Insulated window shutters

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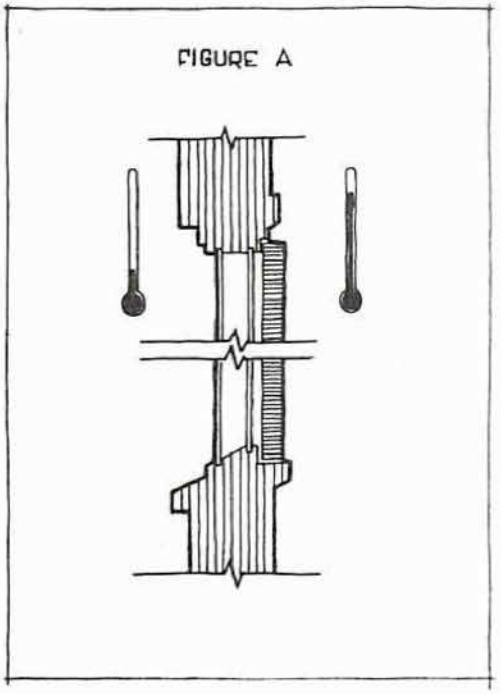
Insulated window shutters can lessen considerably the amount of heat lost through windows. A standard double-glazed window has a thermal resistance of about R2 (RSI 0.35). An insulated shutter with a resistance 2 to 3 times that of a window, say R5 (RSI 0.88), will reduce substantially the energy loss of that window, particularly at night when the house does not benefit from solar radiation. Many different kinds of window shutters are now available. This Note has been prepared as a guide in selection as there are a number of key points to consider to achieve an effective and relatively trouble-free operation of a window shutter.

In choosing, designing, or building an insulated window shutter, the principal fact to consider is its location with respect to the window. The preferred technical option is to position a window shutter so that it covers the outside of a window and can be operated manually or electrically from the inside and perhaps automatically by a programmed timer. A second option is to design and build a window shutter that will operate within the cavity of a double-glazed window, i.e., between two single panes of glass. A third option, which is the easiest and perhaps least expensive but least desirable, is to attach an insulated shutter on the room side of a window assembly.

Shutter on Room-Side of Window

With an inside insulated window shutter (Figure A) it is probable that condensation and perhaps icing will accumulate between the glass and the shutter during prolonged cold spells. This occurs as a result of room air seeping in and around the shutter and perhaps by diffusion through the shutter material. To control this, it is necessary that the shutter be air tight to the window and that the shutter construction have a high resistance to the flow of moisture from diffusion. Control of diffusion is easily achieved if the shutter composition includes a layer of aluminum foil or a heavy sheet of plastic.



When a shutter of this type is opened in the morning of a cold winter day, the window will probably fog up for 10 to 20 minutes

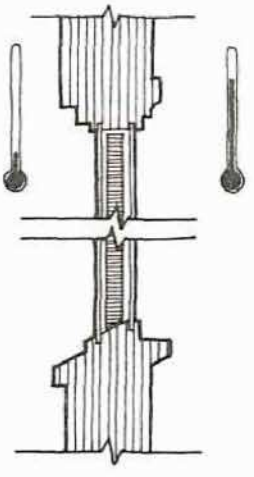
before it warms up to indoor temperatures and becomes clear again. Repeated condensation/evaporation cycles may stain and damage interior finishes and condensation on even a small window, 3 ft by 5 ft (0.9 by 1.5 m) will produce up to 2 cups (0.5 L) of water per day.

A second problem, which may prove more costly to resolve than condensation, is the increased potential for cold weather breakage of sealed units. This is likely to occur when the shutter is opened in the morning exposing the cold window to the higher indoor temperatures. Under these conditions the glass is subject to a rapid increase in temperature in its central region thereby causing a tension stress at the cold edge of the window. This is the cause of cold weather breakage of glass. If the shutter is kept closed all day, the window and the shutter may experience an even more severe temperature change, particularly if the sun heats the air space between the shutter and the window pane. Cold weather breakage is known to occur in sealed units without shutters and inside shutters will certainly aggravate the condition.

Shutter Between Panes

This system, which is designed to be operated between two panes of glass (Figure B), is a more efficient arrangement. When a shutter is inserted between two panes of glass, such as a roll-down curtain or polystyrene beads, the inside light of glass will warm up slightly, thereby reducing any window condensation. When the shutter is opened, the window panes will not be subject to thermal shock as both panes are at a temperature close to the equilibrium condition, cold on the outside and warm on the inside. There is a drawback to this approach, however, particularly if space in the wall or ceiling is required to accommodate this type of shutter. Some of the energy savings may be lost if the thermal resistance of the adjacent wall or ceiling is reduced to improve that of the window. Roll-down systems and the bead wall circumvent this difficulty. And if the shutter happens to remain closed for a day, the cavity may heat up to very high temperatures resulting in undesirable glass stresses or detrimental effects to the shutter composition. Cleaning and general maintenance of the window will naturally increase.

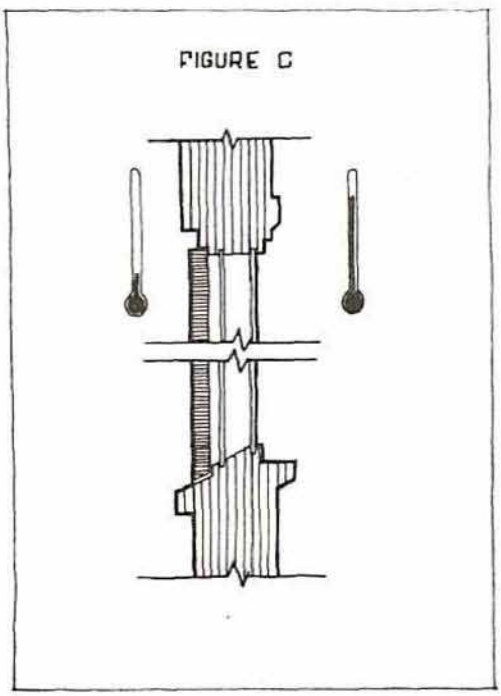
FIGURE B



Shutter on Window Exterior

This is perhaps the most desirable option as it eliminates the difficulties previously described (Figure C).

When an outside insulated window shutter is closed, the window glass will warm up to indoor temperatures thereby reducing, if not eliminating altogether, the potential for condensation on the window glass. The air tightness of the shutter system is not critical and the diffusion characteristic is immaterial. When the window shutter is opened for daytime use, the window may experience rapid cooling in its central region. Although this effect induces a compression stress at the edge, the window can easily cope with this as it is opposite to the stress that occurs with an inside shutter system. When the window shutter remains closed all day, the window will not experience any adverse effects. The two main problems in connection with this system are: 1) the accumulation and control of snow and ice and the effect of strong winds on the shutter and 2) the design of the control mechanism required to operate the system from the inside. Although this is the most desirable option from a thermal point of view, it may prove to be the most costly.



Types of Window Shutter Systems

There are a variety of window shutter systems on the market, including:

- rigid insulation types that slide into a wall cavity either horizontally or vertically,
- roll-down curtains composed of layers of highly reflective material that have air space between the layers,
- rigid systems mounted on hinges which swing out or in, and
- more expensive systems, such as the bead wall utilizing styrene bead insulation which is blown in between glass plates.

An insulated window shutter may be cost effective, particularly if it is operated consistently throughout a heating season. A computer study of a typical 2-storey house has shown that 150 sq ft (14 m^2) of shuttered window closed between 11 p.m. and 7 a.m. having an R-factor of 5 saved 18 per cent of the fuel bill of a house operated in Ottawa and built to the requirements of the National Building Code of Canada (1975 edition). This is $72.00 of a $400.00 fuel bill. This is an example case only; the heat energy savings to be expected of insulated shutters must be determined for each shutter type, hours of operation, and specific building features.