Technical Corner

Solar Heat Gain Retention

Henry Taylor , President, Architectural Testing, Inc.

Today's novice scientists, as well as some experienced academics as well, often consider the management of solar radiation as a newly discovered phenomenon and technology. However, our ancestors of a hundred years ago routinely managed solar heat gain (SHG) to great effect. Travel through the historic farmlands between the Appalachians and the Rocky Mountains to get a glimpse of thousands upon thousands of farm homesteads, all of similar character.

These farm houses are quickly and easily distinguishable in the middle of fertile fields, often because they are surrounded by numerous mature trees. Furthermore, expansive porches are standard and most have large, operable double hung windows with shades and draperies. In the decades past, these now often cherished landmarks were heated by coal-burning pot-bellied heaters, fireplaces throughout, and wood-burning kitchen stoves.

The porches were specifically constructed to protect the windows and walls from the heat of the searing sun in summer, and the shade trees interrupted that same direct heat in the morning and evening. In wintertime, the sun was lower and the fallen leaves allowed the lower sun to warm the house for much of the day during the seasons when warmth was welcome.

Second floor windows were opened to exhaust unwanted hot air in the evenings and nighttime while the first floor windows invited the cool evening air inside to improve comfort levels. And to a less dramatic extent, a single room could be “conditioned” by lowering the top sash a few inches for exhausting the stratified hot air while cool replacement air could enter through the open lower sash.

Fifty years ago energy was cheap; suppliers would fight to supply energy for your all-electric or all-gas home, and fuel oil suppliers lobbied for installation of fuel-oil fired furnaces. Air conditioning wasn't yet a commodity and was seldom considered in the construction process, and the labor-saving appliances had not made a dramatic debut. But how times have changed in the last few decades!

Today air conditioning, computers and peripherals, dishwashers, microwave ovens, and automatic "everythings" are considered necessities. Now we face energy rationing, either directly or indirectly, and all this while energy prices are dramatically rising. Our capitalist system of supply and demand has caused many glass and window manufacturers to invent new ways to improve on the performance of windows and glass by use of coloring, tints, coatings, and more. And today, the measurement of solar heat gain becomes increasingly important to help manage both its benefits and disadvantages.

There had been neither new solar calorimeters nor improvements in existing calorimeters for the last forty years. Even the “smart” people said that it was impossible to build a large solar calorimeter to accurately respond to today's needs. Yet such test equipment was absolutely necessary to evaluate emerging new products such as tubular daylighting devices, glass blocks, obscure and screened glasses, domed skylights, and many other valuable products that were kept from the marketplace because of the lack of the scientific data that is now required by the energy codes.

Recently the scientists, engineers, and mechanics of Architectural Testing, Inc. (ATI) have proven the pundits wrong. In the year 2000, ATI quietly embarked on a mission to create this most sophisticated test equipment known as a Solar Calorimeter. Dick Troyer, Director of Research and Development, assembled the team to conquer the daunting challenge by the industry experts. It has proven to be a more complicated and sophisticated chamber than that utilized for thermal transmittance (U factor) testing. The Solar Calorimeter had to identify sun location at all times of the day and year, constantly and concurrently track its location in both the horizontal azimuth and vertical altitude, and provide data to properly measure the heat generated by the sun after accounting for any conduction and convection heat loss or gain from or through the test equipment.

The first of two solar calorimeters to meet the technological and scientific challenges of this twenty-first century was installed at the Fresno , California , site of Architectural Testing in April of 2002; it was acknowledged with rave reviews. A year later enough test data and experience had been garnered to design, construct, and install the "impossible to build" 7 feet by 7 feet solar calorimeter. The international scientific community had given up on creating a calorimeter this large because their academic experience indicated that it could not stabilize; this new science from ATI has a proven stabilization time of only 18 minutes (the time constant), and Dick Troyer believes that the time constant will soon be reduced to less than 15 minutes.

These new devices are located in Fresno because they must be operated for "five time constants" without interference from clouds passing between the calorimeter and the sun. California provides the most cloud-free days of any of Architectural Testing's locations, and it is comparable to any other potential site for solar heat gain measurements. Now other solar calorimeter is recognized to meet the requirements for measuring SHG as required by the recognized energy codes.

Dick Troyer joined Architectural Testing 12 years ago after 24 years as a manager with the Research Center of Johns Manville in Colorado . He has degrees of Bachelor or Science in Mathematics and Physics.

Henry Taylor is founder and CEO of Architectural Testing. He is the recipient of the American Architectural Manufacturers Association's Outstanding Member Award for the year 2001. He also serves as a Board member for NWDA, BETEC, and AAMA. Architectural Testing was the recipient of the first AAMA President's Award for it's outstanding commitment and dedicated support of the fenestration industry.