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Energy Efficiency & Environmental News: Energy Efficient Technologies for Florida Homes[1]

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ENERGY EFFICIENT TECHNOLOGIES FOR FLORIDA HOMES

Window Technology

One of several new technologies appropriate to residential applications is the high R-value and Low E windows. High R and Low E is an abbreviated way of referring to windows that have high resistance to conductive heat transfer (high R value) and low radiant emissivity (Low E). Some of these windows are very expensive and may not be cost effective for south Florida applications but more suited for harsh.

Several manufacturers are developing intriguing glazing systems for windows that reduce solar heat gain without significantly reducing visible light transmission. These manufacturers claim that windows can be tuned to block solar gain in the summertime to reduce cooling loads and maximize solar gain in the wintertime to take advantage of solar heating. Reporting on window technologies, Energy Design Update, indicates that determining the energy impact of a window is not a precise science. The effect of using high R, Low E windows can vary enormously depending on the climate, orientation, shading and thermal characteristics of a building. It is difficult to make accurate comparisons between windows, and designers must rely on computer analyses to predict which window provides the best performance for specific applications. (A general comparison of several high performance windows is shown in Table 1.)

In Florida residences, a more productive approach to energy conservation than using high R windows is to control solar or radiant heat gain and moisture through infiltration prevention. Some window manufacturers indicate that Low E windows do save energy through controlling radiation or solar heat gain. Windows designed to control these factors have a low shading coefficient (sc). The (sc) indicates how much solar energy the window allows in compared to clear glass. For example, a window with a shading coefficient of 0.5 allows in 50% of the solar energy of a clear glass window. A window with a shading coefficient of 0.4 allows 40%, etc.

The term "shading coefficient" has been used for years. This compares the total amount of heat transmitted through treated glass compared to the heat transmitted through 1/8-inch single pane, clear glass. "Solar heat gain coefficient" (SHGC) may be a more useful term. This is the ratio of the total solar heat transmitted through a window compared to the total incidence of solar radiation. The solar heat gain coefficient includes solar radiation transmitted through the glass as well as the solar radiation that is absorbed by the glass and frame. This absorbed solar radiation is then conducted inward into the home. SHGC is still a new term and many window manufacturers may not list it on their specification

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Table 1. Comparison of R-Values and Shading Coefficiencts (SC) for Several Common Brands of Windows and Glazing.

Manufacturer	Shading Coefficient (SC) (whole unit*)	R-Values (whole unit)	Glazing Type
Generic	.80	R-1.1	Clear single glazing
Generic	.71	R-2.0	Double glazing
Andersen	.41	R-3.1	PermaShield casement with high-performance double glazing
	.28	R-3.0	PermaShield casement with HP Sun double glazing
Marvin	.60	R-3.1	Casement with Northern Low-E double glazing
	.38	R-3.1	Casement with Southern Low-E double glazing
Hurd	.54	R-2.9	Casement with Heat Mirror 88 triple glazing
	.42	R-4.5	Casement with Insol-8 Heat Mirror quadruple glazing
	.36	R-3.0	Casement with Heat Mirror 66 triple glazing
LOF	.70	R-2.8	Wood casement with LOF Energy Advantage glazing
Weathershield	.38	R-3.2	Casement with new E4 glazing

* Shading coefficient for whole window is estimated at 0.8 times the center-of-glass calculations (Source: Manufacturers' data published in *Energy Design Update*, February 1994, p. 77)

sheets. Until it becomes more widely accepted, the shading coefficient will still provide a reasonable indication of the ability of glass to control solar radiation.

Andersen Windows claim that their high performance glass saves more in sunny, hot climates than in northern climates. The Andersen computer model shows that by using their glass over clear glass a 1500 square foot house with R-19 walls, R-39 ceilings, built slab on-grade with 260 feet of glass distributed evenly on all four walls saves an estimated $125 a year in Miami and in Phoenix. They also estimate a savings of $65 in Atlanta and $40 in Denver. This model assumes that utility costs are $0.8 per kilowatt hour for electricity and $0.60 per therm for natural gas.

A technology marketed by Marvin Windows and Doors features electrochemical windows which turn from clear to opaque with the flip of a switch. The company refers to this glass as privacy glass and not as a method for control of solar radiation. The windows use a special electro-conductive film sandwiched between two layers of glass. These windows are normally opaque when off, but turn clear when electric current is applied. This film was originally developed by the 3-M Company. These windows do not operate as a solar shade, even though they appear opaque, because they let in almost as much light and solar heat as when they are clear. According to company literature, privacy glass will consume about 131 kwh per 3x5 foot window per year ($10 per window at current prices). However, the stumbling block is the initial high cost of the window which is approximately $90 per square foot above regular Low E windows,

making these windows prohibitive except for high-end homes.

Although some of the windows in Table 1 are effective in reducing solar heat gain, their application may not be cost effective when compared to other window shading options, investing money in a high efficient heat pump or heating and cooling system, or using an efficient water heating system.

The Energy Efficient Building Association (EEBA) recently published an alert indicating that window R-values are sometimes overstated. EEBA reports that these calculated results are consistently and substantially higher than laboratory testing methods show. It seems that the window manufacturing industry almost unanimously have been using calculations provided by ASHRAE in its 1985 or earlier *Handbook of Fundamentals*. Unfortunately, this ASHRAE formula did not include other physical characteristics which must be taken into effect to accurately assess window performance. The 1989 ASHRAE *Handbook of Fundamentals* has improved the formula and the results are more comparable with laboratory results. EEBA indicates that one very popular "Low E" casement, gas-filled, insulated glass window is advertised as having a 4.2 R-value based on the old ASHRAE calculations. The same window has only a 3.2 R-value (26% less effective) using the new ASHRAE calculation method.

Foam Concrete Forms

Another relatively new technology used in residential and commercial construction is the polystyrene or polyisocyanurate foam form for poured concrete walls . Several manufacturers are now making these forms. The forms basically consist of a building block unit with one to two-inch thick inner and outer layers of foam connected by plastic or metal ties. The forms are stackable and are manufactured in various lengths and widths from 4 feet long by 1 foot thick by one foot high to 3 feet long by 1 foot thick by 1 1/2 feet high.

There are several advantages to foam concrete construction. The walls are more energy efficient than traditional concrete block or poured concrete walls and have R-values between R-11 to R-19. This compares to R-4 to R-6 for traditional masonry walls. Another advantage is that walls constructed with these systems are strong and hurricane resistant, particularly when reinforced steel is used in accordance with new building codes (vertically every 24 inches, horizontally every 32 inches). Because these forms are interlocking, they are relatively easy to assemble. Once the forms are assembled, concrete is pumped into the forms from a cement truck to a depth of one to two feet. By the time the pourer returns to the starting place, the concrete has set up sufficiently to continue pouring in a circular manner around the building until the full wall height is achieved. Plastic or steel plates are imbedded in the foam and serve as an anchor for drywall screws and other fasteners (Figure 1).

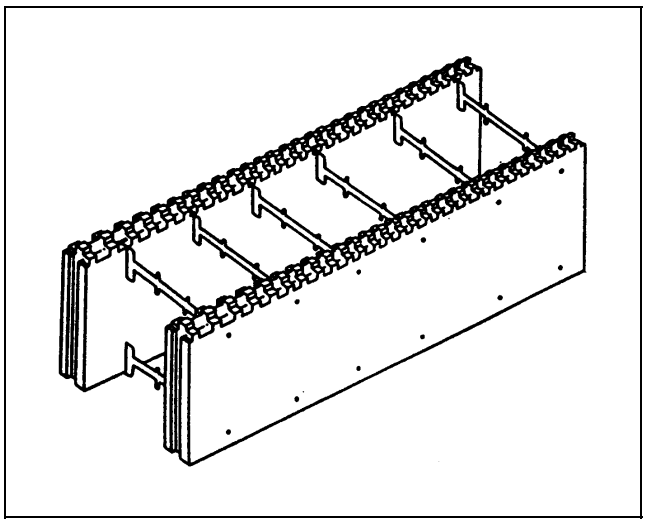

Figure 1. Generic Foam Concrete Form. Steel Webbing or Plastic Ties Are Used to Bridge Unit.

At recent Parade of Homes contests in Lee County and the Pensacola area, some builders used and advertised this method of construction with apparent marketing success.

Heating and Cooling Technologies

There are several new heating and cooling technologies that have recently emerged in the market or are in the final stages of development. One of these technologies is the geothermal heat pump which uses the ground or an available water source as a heat sink to pump heat into in the winter and to receive heat in the summer. Because of the ability of the ground or water to efficiently conduct heat, these units are more efficient than traditional air-to-air heat pumps. One manufacturer claims SEERs of 22 and COPs of 5.8. The Florida Energy Efficiency Code requires cooling efficiencies and SEERs of 10 or higher. A SEER of 15 is considered very high. COPs, used to measure the efficiency of heating, of 3.5 or higher are considered excellent.

Because no water is pumped or wasted, this writer prefers a closed-loop system using a heat exchanger immersed in a lake or other water source such as a river or stream, over a unit which exchanges heat directly with

the soil or uses well water. There is some evidence to suggest that some soils may not be good heating exchange mediums. Some water-source heat pumps use ground water pumped from wells as a heat exchange medium. Because of the parasite energy used by pumps in these systems, they are not as efficient. In addition, unless the water returns to the aquifer, these units may be prohibited by local codes, particularly where water resources are scarce. This writer also believes a simply design may be more reliable and require less maintenance. Some geothermal water-source heat pumps can be quite complicated with many pumps, very long coils, valves, compressors and blowers. The consumer should seek a heat pump that is environmentally friendly and suitable to their regional conditions.

If suitable water sources are not available, some more common air-to-air heat pumps can be purchased which can operate with efficiencies as high as SEER 15. The difference between an air conditioner and a heat pump is that an air conditioner transfers heat from the house or building and expels it to the outside. A heat pump not only performs this function in the summertime, but in the wintertime it reverses the process and takes available heat from outside or in-ground conditions and pumps it into the house or building. This is done by way of a reversing valve which reverses the function of the condenser and the evaporator. For more information on heat pump concepts, refer to Circular 850 by Bucklin, Jones and Peart - *Earth-Coupled Heat Pumps*.

Another promising technology is a residential gas-fired heat pump. Research on this technology is currently underway at Oak Ridge National Laboratory in Tennessee. Basically, this system uses natural or LP gas and operates like an absorption air conditioner often used in campers, mobile homes and large commercial air conditioning systems. The system energy efficiency of the gas-fired heat pump is expected to be very high, and the units should be on the market within two years.

Lennox Industries is currently marketing a high efficiency gas furnace with an Annual Fuel Utilization Efficiency (AFUE) rating of about 92%. The low combustion products ┌ temperature associated with these high efficiency units permit the use of PVC pipe for the flue or chimney. By comparison, conventional gas-fired furnaces have efficiencies between 70 and 80% and require sheet metal tubing or pipe for flues to carry away the high temperature combustion gases.

Cellulose Insulation: A Better Alternative

Use of blown cellulose or cellulose is becoming more and more popular because of its excellent insulating ability, its low cost and the fact that it is made from recycled paper. (Cellulose insulation has an R-value between 3.3 and 3.5 per inch, about the same as fiberglass or rockwool insulation.) When cellulose was first widely used in the 1960s and 1970s it was treated with a sulfate-based chemical to make it fire-resistant. This salt absorbed moisture from the air and became a weak acid, making the insulation less effective and causing it to slump and corrode surrounding pipes and metal.

This has all changed. New product specifications require the use of boron-based chemicals to make the insulation fire-retardant. These chemicals are more environmentally benign and have the additional benefit of repelling fleas, cockroaches and many other insects. There is some evidence to suggest that fiberglass fibers, particularly those with a 1:3 aspect ratio that is, three times longer than they are thick, may be harmful to human lung tissue. These fibers tend to get lodged in the small air sacks in the lungs, causing irritation and respiratory problems. Cellulose insulation avoids these air quality problems.

If you are considering adding insulation to your attic, blown-in cellulose may be the best option. It can be placed over existing fiberglass or rockwool insulation, making it more effective than adding the equivalent fiberglass or rockwool insulation. At a recent visit to Oak Ridge National Laboratory, this writer became aware of a research study which shows conductive air currents in fiberglass insulation renders it less effective than comparable levels of cellulose insulation. Apparently, convective air currents are minimized in cellulose.

New techniques for spraying cellulose has made it an option for wall insulation. Blowing damp cellulose between wall cavities provides complete cavity filling, including around wires and piping. The excess can be scrapped smooth and be reused. This insulation should be completely dry before sheetrock is installed, to prevent future mildew and moisture problems.

Infiltration and Moisture Control

In an article appearing in the April 1994 edition of *Energy Design Update*, it was reported that building scientists meeting at the Affordable Comfort Conference in Philadelphia in March 1994, concluded that there is no such thing as a "too tight house." "The idea that house tightening should be eliminated to avoid air

quality problems is fallacious and should be put to rest."

Studies on mildew conducted by Dr. Virginia Peart and Gary Cook, and other studies on radon problems in residential buildings conducted by the University of Florida Radon Task Force, conclude that there is no correlation between homes having mold or radon problems which were constructed to tight standards and those constructed pre-1974 when codes permitted less tight construction.

As a result of the Affordable Comfort Conference, a policy statement was developed which included the following three points:

1. Pollution source strength, not arbitrary amount of air exchange, is the most powerful detriment to indoor air quality.

2. Natural air infiltration alone cannot be relied upon to consistently maintain recommended levels of ventilation, even in leaky houses.

3. Relying on any minimum test of ventilation rate is not a guarantee of health and safety.

ASHRAE standard 62-89 calls for ventilation rates between 15 and 20 cubic feet per minute per person. This compares with 5 to 7 1/2 cubic feet per person under the old standards. These new standards may be counterproductive in terms of air quality for Florida applications because of the high humidity introduced with ventilation air. Unless the high humidity from outside is removed, serious mold and mildew problems could occur which may cause adverse indoor air quality.

Over the past several years, Dr. Virginia Peart and Gary Cook have advocated the use of a 6 mil plastic ground cover sheet to prevent moisture from entering a home or building, particularly when the home or building is constructed off-grade. The effectiveness of this procedure was recently confirmed by research at the University of California. Results show that control of soil moisture is the most effective way to prevent crawl space moisture problems, and with proper ground cover, cross-ventilation is unnecessary. A plastic sheet placed under any home, mobile or site-built, can lower humidity both in the crawl space and the home. High humidity in the crawl space can also cause structural decay. To install properly, plastic sheeting should be placed entirely over the ground surface, in the crawl space and taped to any foundation columns or walls.

To further minimize moisture problems, it is recommended that roof guttering be placed completely around the home, with downspouts feeding into drains that carry moisture away from the home or building.

Other New Technologies

Other new technologies include:

- the development of the "golden carrot" refrigerator by Whirlpool which is 30% more efficient than current refrigerators and uses environmentally friendly refrigerants;

- the development of high efficiency compact fluorescent lighting that is three to five times more efficient than current incandescent lighting and lasts up to ten times longer; and

- infrared and ultrasonic sensors which operate similarly to TV controllers. These sensors can turn lights on and off automatically and control other energy-using equipment.

References

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Site visit to Oak Ridge National Laboratory, May 24-25, 1994.

CONGRATULATIONS!

Dr. Michael West and Roy Johannesen received the International Award for Best Environmental Project of the Year from the Association of Energy Engineers. Their project, a solar/electric desiccant air conditioning system installed at KFC in St. Petersburg, was initiated by Karen Miller as part of the Energy Extension Service restaurant program. It shows promise for being the first cost effective, commercially viable application of solar thermal technology for the air conditioning market. It uses an innovative combination of new and existing technologies. The project demonstrates the technical and economic feasibility of an integrated solar/electric desiccant cooling system in a high humidity restaurant application. The desiccant system is designed to meet the latent cooling load, add 6 peak tons of air conditioning, reduce utility peak load, and use solar heat sources for regeneration of the desiccant material while conditioning 100% outside air. Karen Miller made the nomination.

HE'S BACK

Roy Johannesen has re-joined the Energy Extension Service staff as the Energy Specialist to provide leadership for the Attractions Program. Roy served as the Mechanical Engineering Energy Specialist for EES before he joined Florida Power Corporation's Department of New Technologies and Services. We are very pleased to have him rejoin us, bringing his new experiences along with his familiarity with Energy Extension programs.

BECAUSE YOU ASKED

Q: What can I do about moisture that condenses on my windows or, even worse, inside my double-pane insulated windows?

A: Condensation occurs in windows when the glass temperature gets below the dew point of either the inside or outside air. In Florida this occurs mainly on the inside of windows in the wintertime when humidity builds up in the house from cooking, showering and even human activities such as breathing. When a cold front comes through, the temperature of glass may get below the dew point of the inside air and condensation occurs, causing windows to fog and even cause water to run down the windows. Generally, this condensation will evaporate when the heating system comes on and the inside dew point temperature is lowered or when the outside temperature increases.

To minimize this problem, it is suggested that long showers and excessive cooking be minimized just prior to cold fronts arriving. The only permanent problem this may cause is the rotting of window sills and perhaps mold and mildew where moisture is allowed to accumulate on the sills or carpet under the window. To prevent this, it is suggested that a spongy foam strip be placed below the window on the sill to catch any excess moisture.

Water condensing between two panes of glass is a more serious problem. Once it gets inside these windows, it is hard to remove. This makes for poor viewing through the window. Some of the windows reported on earlier in this newsletter are filled with argon or other inert gases and are sealed to prevent moisture entry. However, even these windows can have leaky seals and allow moisture entry. An effective technique calls for the drilling of several small holes (1/16" in diameter) at the bottom and top of the window to allow moisture to escape. A special carbide or diamond-tipped drill designed for gas must be used only by a glass professional. Ordinary drills might break the glass. Some windows are manufactured with these holes already in place. The holes will not significantly degrade the insulating performance of standard double pane windows.

This technique is not recommended on high efficiency or Low E windows that have films suspended between the glass panes. In addition, double pane windows are not recommended for south and central Florida unless street or airport noise is a problem. The extra savings should be invested in high efficiency air conditioning/heating equipment for a more efficient return on your investment.

DID YOU KNOW. . .

For the last several years, 4-H has included an energy and environmental segment in their programs. Nationally, the 1993 enrollment in 4-H energy and related topics (energy, transportation, farm/home energy) was approximately 51,000. Over the last three years, enrollment in Florida 4-H energy education as classified by National 4-H has been approximately 5,300 (10% of total energy enrollment). 1993 enrollment in Florida 4-H was 235,015 (with energy 2% of total enrollment).

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