Exterior Insulating Shutters

Due to the really cold winters we experience here in the Upper Midwest (southeastern Minnesota), and because we have large south-facing windows that collect lots of solar heat during the day but lose heat very rapidly during cold nights, we have tried for the past 12 years to design some sort of insulation system for these windows. There are lots of plans available, some for interior, roll-up, insulating curtains, some for fixed, removable insulating panels, and a few for exterior insulating panels. They all have pros and cons.

Interior panels or curtains used in a tightly sealed home during really cold winters are all subject to problems with humidity. At some point the difference in indoor and outdoor temperatures, and high indoor humidity, will result in the condensation of that humidity on the nearest cold surface. Uninsulated windows, especially those that are simply composed of a single or double glass layer, are the first to condense water. This either beads up in place, starts to drip down onto window sills, or freezes in place, depending on the outdoor temperature. An interior curtain or panel that allows humidity to seep around its edges could either get soaked with water or even freeze into place. Edge seals that are tight enough to seal out humidity can be complicated, cumbersome to work with, and difficult to build.

Exterior panels have to deal with all that Nature can throw at them, staying in place despite the worst of winds, remaining effective during a deluge of rain or buckets of snow, and holding up under a barrage of ultraviolet light and highly variable temperatures. And of course they still have to be easy to handle, opening, closing, and locking into either position, often with frozen fingers and despite gusty winds. Plus you may be concerned with the aesthetic component of what could potentially look like an unsightly thermal “crutch” on an otherwise lovely home exterior.

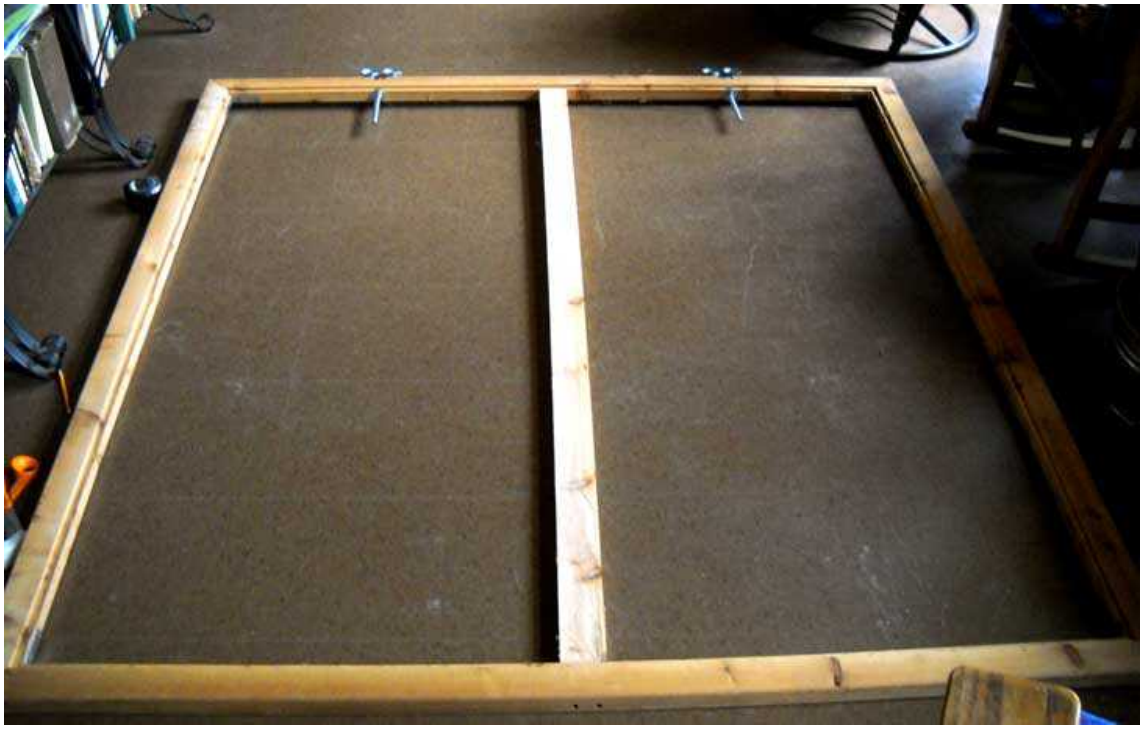
After years of trial and error, the photograph below shows what we settled on for our situation.

The sliding shutters are shown in their open position, all of them pushed to the right, suspended on ball-bearing roller “trollies” and steel tracks designed to hold the weight of heavy barn doors. They only cover the lower windows on the south side since all of the other windows above them and on the east and west sides of the house are more highly insulated, coated with reflective surfaces and argon filled. This makes them better at keeping excessive heat in or out, depending on the weather, but it also reduces their solar gain. Our big windows are simpler but better at allowing sunlight into our passively solar heated home. In our climate solar gains provide about 50% of our heating in the winter so they do their job quite well. But the heat loss at night can be pretty extreme. Below is a photograph of the same shutters rolled into place to control heat loss or gain on a cold night or an excessively hot, sunny day.

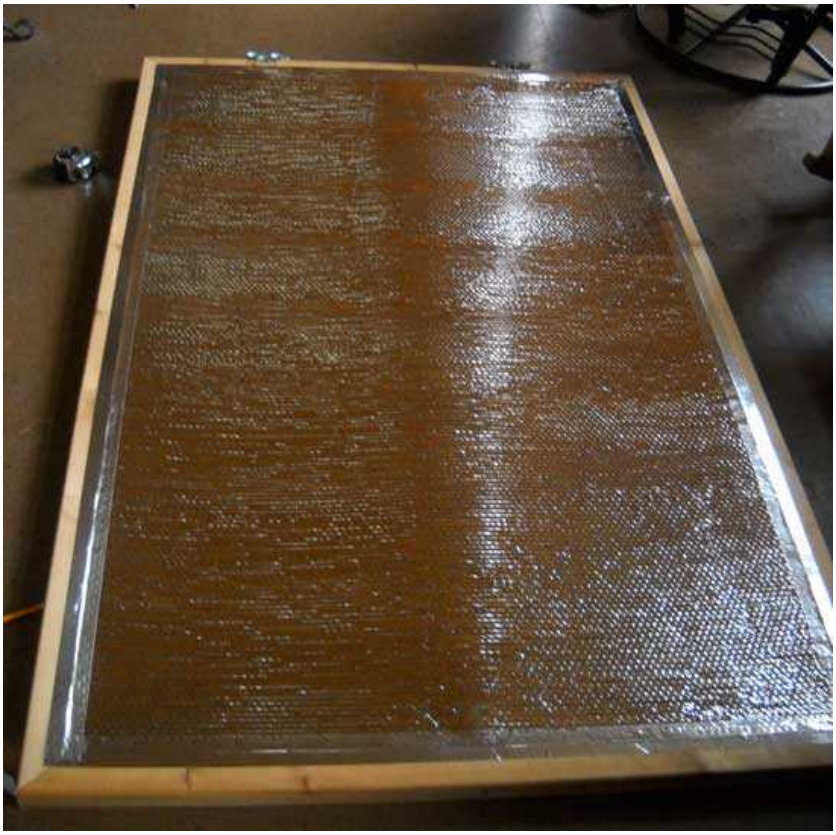
We had considered constructing the center panel with two halves that would split in the center and move both left and right to yield a more symmetrical design. In this option the left shutter would have also rolled left instead of right. But the increased edge surface and possibility for thermal leakage right in the center of the middle window made this choice less than ideal, and remembering to roll the left shutters left and the right shutters right might have been too much strain on our early-morning, half awake minds. The design shown used the least amount of purchased materials since the steel tracks and red cedar lumber were not cheap.

In order to keep the weight of the shutters to a minimum while maximizing the insulating value (and to make sure that the insulation retained its R-value even when possibly wet), we used two layers of Reflectix brand aluminum foil “bubble wrap” insulation. The combination of Reflectix with air spaces in the shutters brings the overall R-value up to around 15. We used red cedar 2-by-6 lumber, ripped down to 2-by-3's for the shutter frames. They were cut at 45-degree angles at the corners and screwed together with 3-inch coated construction screws on the outside edges, then reinforced with steel angle brackets screwed into the frames on the inside edges. All screw holes were pre-drilled to avoid splitting the cedar since it tends to do so quite easily.

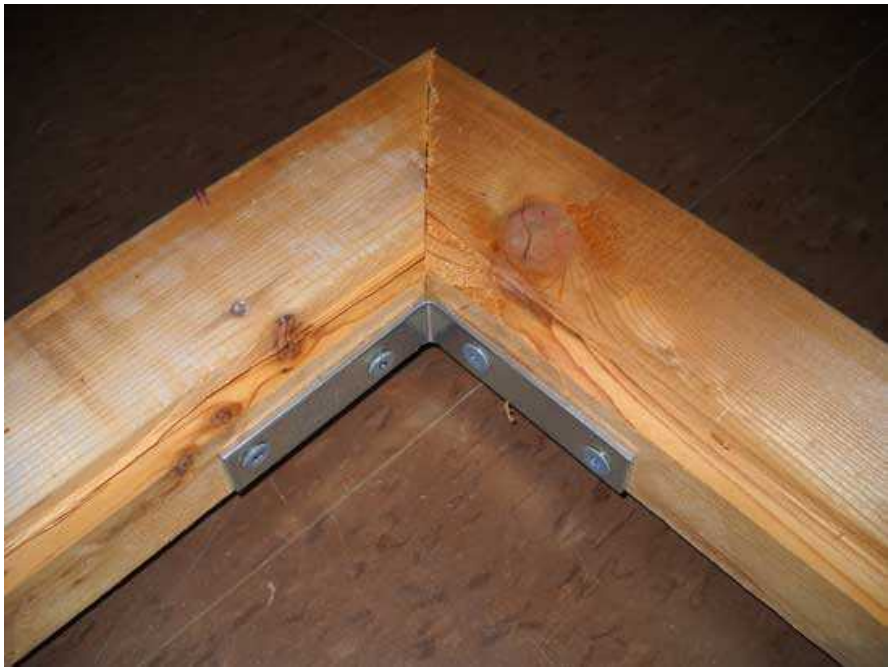
The photo below shows how the construction process began.



This is the frame for the middle window, measuring roughly 78 inches tall and 72 inches wide. You can see that we ripped a 1/2-inch wide, 1/4-inch deep trough into the inside edges of the frames, on the inside of the panel, to hold the Reflectix in place without compressing it. The Reflectix was then cut and taped into place using aluminum foil tape. You can see the result below on one of the narrow shutters.

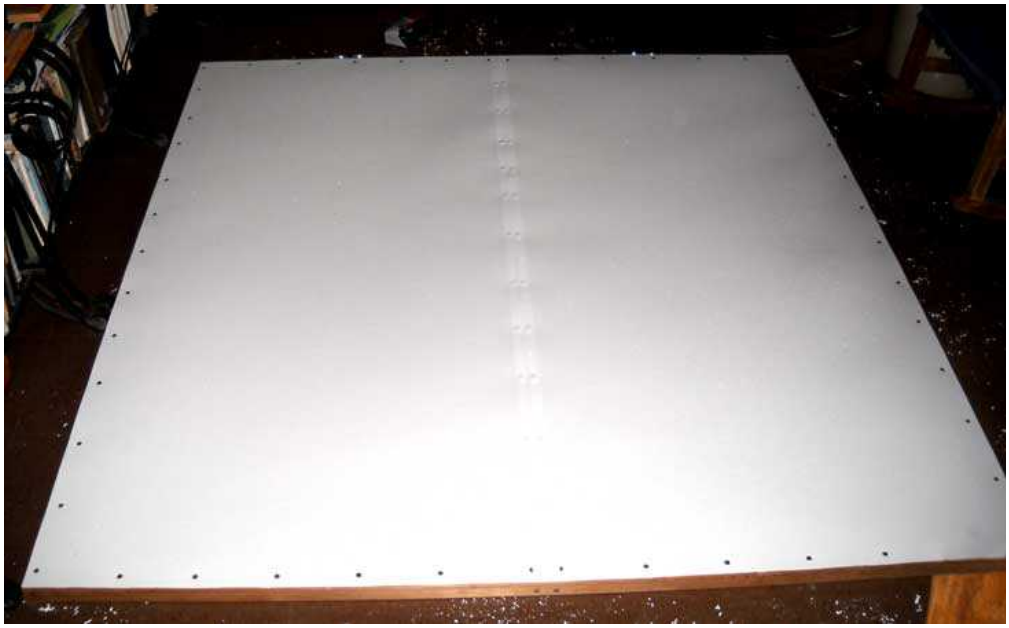


The photo below shows a detail of one of the frame corners, showing the steel angle bracket added to reinforce the corner joint and the trough cut for the insulation.



And the next photo shows a detail of one of the steel trollies used to hang the panels. The cedar frame was notched about 3/4 of an inch to allow the trolley to mount as close to the frame as possible. That would not be necessary for most installations. But in our case we did it because the windows above the panels and track are often opened for ventilation in the summer. We had very little room between the upper and lower windows in which to mount the track so cutting a notch gained a little more space.

The final layer on the inside of the panels is made from 4-by-8 foot sheets of white, pebble-surface, fiberglass-reinforced plastic paneling that is about 1/16th inch thick. We chose it as an inside surface because of its stiffness, to hold the panel square, its color and texture, which reflect light back into the room at night while breaking up reflections, and its ability to shed water if needed.



Shown above on the wide panel, the big sheets of plastic were cut down to make two 78-inch by 3-foot panels. They were pre-drilled to prevent cracking and nailed into the wooded frames using short galvanized roofing nails (the kind that are used to secure common asphalt roofing). There is a piece of white duct tape over the center screws that hides them from view indoors when the panel is in its closed position. At this point we screwed the steel tracks onto the house above the big windows and rolled the shutters into position.

Next we were ready to add the second layer of Reflectix insulation and the outer covering. The insulation was simply stapled to the outside edge of the wooden frame. Then we screwed cedar 1-by-4's onto the edges of the panels while they were in their closed position to make a fairly tight, windproof seal around where they meet the window trim. And 1/4-inch thick polyethylene foam weatherstripping strips were applied near the top of the white inner layer where it meets the top of the window frames. This helps to prevent upward air flow across the panels which would defeat the work of the insulation. Not shown in the photos is another 1-by-4 strip added to the bottom of the windows for the same reason.

We then cut 12-foot pieces of 1-by-8 beveled cedar siding in half to make 6-foot pieces for the middle panel, and we cut 8-foot pieces in half for the two 4-foot panels. These were screwed into the cedar frames using 1.5-inch stainless steel trim screws, stainless to prevent corrosion of the fasteners in contact with the cedar, and trim heads to help prevent splitting of the cedar. Roughly 6 inches of the siding is visible per layer, leaving about 1.5 inches overlapped. When finished, the cedar was oiled heavily using boiled linseed oil.

The photo above shows both the cedar siding and one of the locking rods used to hold the shutters either in the open or closed position. The bottom screw-eye is screwed through the cement-board siding and into a treated wood 2-by-4, shown just above the sloped glass air pre-heater that warms incoming house air on sunny winter days. The upper screw-eyes fasten through the cedar siding into the middle cedar frame uprights. The next photo shows one locked into the open position, just to give a better sense of how they are mounted.

To operate them we simply pull the rod upward, pull the panel out from the wall slightly to allow the side-mounted 1-by-4's to slip past the windows that they partly surround, slide the unit sideways, then lock it down in the other position. During extreme cold we may have to be careful to avoid sudden thermal shock to the windows by opening the panels rather slowly.

Our experience with the panels so far has been very positive. Outdoor temperatures going into late fall have been as low as 24 F while indoor relative humidity has been fairly high, around 60%. This would have caused loads of condensation in previous years but none anymore. And instead of the indoor temperature dropping about 10 F at night we now drop less than half as much, making our decisions not to bother with a night-time wood fire both more rewarding and more economical on wintertime firewood use. But when we do light the wood-stove we'll be holding onto more of its radiated heat at night, again saving on the wood supply.

As we continue to use these shutters we will add to this PDF to report on how well they operate during extreme cold on winter nights and the extreme heat of sunny summer days.