,000	

Outdoor Temp	Normal Cooling Load	Set-Up Cooling Load	A/C Capacity	Bin Hours	Normal % Oversizing	Set-Up % Oversizing
65	0			1069		
70	5333		56,500	1263	959%	
75	14,222	0	54,600	1621	284%	
80	23,111	8,889	52,700	922	128%	493%
85	32,000	17,778	50,800	676	59%	186%
90	40,889	26,667	48,900	323	20%	83%
95	49,778	35,556	47,000	53	-6%	32%
100	58,667	44,444	45,100	1	-23%	1%
105	67,556	53,333	43,200	0	-36%	-19%

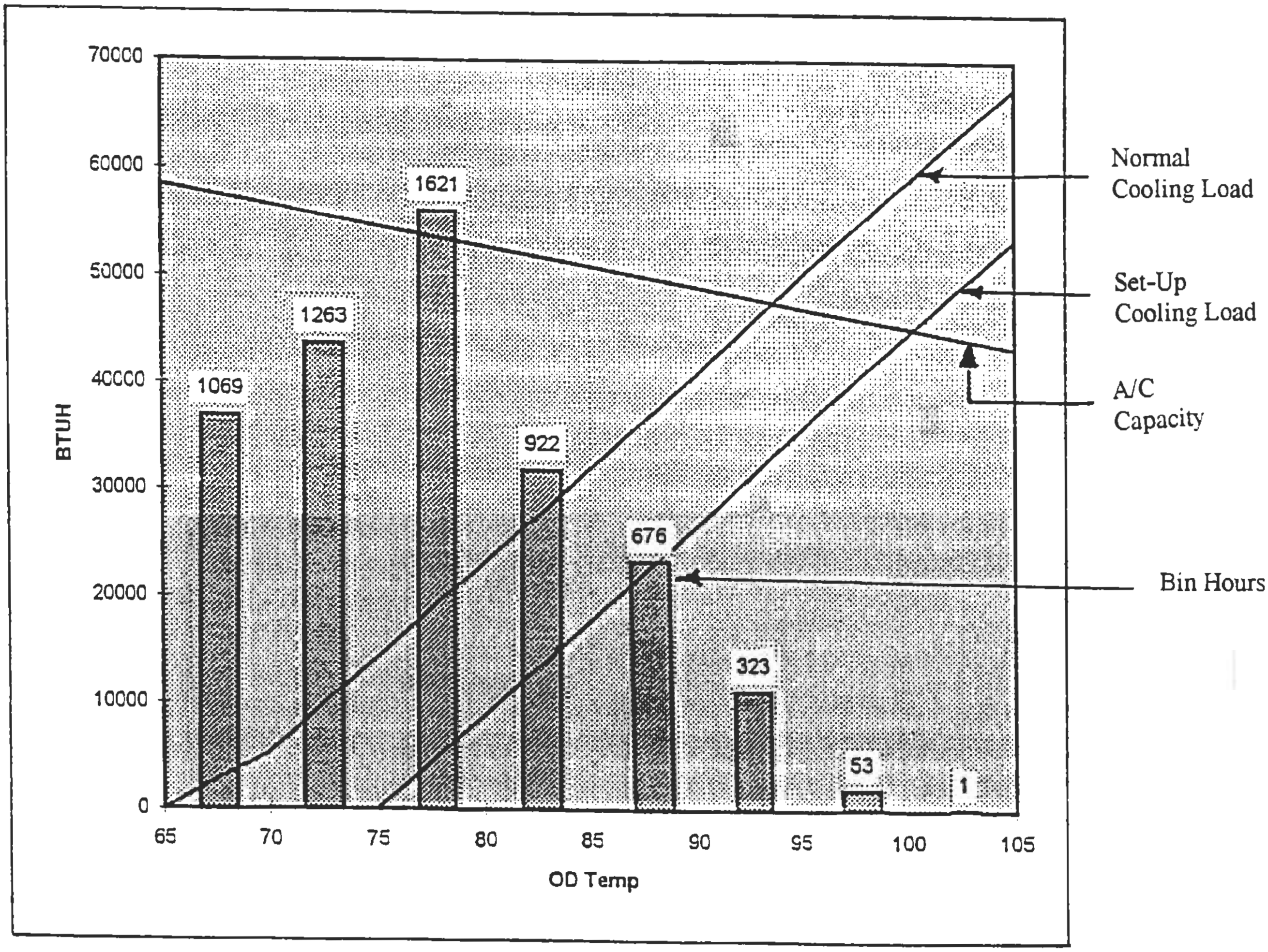

Figure 2 Houston Cooling Load vs. Air Conditioner Characteristics

CONCEPT

The objective is to move moisture (humidity) from the air where it is objectionable to where it is not objectionable. Comfort is attainable when humidity is lowered, even at higher cooling set points. A desiccant material and process can accomplish this.

Desiccants attract moisture from the air by creating an area of low vapor pressure at the surface of the desiccant. The water vapor (humidity) in the air exerts a higher pressure. The result is that the water vapor (humidity) will move from the air into the desiccant, thus causing the air to be dehumidified. Desiccants can attract, collect, and hold 10 to 10,000 percent of their dry weight in water vapor (3).

At some point, the desiccant will approach the surrounding air conditions and cannot collect any more moisture. The same properties used to attract the moisture can also be used to drive the moisture from the desiccant. If heat is applied to the desiccant, the water vapor pressure is raised higher than the surrounding air. The water vapor will then move out of the desiccant to equalize the pressure differential.

By placing the desiccant on a rotating honeycomb type wheel, this concept can be applied to a constant and repeatable process. The process can be used to reach the objective and provide comfort with humidity control.

DESICCANTS

The ability of desiccants to adsorb moisture and to control this process is the key to getting comfortable with dehumidification. There are many types and varieties of desiccant materials.

The intent of this paper is to demonstrate how this process can be used to improve comfort, not to explain the details of desiccants. Therefore, should the reader want to learn more about desiccants an appropriate resource should be used, such as the ASHRAE Fundamentals Handbook (1) or The Dehumidification Handbook (3).

OPERATING CYCLE

The dehumidification process for the desiccant based system is shown in Figure 3.

1. Humid air flows to the unit through a flexible duct from the space being conditioned. This could be from a return air duct or directly from a single zone (i.e., basement or family room).

2. The humid air passes through the rotating silica gel desiccant wheel which adsorbs the moisture. Approximately 74 pints / day of moisture can be removed.

3. The dry air flows back to the conditioned space, either to the return air duct work or a diffuser in a single zone application.

4. Air for the "regeneration process" is typically ducted to the unit from outside.

5. This outside air is drawn through a coil where it is heated. The finned coil draws the heat energy from a gas water heater.

6. The heated outside air then passes through the rotating silica gel desiccant wheel. The heated air reverses the process and the moisture is released into the heated air stream.

7. The warm moisture-laden air is then expelled as vapor to the outside air.

TYPICAL CONDITIONS

Figure 4 illustrates a set of operating conditions. Due to the variety of ranges of the variables this data can not be construed to represent performance across the entire range.

Process air and regeneration air flows are both at 165 CFM. Hot water flow is 1 GPM and is supplied at 160° F. Leaving water temperature is 135° F.

Air is entering the process side of the unit at 78° F and 52 % relative humidity (73 Grs / Lb.). This represents the air coming from the conditioned space.

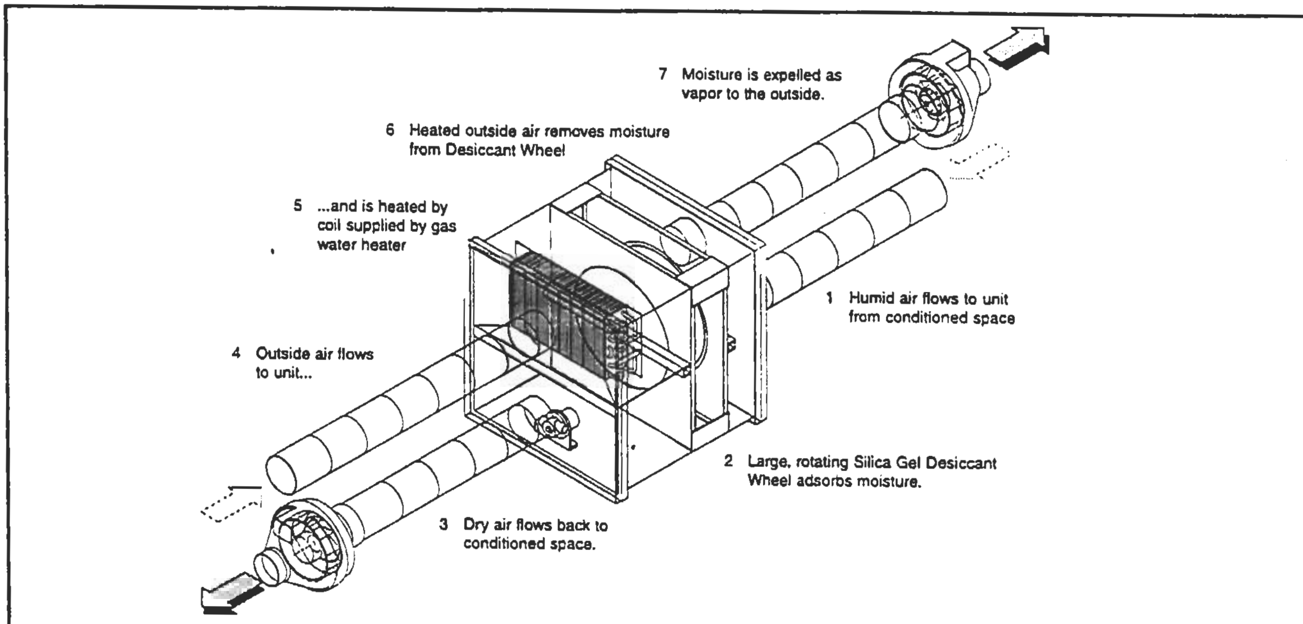

Figure 3 Operating Cycle

Typical Conditions

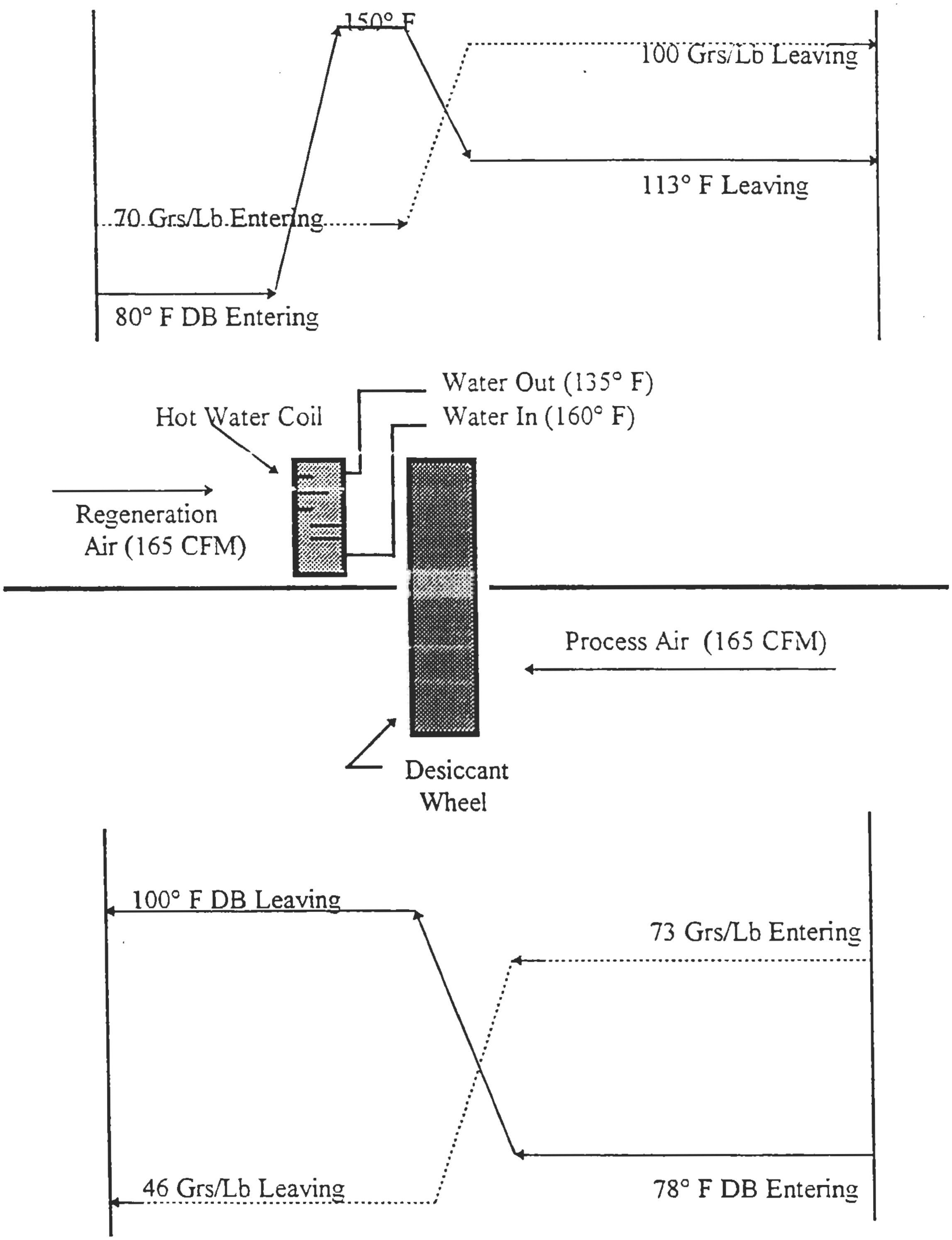

Figure 4 Operating Conditions

Going through the desiccant wheel and process there is a latent heat of vaporization that occurs. This causes the sensible temperature to rise, under the conditions provided this rise is 22° F. The 100° F process air will then be mixed with and diffused through out the conditioned space. Table 2 provides data on the resultant air temperatures for a range of system CFM values.

Table 2 Resultant Mix Air Temperatures

System CFM	Return Air	Process Air (165 CFM)	Mix Temp
400	78	100	87.0
600	78	100	84.0
800	78	100	82.5
1000	78	100	81.6
1200	78	100	81.0
1400	78	100	80.6
1600	78	100	80.3
2000	78	100	79.8

The moisture level leaving the process side is at 17 % relative humidity (46 Grs / Lb.). This dry air would then be mixed with and diffused through out the conditioned space. Table 3 provides data on the resultant grains for a range of system CFM.

Table 3 Resultant Mix Grains (RH %)

System CFM	Return Air	Process Air (165 CFM)	Mix Grs (RH %)
400	73	46	61.8 (33 %)
600	73	46	65.6 (38 %)
800	73	46	67.4 (41 %)
1000	73	46	68.5 (43 %)
1200	73	46	69.3 (44 %)
1400	73	46	69.8 (45 %)
1600	73	46	70.2 (46 %)
2000	73	46	70.8 (47 %)

The air entering the regeneration portion of the unit is at 80° F. This air temperature is raised to approximately 150° F after passing through the hot water coil. The desiccant wheel process will lower the air to 113° F.

The moisture level entering the regeneration cycle is at 46 % relative humidity (70 Grs / Lb.). The moisture level is at 25 % relative humidity (100 Grs / Lb.) when the air is discharged to the outdoors. While this seems backwards, keep in mind that the air temperature has changed from 80° F to 113° F. Relative humidity is lower, but the grains / lb of dry air is higher (70 vs. 100).

WHOLE HOUSE APPLICATION RESULTS

Figure 5 is a graphical presentation of data collected in a single residence located in Miami, FL during a period of time in March 1995. Tabular data for this chart can be found in Appendix 1.

During the first three days the air conditioner was being run and the dehumidifier was not operated. Relative humidity outdoor ranged from 62% up to 95%. Relative humidity indoor ranged from about 49% up to 58%. Through out this period the fluctuation in the range was wide and tended to pattern after the air conditioner cycle pattern. Air temperature within the conditioned space was relatively stable at 75° F.

On day 68 the dehumidifier was started. The relative humidity level was then held to 50% with very little swing or range. During this same period of time the outdoor relative humidity ranged from 50% to 83%.

It should be noted that for two days (days 69 and 70) the outdoor temperature was low and the air conditioner did not run. However, the indoor relative humidity was held at the 50% level by the dehumidifier. During days 72, 73, and 74 the air conditioner did run at a higher percentage, but the indoor humidity was still held at the 50% level.

CONCLUSION

Comfort can be obtained by controlling temperature and humidity separately. An air conditioner can be used to provide for temperature control, while a whole house dehumidifier can be used to control the humidity level. Each device can work independent of the other. Therefore, a conditioned space can be maintained at any combination of temperature and humidity to suit the occupants.

Air conditioning units alone can not provide a satisfactory level of comfort. Up until now consumers only had one choice and that was just the

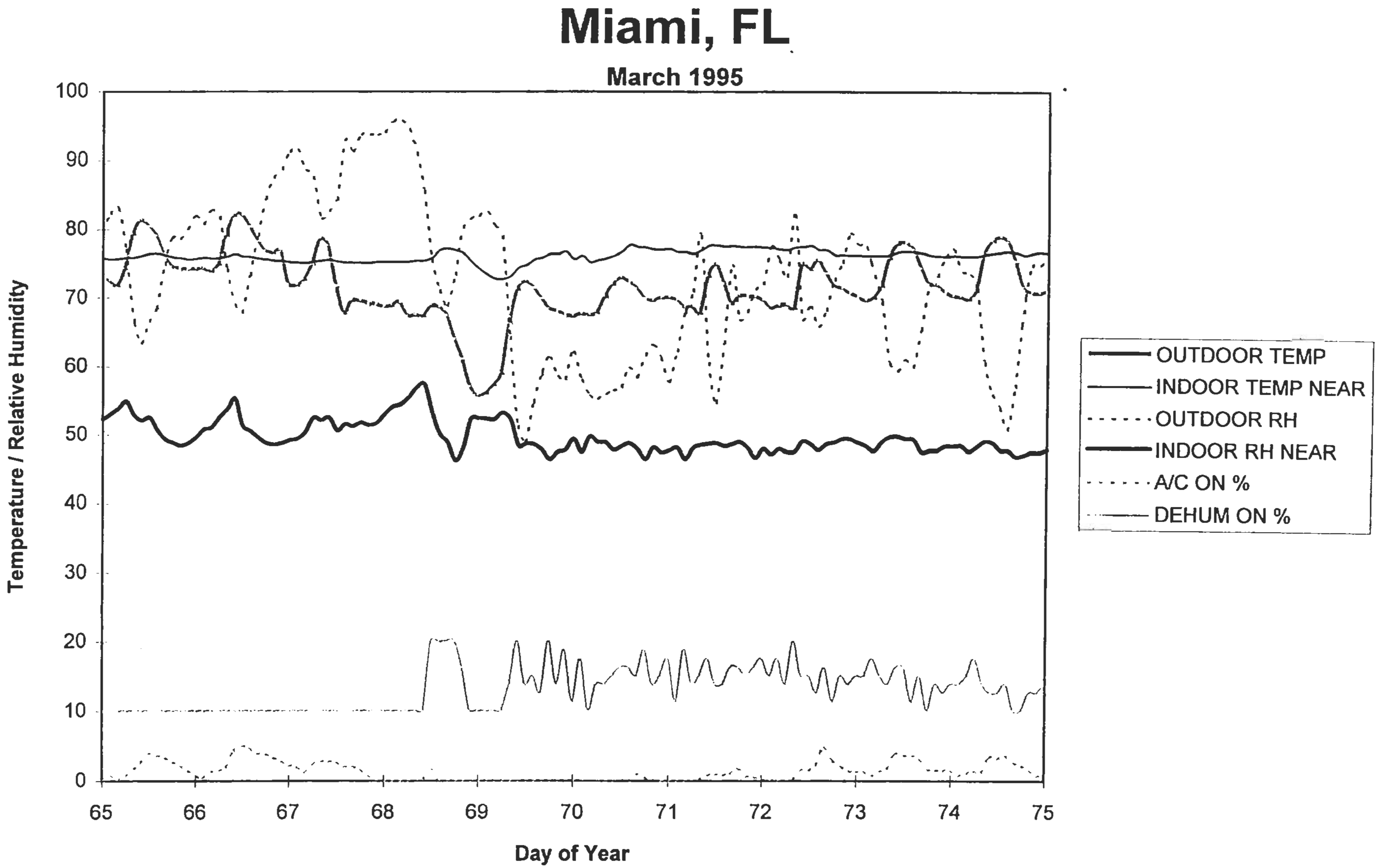

Figure 5 Miami Test Site (March 1995)

air conditioner. Now with a whole house dehumidifier available several learning processes must occur.

Air conditioning contractors must identify more about the latent and sensible loads in a space. Additional education will be needed to help them understand the capabilities of an air conditioner as it relates to comfort.

The consumer has not had a choice before, except to turn down the thermostat. With the dehumidifier it is now possible to raise the cooling set point and be comfortable. This process will be the most difficult hurdle on the way to comfort.

In high humidity situations there is a problem with indoor air quality. Controlling the humidity with a desiccant product can help to control mold, mildew, dust mites and other indoor air pollutants at a much higher degree or level of acceptability.

ACKNOWLEDGMENT

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Appendix 1

DAY	Time of Average	Average Outdoor Temp.	Average Indoor Temp.	Average Outdoor R. H.	Average Indoor R. H.	0=0% On 10=100% On A/C On %	10=0% On 20=100% On Dehumid. On %
65	2	72.3	75.7	82.2	53.0	0.8	10.0
65	4	71.6	75.8	83.2	53.9	0.0	10.0
65	6	74.0	75.9	77.2	54.9	0.8	10.0
65	8	79.1	76.0	67.0	52.9	1.6	10.0
65	10	81.1	76.2	63.3	52.1	2.5	10.0
65	12	80.3	76.5	66.4	52.5	3.8	10.0
65	14	79.0	76.5	68.4	50.7	3.6	10.0
65	16	76.3	76.3	74.8	49.3	3.3	10.0
65	18	74.5	76.0	78.7	48.8	2.8	10.0
65	20	74.2	75.9	78.5	48.4	2.3	10.0
65	22	74.0	75.7	80.0	48.8	1.5	10.0
65	24	74.0	75.8	81.9	49.6	0.8	10.0
66	2	74.1	75.9	80.7	50.8	0.3	10.0
66	4	73.7	75.8	82.7	51.1	1.2	10.0
66	6	74.8	75.9	82.0	52.6	1.4	10.0
66	8	78.9	76.1	74.4	53.8	1.8	10.0
66	10	81.8	76.4	69.2	55.3	4.2	10.0
66	12	81.9	76.1	67.8	51.3	4.8	10.0
66	14	80.3	76.1	73.2	50.5	4.7	10.0
66	16	78.3	75.8	79.0	49.6	3.8	10.0
66	18	76.7	75.7	84.2	48.8	3.8	10.0
66	20	76.4	75.5	87.3	48.5	3.3	10.0
66	22	76.6	75.5	88.5	48.7	2.8	10.0
66	24	71.9	75.3	91.0	49.2	2.2	10.0
67	2	71.6	75.2	91.6	49.4	2.0	10.0
67	4	72.5	75.2	88.6	50.4	1.1	10.0
67	6	74.8	75.3	87.7	52.5	2.3	10.0
67	8	78.3	75.5	81.6	52.2	2.7	10.0
67	10	77.5	75.6	82.5	52.5	2.7	10.0
67	12	71.6	75.4	84.1	50.6	2.6	10.0
67	14	67.6	75.3	92.8	51.5	1.9	10.0
67	16	69.3	75.2	91.1	51.3	2.0	10.0
67	18	69.3	75.2	93.5	51.8	1.6	10.0
67	20	69.0	75.2	93.7	51.4	0.8	10.0
67	22	68.8	75.3	93.6	51.7	0.0	10.0
67	24	68.5	75.3	93.9	53.0	0.0	10.0
68	2	68.6	75.3	95.5	54.1	0.0	10.0
68	4	69.1	75.3	95.7	54.5	0.0	10.0
68	6	67.2	75.4	94.6	55.4	0.0	10.0
68	8	67.3	75.5	91.2	56.8	0.0	10.0
68	10	67.1	75.5	85.6	57.4	0.0	10.0
68	12	68.6	76.0	75.8	53.3	1.7	20.0
68	14	68.4	77.1	71.2	50.1	0.0	20.0
68	16	67.4	77.2	68.7	48.8	0.0	20.0
68	18	63.9	77.0	73.3	46.2	0.0	20.0

DAY	Time of Average	Average Outdoor Temp.	Average Indoor Temp.	Average Outdoor R. H.	Average Indoor R. H.	0=0% On 10=100% On A/C On %	10=0% On 20=100% On Dehumid. On %
68	20	61.0	76.5	80.1	48.0	0.0	16.3
68	22	56.9	75.4	81.4	52.3	0.0	10.0
68	24	55.5	74.3	81.9	52.4	0.0	10.0
69	2	55.8	73.4	82.6	52.3	0.0	10.0
69	4	57.0	72.8	80.5	52.3	0.0	10.0
69	6	58.7	72.8	79.1	53.2	0.0	10.0
69	8	66.0	73.3	64.4	52.2	0.0	13.8
69	10	71.0	74.5	51.3	48.4	0.0	20.0
69	12	72.2	74.9	48.7	48.7	0.0	13.8
69	14	71.3	75.7	54.6	48.6	0.0	15.0
69	16	69.8	75.9	58.6	47.8	0.0	12.5
69	18	68.3	76.5	61.3	46.4	0.0	20.0
69	20	67.9	76.5	58.6	47.4	0.0	13.8
69	22	67.4	76.8	58.0	47.8	0.0	18.8
69	24	67.1	75.7	62.1	49.4	0.0	11.3
70	2	67.4	76.2	58.1	47.5	0.0	17.5
70	4	67.3	75.3	55.8	49.7	0.0	10.0
70	6	67.6	75.6	55.1	48.9	0.0	13.8
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70	20	69.4	77.2	63.1	48.2	0.0	13.8
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71	2	69.5	76.8	62.0	48.1	0.0	11.3
71	4	68.5	76.8	67.7	46.4	0.0	18.8
71	6	68.5	76.6	70.8	48.1	0.0	13.8
71	8	67.6	77.1	79.2	48.5	0.0	15.0
71	10	73.0	77.7	60.7	48.7	0.7	17.5
71	12	74.7	77.7	54.5	48.8	0.8	13.8
71	14	72.1	77.5	63.3	48.4	0.7	13.8
71	16	69.0	77.6	74.8	48.6	0.9	16.3
71	18	70.1	77.5	66.8	48.9	1.8	16.3
71	20	70.1	77.5	67.9	48.1	0.6	15.0
71	22	69.9	77.5	71.1	46.6	0.4	16.3
71	24	69.5	77.4	71.9	47.9	0.2	17.5
72	2	68.4	77.4	77.4	47.1	0.0	15.0
72	4	68.6	77.1	75.6	47.9	0.0	17.5
72	6	68.8	77.1	73.1	47.5	0.0	13.8
72	8	68.3	77.4	82.1	47.6	0.0	20.0
72	10	74.7	77.5	66.9	49.1	1.4	15.0
72	12	74.0	77.7	68.9	48.6	1.4	15.0

DAY	Time of Average	Average Outdoor Temp.	Average Indoor Temp.	Average Outdoor R. H.	Average Indoor R. H.	0=0% On 10=100% On A/C On %	10=0% On 20=100% On Dehumid. On %
72	14	75.3	77.1	65.7	47.8	2.1	12.5
72	16	73.5	77.0	68.1	48.6	4.6	16.3
72	18	71.7	76.4	72.5	48.9	2.9	11.3
72	20	71.2	76.4	75.1	49.4	2.1	15.0
72	22	70.5	76.3	79.3	49.4	1.4	13.8
72	24	70.0	76.3	77.7	48.9	1.2	15.0
73	2	69.4	76.3	77.5	48.4	1.3	15.0
73	4	69.8	76.2	73.5	47.7	0.6	17.5
73	6	71.5	76.3	69.6	49.0	1.3	15.0
73	8	75.7	76.4	60.6	49.7	1.6	13.8
73	10	77.7	76.8	59.2	49.8	3.7	16.3
73	12	77.9	76.9	61.0	49.4	3.7	16.3
73	14	77.0	76.8	59.8	49.3	3.5	11.3
73	16	74.4	76.7	65.3	47.5	3.3	15.0
73	18	71.9	76.4	71.8	47.7	1.6	10.0
73	20	71.7	76.3	73.2	47.8	1.5	13.8
73	22	70.7	76.2	76.0	48.4	1.4	12.5
73	24	70.1	76.3	77.2	48.4	1.5	13.8
74	2	69.9	76.2	74.0	48.4	0.6	13.8
74	4	69.6	76.2	73.6	47.6	1.0	15.0
74	6	70.9	76.3	71.5	48.3	1.3	17.5
74	8	76.3	76.5	60.7	49.1	1.1	13.8
74	10	78.1	76.6	56.0	48.9	3.4	12.5
74	12	78.7	76.8	54.1	47.8	3.0	12.5
74	14	78.1	76.9	50.7	47.7	3.6	13.8
74	16	75.4	76.7	56.9	46.9	2.6	10.0
74	18	71.5	76.4	67.9	47.0	2.3	10.0
74	20	70.6	76.6	74.7	47.5	1.5	12.5
74	22	70.5	76.8	74.9	47.4	0.7	12.5
74	24	70.7	76.7	75.3	47.8	0.6	13.8
75	2	70.2	76.7	77.3	48.4	0.5	12.5