PILKINGTON

Technical Information

ATS-146
October 4, 2000

Rating Windows for Energy Efficiency

The grading of windows by the National Fenestration Rating Council (NFRC) is intended to give the consumer a standardized measure to compare various options and materials. Currently the NFRC has in place a procedure to determine the U-value (thermal conductivity) of window products. The advantage to this grading system is that for the first time there is a basis on which to evaluate the U-value properties; however, evaluating the energy efficiency of a window only in terms of the U-value ignores the fact that windows are transparent and allow solar heat gain which helps to offset winter heating requirements. Unlike opaque building insulation products such as fiberglass, windows because of their transparency need more than a U-value measure to fully compare materials and options. NFRC realizes this fact and is currently working on standard procedures for determining a window's solar heat gain coefficient (shading coefficient) and air infiltration.

Window energy performance is dependent on three factors: heat loss (U-value), solar gain (shading coefficient or solar heat gain coefficient), and air infiltration. Having these essential window performance numbers, the net heat flow through a glazing can be calculated. Net heat flow through a window unit is positive if more energy is gained than lost or negative if the interior space loses more energy than it gains.

Energy Rating

The Energy Rating (ER) is a net heat flow calculation procedure and is designed to compare window products for their heating season efficiency under average winter conditions for the northern United States and Canada. The index permits a convenient standard of comparison for all glass products. ER is currently utilized by the Canadian Window and Door Manufacturers Association (CWDMA) and is part of Canadian standard CSA A440 (Energy Performance Evaluation of Windows and Sliding Glass Doors). Ontario Hydro, a utility company, offered a rebate of $5 per square foot for windows that met a given ER criteria. Finally, Canada's national building code is expected to incorporate ER as an addendum.

$$\text{ER} = \text{Solar Gain} - \text{Heat Loss} - \text{Air Infiltration}$$

The ER employs average weather data for winter temperatures and sunlight intensity representing several North American cities having a heating dominated energy use pattern. The sunlight level used to calculate solar gain is an average of four building elevations. The ER is calculated using the following energy balance equation:

$$ER = [72.2 * SHGCw] - [21.9 * Uw] - [0.54 * L75 / Aw)]$$

ER = Effective energy efficiency rating (W/sq.m)
SHGCw = Solar heat gain coefficient of total window (no units)
Uw = U-value of total window (W/sq.m./°C)
L75 = Average air leakage of the window (cubic m/hour)
Aw = Area of the window (sq.m)

When the ER formula is applied to several of the most popular window glass products used today, the following performance ratings resulted (assumed vinyl frame casement style window, low-e units are argon filled, all have insulated spacer, 610 mm x 1220 mm, air-infiltration of 0.55 cubic m/m/hour, and L75 = 2 cubic m/hour). As ER becomes more positive, the glass options are more energy efficient during the heating season. This table clearly shows why a U-value comparison between products is not sufficient to rate windows.

Glass option	ER	Uw	SHGCw
Energy Advantage™ Low-E (e=0.20)	**- 1.8**	**1.73**	**0.52**
Soft coat low-e (e=0.09)	– 2.1	1.58	0.47
Soft coat double low-e (e=0.05)	– 13.1	1.52	0.30
Clear IG	– 15.2	2.44	0.55

Energy Rating Specific

The Energy Rating Specific (ERS) is another computation procedure established within CSA A440. This procedure determines a specific ER value for a window used in any of thirteen cities throughout Canada. In addition to material options and window size, ERS is dependent on the climate of a particular location, the window to floor area ratio, and the window orientation on the house. The ERS calculation procedure utilizes average rates of solar radiation incident on a window, accounting for the solar effects of the off-normal incidence angle and the solar utilization factor for each specific location and cardinal orientation. The ERS number then represents the average rate of net heat loss (negative ERS value) or net heat gain (positive ERS value) through a unit area of the window during the heating season.

The following table contains ERS data for four Canadian cities and two popular window glass products. The soft coat double low-e glass option has ERS values which are more negative than the Pilkington **Energy Advantage**™ Low-E glass option; therefore, the soft coat double low-e glass option is less efficient and will result in higher heating season energy costs. Estimates of the greater heating costs associated with using a soft coat double low-e instead of Pilkington **Energy Advantage** Low-E are given in the table in terms of both kWh and dollars (based on: a house with a floor area equal to 186 sq.m (2000 sq.ft.), a window to floor area ratio equal to 15%, a total of 5088 hours in the heating season, a cost for fuel oil equal to $1.00 per gallon and a furnace efficiency equal to 70%).

City	Glass Option	ERS (W/sq.m) (for specific elevation & average)				Cost Increase -vs- LOF Low-E	
		S	E or W	N	Average	kWh	$$
Montreal	**Energy Advantage** Low-E	19	– 8	– 23	– 5	--	--
	Soft coat double low-e (e=0.05)	– 1	– 17	– 25	– 15	1443	$51
Toronto	**Energy Advantage** Low-E	20	– 7	– 21	– 4	--	--
	Soft coat double low-e (e=0.05)	1	– 15	– 24	– 13	1373	$48
Winnipeg	**Energy Advantage** Low-E	28	– 14	– 33	– 8	--	--
	Soft coat double low-e (e=0.05)	1	– 23	– 34	– 20	1651	$58
Vancouver	**Energy Advantage** Low-E	17	– 5	– 16	– 2	--	--
	Soft coat double low-e (e=0.05)	2	– 11	– 18	– 10	1015	$36

The information contained in this bulletin is offered for assistance in the application of Pilkington North America, Inc. flat glass products and like products manufactured and sold under the Pilkington Libbey-Owens-Ford Co. name, but **IT DOES NOT CONSTITUTE A WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE**. Actual performance may vary in particular applications.