SIZING COMPONENTS

How big a collector? How big a storage bin?

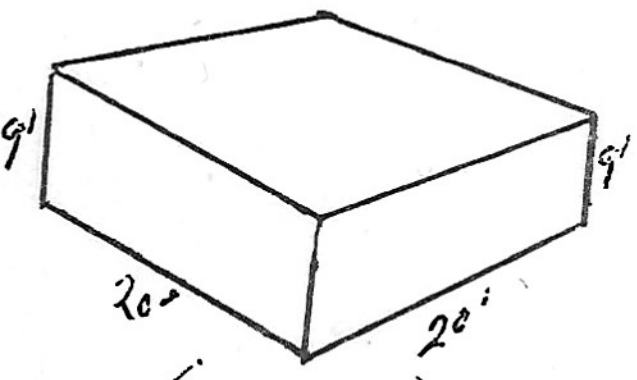
A large rock bin coupled to a small collector will warm only slightly during a day of collecting.

A small rock bin coupled to a large house with great heat loss will cool considerably when supplying heat during the night.

What kind of relationship should there be between the size of the house, the size of the collector and the size of the storage bin? The most essential part of the construction of a solar heated house is to make the house tight and well insulated so that it does not require a great deal of heat. In New Mexico the roof should have 6 to 9 inches of fiber-glass insulation, the walls should have 6 inches, the footings should have perimeter insulation. The windows should be double glazed.

We will take two box shaped houses and calculate the heat loss through the walls and ceiling assuming there are insulated walls and ceiling with 6" of fiberglass insulation giving a total resistance to heat loss of 20 or equivalently that 1/20th of a BTU flows through each square foot of wall each hour for each degree difference in temperature there is between one side and the other.

Box # 1



(Figure 5)

total surface, walls and ceiling =
400 + 4 (180) = 1120 sq. ft.
heat loss = 1120 sq. ft. x 1/20 BTUs/sq. ft. hr. ° F. x 24 hrs. x = 1344 BTUs/day ° F. Perimeter heat loss (assuming perimeter insulation)
4 (20) ft. x ½ BTU/ft. hr. ° F x 24 = 960 BTUs/day ° F.

Air change heat loss - assuming we change the air in the house every 4 hours.

400 sq. ft. x 9 ft. x 1/15 lbs./sq. ft. x ¼ specific heat air x 6 changes/day x = 360 BTUs/day °F.

In calculations for the box we are omitting losses through windows - which can be very great if they are located on the north side of the house - or can be balanced out by the sun which shines through them on the south side of the house.

Omitting windows then we find that the box loses 1344 + 960 + 360 = 2664 BTUs/day °F.

So that if we take a cold winter day in Albuquerque where over the 24 hours the temperature averages 20°F then if the box is kept at 65 degrees it will lose 2664 (65-20) = 119,880 BTUs/day.

How big a collector do we need to capture this much heat? A good air loop collector can capture and store about 800 BTUs/day sq. ft. during clear winter weather.

$\frac{119,880}{800}$ = 150 sq. ft. of collector.

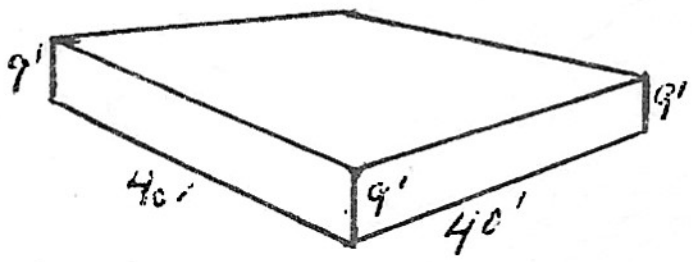
But we would like to have some heat left over after this cold day in case it's cloudy the next day - so let's size the collector for this 400 sq. ft. box at 200 sq. ft.

How much storage do we need? Let's say we want enough so that if we have our rocks at 110 degrees F they can take us through 2 days as cold as the one we have described. The rocks are useful until they fall to about 75 degrees F. One pound of rock stores 1/5 of a BTU for one degree F.

(119,880) x 2 = X lbs. x 1/5 (sp. ht. rock) x (110-75) 239,760 = X (7)
x = 34,251 lbs. rocks

Rocks take up about 100 lbs./cubic foot So we need about 340 cubic feet of rocks to store heat or a layer a little less than one foot deep under the entire floor.

Box # 2



(figure 6)

Total surface walls and ceiling 1600 + 4 (360) = 3040
Heat loss = 3040 sq. ft. x 1/20 BTU/sq. ft. hr. x 24 hrs x = 3648 BTUs/day ° F.
Perimeter: 4(40) ½ BTU/ft ht. F x 24 = 1920 BTUs/day°F.

Air change: 1600 sq. ft. x 9 ft. x 1/15 lbs./cubic ft. x ¼ sp. ht. air x 6 changes/day = 1440 BTUs/day ° F.

3648 + 1920 + 1440 = 7008 BTUs/day ° F.
(7008) (65-20) = 315,360 BTUs/day
315,360/800 = 394 sq. ft. collector + fudge factor = 500 sq. ft..collector
(315,360) (2) = x lbs x 1/5 x (110-75)
630,720 = 7X
X = 90,102 lbs. rock =
900 cubic feet rocks

900/1600 = .5625 ft. = 6 ¾" of rocks under entire floor.

Are these sensible assumptions to make about houses? Few houses are as well insulated as the two boxes I have described, but there is no reason they cannot be. There would be additional heat loss through the perimeter from the storage bin which would need extra thick insulation to protect the above 100 degree temperature.

The house should be insulated from the storage bin by at least 6" of insulation below the floor. The ground directly below the storage bin should perhaps be insulated.