

TECH TIP # 22



One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

NIGHT AIR COOLING -- DOES IT CUT OPERATING COSTS? DOES IT AFFECT COMFORT?

Standard residential design procedures such as outlined in Manual J, published by the Air Conditioning Contractors of America (ACCA) are formulated based on two important conditions: first, some heat gain from outside is absorbed by a building's walls, ceilings, floors, etc., and this stored heat must be accounted for. The phenomenon is commonly referred to as the flywheel effect, and by considering heat storage smaller-sized cooling equipment can be used. The second consideration is that the unit and controls are set to maintain a constant indoor temperature 24 hours a day.

With these conditions as prerequisites, it is apparent why most manufacturers and trade associations do not recommend operating air conditioning equipment solely during hours of peak loads. For one thing, a larger Btu capacity would be needed to obtain instant response when a unit is turned on at the hottest portion of the day; and for another, there would be less effective control over indoor relative humidity.

But with the rising cost of electricity, more and more people will be shutting off units at night and opening windows and doors to take "advantage" of the cool night air and conserve energy. The question is: "Are they money ahead?" and "Can they be comfortable?"

Several years ago in one of the warm air test homes at the University of Illinois, a secondary study was undertaken to determine the effect of night air cooling while evaluating regular cooling performance in the residence.

Each evening, about 9:00 pm, if the outdoor temperature dropped to 75° F (which was equal to the indoor control temperature) the doors and windows of the house were opened and the air conditioner was shut off. The house remained open through the night and was closed at 5:30 am the next morning. The air conditioning was also turned back on at this time in anticipation of the next day's heat gain. Temperature, humidity levels and air conditioner operating times for these days were then compared to similar days when full 24 hour air conditioning was maintained.

Based on a comparison of 22 test days, the air conditioning unit, on the average operated four hours less each day when windows and doors were opened to benefit from the cool night air. So, if the compressor operated normally for 12 hours during a "closed up" day, it would only be "on" for eight hours on a day utilizing night air cooling.

Published by the Independent Study Institute, a division of the Heating, Airconditioning & Refrigeration Distributors International. The Institute offers accredited, industry training courses in HVAC/R technology. Direct inquiries to HARDI 3455 Mill Run Drive, Ste. 820, Columbus, OH 43026. Phone 888/253-2128 (toll free) · 614/345-4328 · Fax 614/345-9161

www.hardinet.org

This reduced operating occurs for two reasons. First, and rather obviously, the unit is off during the time the windows and doors are open and the immediate benefits of night air are felt. But additionally, on very cool evenings, say when the outdoor temperature drops into the 60's, the house is subcooled, and the next day further benefits accrue, since the air conditioning unit will not start operating right away because all the subcooled house materials absorb the day's first heat.

Building materials in a typical one-story frame house can absorb about 12,000 Btu per degree F rise in indoor temperature. Thus, if at 5:30 am when the windows and doors are closed, the house is say, at 70° F and the air conditioner doesn't start until 10:30 am, the house structure absorbs heat at the rate equivalent to operating 1 ton of mechanical cooling during that five hour morning period.

It is difficult to place a dollar and cents saving on the value of night air cooling in view of the many factors involved. But, based on the comparative results in the warm air residence, a 40 to 72 percent reduction in daily operating costs is possible -- with the percentage savings increasing with cooler weather.

If an air cooled system requires 1,750 watts per 12,000 Btuh cooling capacity (EER of 6.85), a four hour saving in operating time would equal a savings of 4 x 1.75 or 7kWh per day per 12,000 Btuh output, or the following approximate reductions:

Nominal Size	Savings
2 ton	14 kWh/day
3 ton	21 kWh/day
4 ton	28 kWh/day
5 ton	35 kWh/day

For example: at a power rate of 3.8 cents per kWh, a homeowner in the average six room house with 2 tons of cooling, can save about 53 cents each evening that he can open the windows and employ night air cooling. How much this will reduce a monthly bill depends, of course, on the local climatic conditions. In regions experiencing medium and high temperature swings it could amount to five to nine dollars each month of the cooling season. For larger tonnage units, the savings will be greater.

In the test house at Illinois, which was a well insulated structure, indoor temperature always lagged the outdoor temperature because of the heat storage in the structural components. You should recall that we said the windows were opened when the temperature cooled and was equal to the indoor temperature of 75° F. Often, at this time, the house would actually warm 1° to 2° F as the heat stored in the walls began to come out. It wasn't until the outdoor temperature decreased another 5° F that the actual drop in indoor temperature was always 5° or 6° F less than the outdoor temperature. If the outdoor temperature fell to 65° F, the indoor temperature would remain around 70° or 71° F.

The effect on humidity level is probably the single greatest danger of night air cooling. Very cool nights --- say between 50° and 60° --- are no particular problem, since the outdoor humidity level is probably lower than indoors anyway. For instance, even fully saturated outdoor air (100 percent RH) at 50° F corresponds to a 60 percent relative humidity when brought inside and warmed to 70° F. And air at 60° F, 70 percent RH, is only 42 percent RH when warmed to 70° F. Excessive humidity occurs on slightly warmer evenings.

If windows are open during an evening when the outside humidity level is greater than inside the house, the problem is likely to carry over until the next morning as well. Quite often, proper humidity control is not regained until the air conditioner unit has undergone two or three operating cycles, which often does not occur until noon of the next day.

The following outdoor relative humidity will not exceed the indoor moisture level corresponding to 50 percent RH at 75° F.

Outdoor Temperature	RH
70	60
65	70
60	84

Thus, if windows are open when the outdoor temperature is 65° F and 70 percent RH (or lower) the indoor humidity level will not be increased. Additionally values of relative humidity corresponding to other outdoor temperatures can be obtained from a standard psychrometric chart.

So much depends on the homeowner to make night air cooling effective. Windows and doors must be closed very early the following morning and equipment turned on in anticipation of the build up in the cooling load. If this isn't done on schedule, the homeowner will not have a comfortable house and equipment will operate "overtime" in a futile attempt to catch up with the load.

The homeowner is also likely to make a mistake now and again and open up the house on some "bad" nights. The consequences being a lack of comfort and probably the use of "extra" energy the next day to regain temperature and humidity control indoors.

Obviously, opening windows and doors also permits pollen, dust and dirt to enter the home. This may be a problem depending upon locality, occupants and if accessory electronic air cleaning devices are installed.

Finally, it is possible to utilize night air cooling through the air distribution system by adding appropriate duct./damper/exhaust components regulated by an enthalpy control device. In this manner homeowner judgment is eliminated and system filters can clean incoming outdoor air -- but not, of course, without some added investment or remodeling expenses incurred by the homeowner.