THERMODYNAMIC ASSESSMENT REPORT

A Thermodynamic Product Assessment

Of

NRG Brand 12" Concrete Block

Performed

By

ENERGY MANAGEMENT, INC.
Louisville, Kentucky
502-425-3634

Important Note:

Energy Management, Inc.'s thermodynamic performance assessment should NOT be considered a warranty of thermal performance neither expressed nor implied. This assessment is also NOT a statement of suitability for any particular use or purpose for the reviewed product. This report should be read in its entirety.

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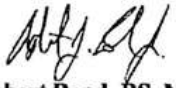
Preface

The following thermodynamic performance assessment report on the NRG Brand 12" foam insulated and thermally broken concrete block product constitutes the professional opinion of Energy Management Inc and not necessarily that of its employees, advisors, consultants, officers nor its Board of Directors.

Great care, diligent oversight, rigorous analyses and the highest ethical standards have been maintained in the effort to generate this product's thermal assessment.

Respectfully,



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An Accredited Energy Rating Systems Provider
A Full Member of the American Meteorological Society
Board of Directors of the National Energy Raters Association

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R E Hally
EXECUTIVE DIRECTOR

Kenneth C. Spengler
SECRETARY-TREASURER

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HIGHLIGHTS

The NRG Brand 12" EPS foam insulated and thermally broken concrete block has undergone extensive computer simulation on its thermal performance with software sub-routines that contain the ability to model thermal mass for the Louisville, Kentucky area. The assessment indicates an

AVERAGE ANNUAL EFFECTIVE R-VALUE: ***R-22***

EXECUTIVE SUMMARY

The Energy Management, Inc. thermodynamic analysis of the NRG Brand 12" concrete block produced an average annual effective R-Value assessment of R-22. The range of effective R-values determined in the analysis varied from a low of R-14 to a high of R- 30. There are a limited number of hours per day in the heating season(s) in which specific circumstances (solar and/or climatological) may lead to the effective R- 14 performance value. This results from heat stored in the thermal mass being completely liberated to the surrounding indoor air. An analogy would be a view that the block's thermal storage battery becomes depleted and is in need of recharging. As a result of this occurrence the furnace run frequency may be greater than an otherwise minimal amount.

Executive Summary (continued)

The effective R-30 value occurs during times of strong winter winds accompanied by frigid temperatures. This is partly the result of thermal mass with a complete thermal break and partly the result of the outstanding air sealing characteristics of masonry construction. The combined effects work to minimize heat loss from air infiltration, radiation and the typical degradation of performance of fiberglass batts that occur during temperatures at or below 20 degrees Fahrenheit. During these times the very cold air can become too dense to be trapped between the individual layers of the fiberglass batt. Additionally the thermal mass acts like a heat sink to absorb both solar heat from the windows as well as excess room heat from space heating, computers, lighting etc. This results from thermal mass having a greater heat capacity (HC) than typical light frame construction. This allows the indoor air to be tempered from outdoor temperature extremes as well as serving as a heat storage battery providing "free heat" for wintertime use. The heat stored during the summer is released many hours later when the air conditioner has much less work to perform. This drastically reduces the peak summer time cooling load on the structure. This lower cooling load should provide air conditioning equipment acquisition cost reductions (reduced tonnage).

NRG Brand 12" Concrete Block Thermal Assessment by Energy Management, Inc.

Executive Summary (continued)

It is important to note that the thermal performance of the 12" NRG concrete block varied during the hours of the day, each day and each season. This should be expected to occur from the effects of varying conditions of climate and solar position. Climatic fluctuations are the norm. Thermal simulations that assume such and consider such are far more meaningful than laboratory steady state temperature testing. It is especially important to note that many insulating products are steady state laboratory tested at a temperature which is known to show favorably on the product being reviewed. This is in sharp contrast to the simulation method employed here in the NRG product review where the product is analyzed as being exposed to the full range of temperature, humidity, wind and solar conditions that actually occur in the Louisville, Kentucky climate.

This computer simulation employed software sub-routines approved by the U.S. Department of Energy. The determined thermal performance values are based on the best available data. Actual structural thermal performance is largely affected by the makeup of the component parts and the quality of their installation. Consequently Energy Management, Inc.'s thermodynamic performance analysis should NOT be considered a warranty of thermal performance neither expressed nor implied. Energy Management Inc.'s thermodynamic performance assessment is also NOT a statement of suitability for any particular use or purpose for the reviewed product. This report should be read in its entirety.

NRG Brand 12" Concrete Block Thermal Assessment by Energy Management, Inc.

Introduction

Energy Management, Inc. has performed a thermodynamic analysis of the NRG Brand 12 inch thermally broken concrete block. The analysis involves the review of three structures (1 story, 2 story and 3 story) each of which is assessed on 3 different foundations (basement, slab and crawl). Computer simulations were employed that considered the effects of the physics of thermal mass (heavy framing) construction on the energy efficiency of a structure. The structures were reviewed on an hour-by-hour basis for all 365 days of the year. This review considered the average range of temperatures and the average weather conditions for each day. Daily values were averaged for weekly, monthly, seasonal and a final annual determination.

Product Description

The assessed product is the 12 Inch NRG Brand Insulated Concrete Block. The block is 16 inches long, 8 inches high and 12 inches wide. The block is composed of an inner component concrete block material that is completely thermally broken from an outer component concrete block material. The thermal break is provided by a varying width of expanded polystyrene (EPS) insulating material. The insulating EPS is held firmly between the two concrete block pieces creating a cohesive and tightly fit single block unit. Employing area integration techniques the molded EPS insulation insert demonstrated a two and one half inch (2 ½) average depth. **This 2-½ inch EPS depth adds an approximate steady state R-Value of 10 (2 ½ inches x 4/inch) to the standard steady state R-Value of a 12-inch concrete block.**

Energy Management, Inc. (EMI) took the estimated steady state R-Value of this block and performed a series of computer simulations that took into account the physical characteristics of the block and the resulting "thermal lag" effect that thermal mass offers. The term "thermal lag" pertains to the heat absorbing characteristics of thermal mass. This characteristic shifts the heating that would otherwise occur to many hours later helping to prevent summertime overheating. **This can dramatically reduce the peak-cooling load in the summer while offering "free" heat in the colder evening hours in the winter.**

Since thermal mass absorbs heat readily it tempers the indoor summer air temperature much as the beach is cooler than nearby inland locations during summer (water has a large heat capacity). Later in the evening after the outdoor temperature has dropped, the heat stored in the thermal mass is slowly released to the room when the air conditioner is performing much less work. **The "thermal lag" associated with thermal mass can produce significant savings in the acquisition cost of cooling equipment since the peak cooling load can be greatly reduced.**

Product Description (continued)

Likewise thermal mass can absorb winter daytime solar heat and store it to be released later in the night when it is needed for the winter nighttime temperature drop. Thus the thermal mass lends itself to creating an energy efficiency performance threshold that exceeds comparable steady state insulating R-values. **The thermal break greatly reduces the otherwise significant heat loss that non-thermally broken thermal mass experiences.** Non-thermally broken thermal mass absorbs heat from the inside room, conducts it to the outside of the block and then radiates it to the outside air.

Methodology

The EMI thermodynamic analysis considered the hour by hour heating and cooling differential between the seasonal typical indoor air temperature and the average range of the outdoor temperatures for each day of the year in the Louisville, Kentucky area. A Latitude of 38.18° North and a Longitude of 85.73° West were employed at an elevation of 489 feet and a mean pressure of 14.5 psia. Some of the climatic variables utilized include:

- Monthly and yearly average temperature (°F)
- Average daily minimum temperature (°F)
- Average daily maximum temperature (°F)
- Record minimum temperature (°F)
- Record maximum temperature (°F)
- Average heating degree days (HDD), base 65°F
- Average cooling degree days (CDD), base 65°F
- Average humidity ratio (kg water vapor per kg dry air)
- Average wind speed
- Average sky clearness index (K_t)
- Average incident solar radiation (Btu/ft^2/day)
- Average transmitted solar radiation for double pane Low-E windows

The methodology essentially computes an average daily effective R-Value. These values are then averaged for monthly and seasonal effective R-Values. Finally, the data is averaged to determine the average annual effective R-Values.

NRG Brand 12"Concrete Block Thermal Assessment by Energy Management, Inc

Methodology(continued)

The process was performed for each cardinal direction (N,S,E,W) that a structure might face. South facing structures provided the optimal performance. The analysis reviewed three different structures on three different foundation types for a total of nine buildings. The three structures consist of 1, 2 and 3 stories. The foundations reviewed included a poured concrete basement with no insulation, a poured concrete slab with R-10 edge insulation and a crawl that uses the NRG 12" block as its foundation. Each structure's input values included window areas that approximate 12% of the floor space. Windows were assumed to be moderate quality Low-E on insulating (dual pane) glass.

- The window U-Values were assumed to be .40, their Solar Heat Gain Coefficient was assumed to be .40 and their air infiltration values were assumed to be .20.

The air exchange rate between inside the structures and the outdoors was assumed to be at the ASHRAE standard of .35 Natural Air Changes per Hour (NACH).

The building thermal performance simulations were created on a baseline comparison basis. A typical light frame wood construction technique was used as the baseline for comparison given the previously mentioned assumptions. The buildings' thermal performance simulations were derived from software approved by the US Department of Energy, the US Environmental Protection Agency and the National Association of State Energy Officials. The software contains sub-routines for evaluating the affects of thermal mass. These sub-routines were developed in consultation with and approval by the US Department of Energy.

Test Results

The computer simulations considered the previously stated assumptions and determined that the thermal performance of the NRG Brand 12" concrete block varied during each day and each season of the year. This would be expected to occur from the varying conditions of climate. Climatic fluctuations are the norm. Thermal simulations that assume such and consider such are far more meaningful than laboratory steady state temperature testing. **It is especially important to note that many insulating products are steady state laboratory tested at a temperature which is known to show favorably on the product being reviewed**...as opposed to the full range of temperature, humidity, wind and solar conditions that actually occur at a given location's climate. **The thermal performance of the NRG Brand 12" concrete block also varied by the hour within a day...again as would be expected in the real world.**

TEST RESULTS (continued)

Energy Management, Inc. has determined, with a reasonable degree of certainty, that the *average annual effective R-Value* of the NRG Brand 12" thermally broken and foam-insulated concrete block is *at least* comparable to a 2 x 6 wood-framed structure ("light framed" or "low mass") on 24" centers with properly installed (rarely occurs) R-19 fiberglass batts covered on the outside with R-3 polystyrene foam sheathing which is in contact with the batts. Thus the reviewed NRG block is at least an R-22 annual average effective R-Value.

It is important to note that climatic extremes actually improved the thermal performance of the structures modeled using the NRG Brand 12" concrete block.

The simulations assumed the structural air leakage rate was .35 NACH for both the baseline wood structure and the NRG block structure. *Rarely* do wood-framed structures achieve this degree of air tightness in the Louisville area. Generally speaking, our structural air leakage testing experience (blower door tests) in this area reveals that wood structures (new construction) leak air at the rate of between .60 and .80 NACH. This data demonstrates the possibility of an even higher effective R-Value than that listed for the NRG 12" concrete block. It is important to note that our local experience testing block construction for air leakage routinely demonstrates air leakage values ranging from .10 to .12 NACH. Thus providing even greater thermal performance for the NRG brand 12" concrete block, as compared to the baseline wood structure. The lower the NACH value, the lower the amount of inside conditioned air escaping to the outside.

Conclusion

The Energy Management, Inc. thermodynamic analysis of the NRG brand 12" concrete block produced an average annual effective R-Value of R-22. The range of effective R-Values determined in the analysis varied from a low of R-14 to a high of R-30.

The limited hour(s) per day in the heating season(s) in which certain circumstances occur, under specific solar and climatic conditions, may lead to the **effective R-14 performance value**. This results from the heat stored in the thermal mass being completely liberated to the surrounding indoor air (the thermal storage battery effect becomes depleted). As a result of this occurrence, the furnace may be required to engage and provide space heating on a slightly more frequent basis.

Conclusion (continued)

The effective R-30 value occurs during times of strong winter winds accompanied by frigid temperatures. This was partly the result of thermal mass with a complete thermal break and partly the result of the outstanding air-sealing characteristic of masonry construction. **The combined effects worked to minimize heat loss from air infiltration, radiation and the typical degradation of performance of fiberglass batts.** This occurs when very cold air is too dense to be trapped between the layers of fiberglass within the batt (20°F).

It is important to note that the thermal performance of the NRG brand 12" concrete block varied during the hours of the day, each day and each season. This should be expected to occur from the varying conditions of climate and solar position. It is especially important to note that many insulating products are steady state laboratory tested at a temperature, which is known to show favorably on the product being reviewed. This is in sharp contrast to the NRG product simulation technique in which it was exposed to the full range of the temperature, humidity, wind and solar conditions that actually occur in the Louisville, Kentucky climate.

Disclaimer

The computer simulation employed software sub-routines approved by the US Department of Energy for evaluating the effects of thermal mass. The determined thermal performance values are based on the best available data. Actual structural thermal performance is largely affected by the makeup of the component parts and the quality of their installation. Consequently, Energy Management, Inc.'s thermodynamic performance assessment ***should NOT be considered a warranty of thermal performance neither expressed nor implied.*** Energy Management Inc.'s thermodynamic performance assessment is also ***NOT a statement of suitability*** for any particular use or purpose for the reviewed product. This report should be read in its' entirety.