Effect of Internal Shades on Cooling Loads

We will now examine an interesting phenomenon. ***Adding certain internal shading devices can increase the peak solar load of the window versus the same window without shades!*** This larger solar load component could possibly result in a larger overall *peak* load for the zone containing the window with the shades. A HAP model was created to demonstrate this. For this model, three 2 ft x 2 ft window assemblies were created: one with no shades, one with light shades, and one with dark shades. Then, each window was placed in a space, and each space was made a zone in a VAV air system. Other loads elements such as wall areas, people, and lights were not incorporated in the model in order to observe the effect of internal shades on just the solar component. In this model, an east exposure, a lightweight building structure, and a sunny month (July) were selected. Load calculations were run and the Hourly Zone Design Day Loads reports were requested.

HAP can generate a separate graph for each zone. However, in order to see the dynamic "shift" in magnitude due to time of the hourly solar values, all three zone profiles were plotted on one graph as shown in Figure 2. Notice the "Dark Shade" results in a higher peak load and shifts the peak to an earlier time (from 9 am to 8 am) versus the window with "No Shades". This is due to the heat absorbing characteristics of the dark shades coupled with the light mass of the shades. Notice the light shade has a combined effect of both reducing the peak solar load and shifting the peak load one hour earlier. The area under the light shade curve is less than both the no shade and dark shade cases, indicating the light shade is the best option from a thermal performance standpoint.

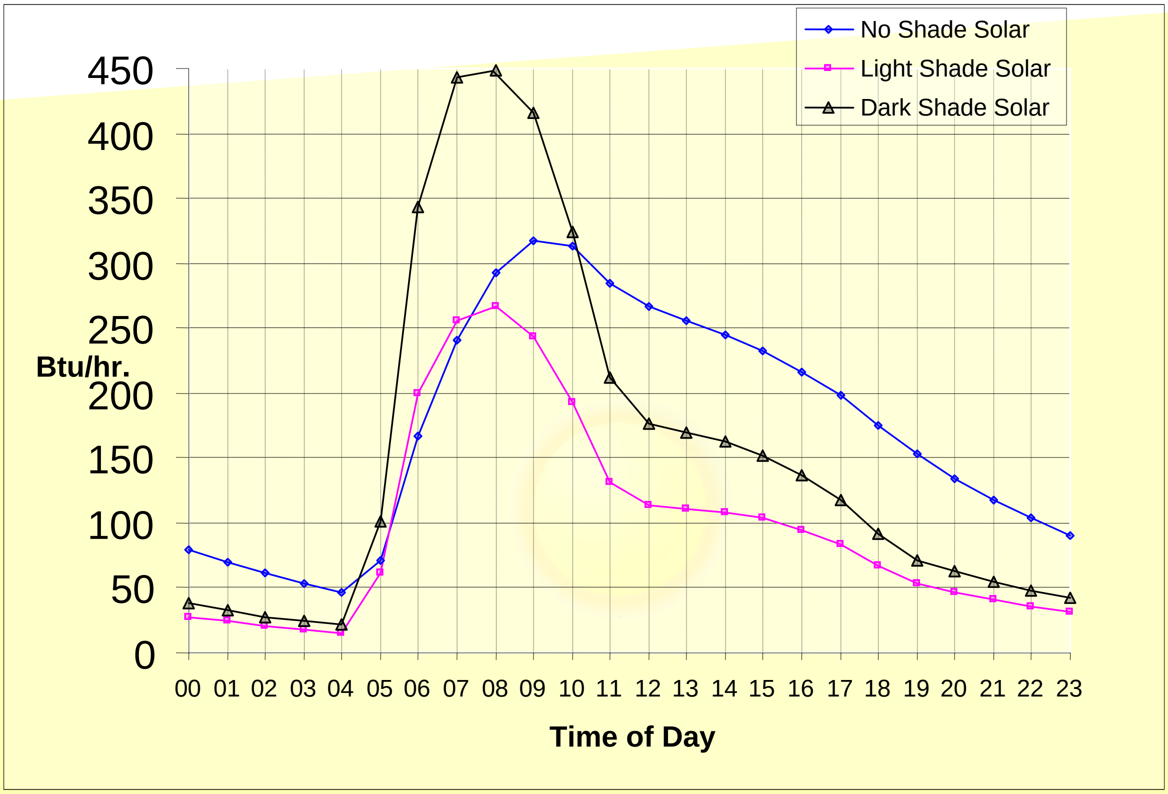

Figure 2 – Hourly Air System Design Load: July, East Exposure

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The conversion of the solar heat gain to an actual load happens much faster when shades are used. This is because the internal shade has a very low thermal capacitance (specific heat x mass), allowing the solar heat absorbed by the shade to be converted into an actual load much sooner. (For more information on how heat gains are converted into cooling loads, see HAP e-Help 004, Transfer Function Methodology). Without internal shades, the conversion of solar heat gain to zone cooling load is slower because the building thermal capacitance is greater than that of the shade device. As a result, solar heat reaches the floor and walls directly and is absorbed by the building mass. Heat is stored longer because the thermal capacitance of the structure is much greater than the lightweight internal shade device. This results in the changes to the shape of the solar load profiles in Figure 2. Without shades, the profile for the same window has a lower, wider peak than with shades.

As a side note, the Btu/hr values shown in Figure 2 also contain a transmission heat gain component for the window. So, these curves do not represent purely solar heat gain. The transmission is reduced by the use of shades since these devices reduce the overall U value of the window assembly.

Conclusion:

The hourly peak solar load component for a window assembly is affected not only by the use of shades but also by the heat absorbing characteristics of the shade itself. When compared to light colored shades or no shades, dark colored shades absorb more solar heat and release it sooner where it becomes an immediate cooling load in the space. Lighter colored shades reflect a portion of the solar gain back out of the window and a smaller peak load results. Regardless of whether light or dark internal shades are used, the total solar heat load through the window assembly over a 24 hour period is less for windows with any type of shade than without. This can be seen by comparing the resulting area under each curve.

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