PASSIVE BUILDING

User Behavior, Misconceptions, and Educational Opportunities

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The Woodstock Passive House & Apartment

This is the Woodstock which lent its name to the 1969

Woodstock Music and Art Fair

The late Joe Cocker and his band; August 17, 1969

Building with AAC: vertical reinforcement, hand tools, and a masonry cutting band saw

THE WOODSTOCK PASSIVE HOUS: ½ SCALE MOCK-UP
RIGHT: A SWEDISH ALTERNATIVE

ATTRIBUTES OF AUTOCLAVED AERATED CONCRETE

- Fire resistant: 4 hour UL rating for 4” or greater
- Termite and pest resistant
- No mice or other rodents; no need for exterminators
- Higher R value than concrete: R1 per inch for common density
- Lightweight: concrete that floats
- Cut with woodworking tools
- Acoustic insulation
- Does not feed mold; can dry if flooded
- Recyclable
- Airtight
- No need for an air or water vapor barrier
- Lifespan in centuries

Johan Axel Eriksson (July 24, 1888 – June 6, 1961) was a Swedish architect and inventor.

In 1923, he invented autoclaved aerated concrete (AAC) at the Royal Institute of Technology in Stockholm. He was conducting research on the thermal insulation of building materials. AAC went into commercial production in 1929.

A study conducted in Israel compared the performance of AAC and other concrete blocks. Published by ASHRAE in 2007.

AAC was found to have air leakage of 0.01 to 0.02 air changes per hour at 150 pascals. There was no measurable leakage at 65 pascals.

Air Permeability and Thermal Performance of Concrete Block Wall Sections

Rachel Becker, PhD

ABSTRACT

Air permeability of 1.25 × 1.25 m block wall sections was measured in the 0–200 Pa range by means of a pressure box. Extrapolating results to a standard 100 m^2 dwelling indicated that nonrendered autoclaved-aerated-concrete block walls are extremely airtight, leading to an estimated leakage rate of 0.01–0.02 ach under 150 Pa; nonrendered regular-aggregate-concrete block walls, as well as lightweight-aggregate-concrete blocks, are highly permeable, with estimated rates of ~2–6 ach and ~5–10 ach under 50 and 150 Pa, respectively. An external 3 mm cementitious brown coat reduced these values to 0.07–0.16 ach and 0.18–0.21 ach. An internal 10 mm lime-cement rendering reduced them to 0.07–0.13 ach and 0.16–0.19 ach.

Thermal resistances of the hollow-core specimens were estimated by comparing temperature differences across specimens, measured by means of an insulated box, to estimated room-side surface resistances. A small pressure difference induced across specimens (0.1–1.0 Pa) decreased the estimated heat-flow rates but did not affect estimated R-values.

INTRODUCTION

Orme (2001) estimated the effect of infiltration rates in buildings on the energy consumption, CO_2 emissions, and monetary expenditure for 13 heating-dominated countries. Infiltration rates varied between 0.4 (Sweden) to 0.75 (Belgium) ach. Apparently, a third of the energy delivered for heating and cooling is attributed to air change losses, 30% to heat conduction losses, 27% to heating equipment losses, and 10% to delivered space cooling. He foresees that with the increasing demand for higher levels of thermal insulation, the relative contribution of infiltration will increase significantly. Similarly, Probst (2004) showed that under Monterey, California, weather conditions, infiltration may cause as much as a 50% increase in cooling energy consumption even when a relatively airtight building envelope (with a total rate of 0.5 ach) is applied. Dale et al. (Dale et al. 1985; Kostiuk and Dale 1987) measured the impact of various factors, including total natural infiltration, on the power consumption in two similar test rooms. They observed that after a drop of some 53% in the infiltration rate, affected by sealing the makeup air vent in one room, power consumption in that room decreased by some 20%. Consequently, limiting building infiltration rates should be sought in design and construction, and lately become mandatory by various energy codes either implicitly, as in Israel, or explicitly, as in Sweden. In Israel (SII 2003), this is accomplished by limiting the G-value (heat loss rate per unit volume of the design space and unit temperature difference [$W/m^3 \cdot K$]), which includes the contribution of the total air change rate. With accepted minimal insulation levels, the total infiltration rate is limited to approximately 1 ach or less. In Sweden (Mattsson 2006), a more direct step was taken, whereby the energy code requires that building envelope leakage rates do not exceed 0.8 $L/m^2 \cdot s$ (i.e., 2.88 $m^3/m^2 \cdot h$) under a pressure difference of 50 Pa. This requirement serves as a reference in the current investigation.

A literature survey indicated that, in general, although building envelopes seem to be much more airtight than windows and other openings, they are not completely airtight and may leak in the range of 0.03–10.35 ach under normal or extreme use conditions (Dumont et al. 1981; Kronvall 1978;

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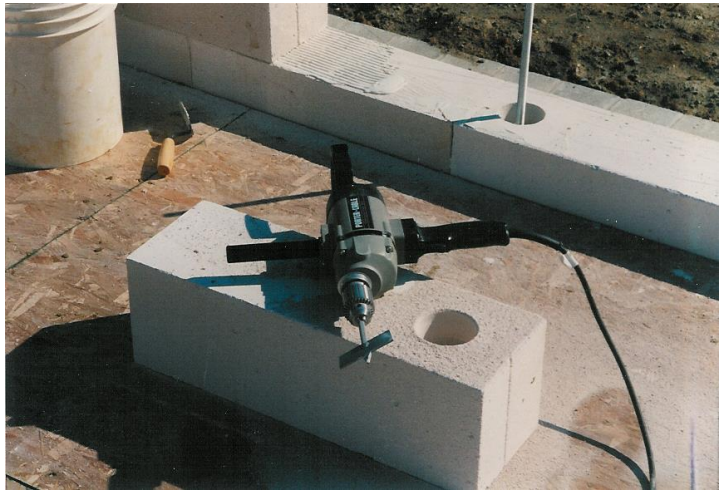
Aercon’s plant in Florida

A twelve-year old can lay AAC, with some help. My first experiment; 1999.



In 1999, the insulation requirement in Maryland for thermal mass walls was R5. AAC alone provided R8. Plaster interior; stucco exterior.

No longer alone: start of construction on the first AAC house certified by PHIUS.

Several stages in one photo: AAC, rigid mineral wool insulation, fiber cement siding

Steel reinforced panels are commonly used for commercial projects. Aercon produces reinforced panels up to 2 feet x 20 feet x 12” thick.

The Woodstock project is constructed with AAC block, 8” x 8” x 24”.
Solid blocks, block cored for rebar, U-blocks for bond beams, and pre-cast lintels were used.

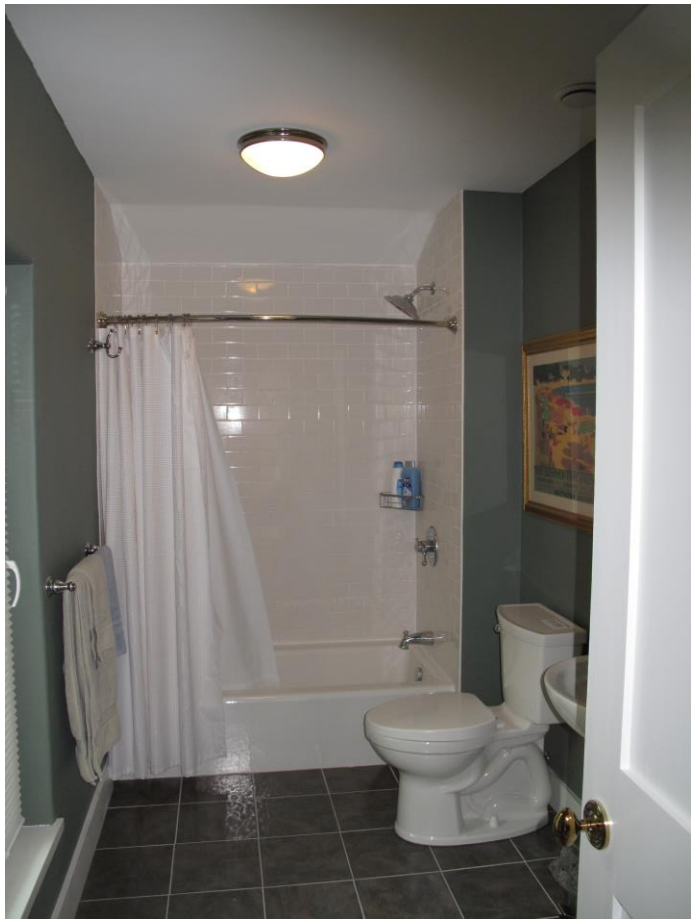
Larger blocks are available, including 24” x 48” in various thicknesses from 3” to 12”.

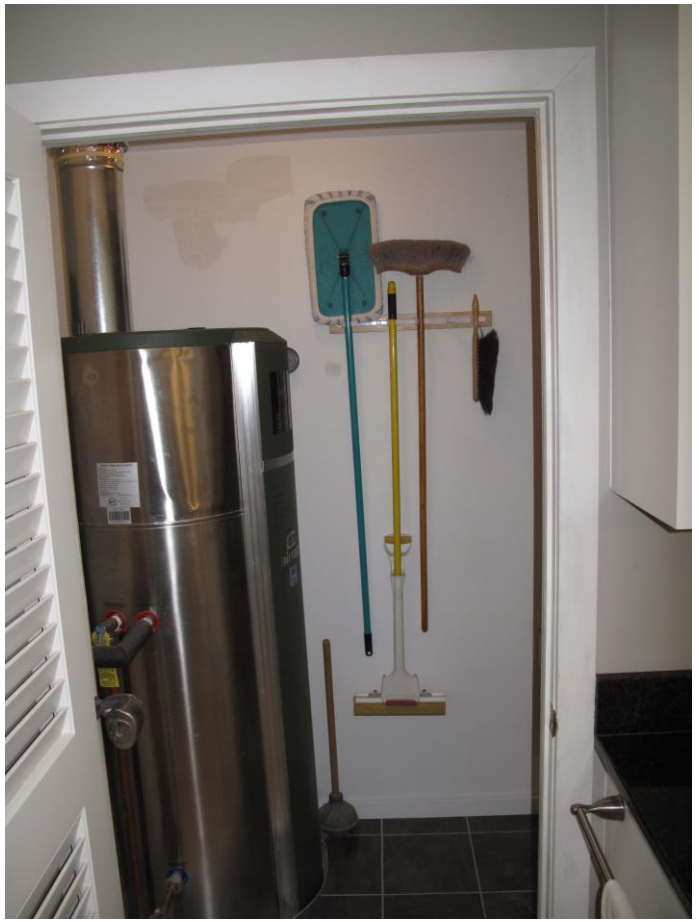
AAC is used for many low-rise hotels in the US.

WOOD HAS LIMITATIONS

The Apartment, 24’ x 24’, plus 1st floor foyer

The apartment bathroom and utility room are behind the kitchen.





The home's living room and dining room. 1186 sf/floor; 2,372 sf total.

A juggling act; some work remains in progress—the eat-in area in particular.

The AirBnB bedroom and hall. Scissors truss above; 24” cellulose insulation; ventilated roof.

The screened porch is ideal for enjoying nature:
bear, deer, ground hogs, rabbits, squirrels, chipmunks, one turtle, and many birds. Most timber was sawn on site.

These two make rare appearances.

Guest’s and Renter’s Reactions

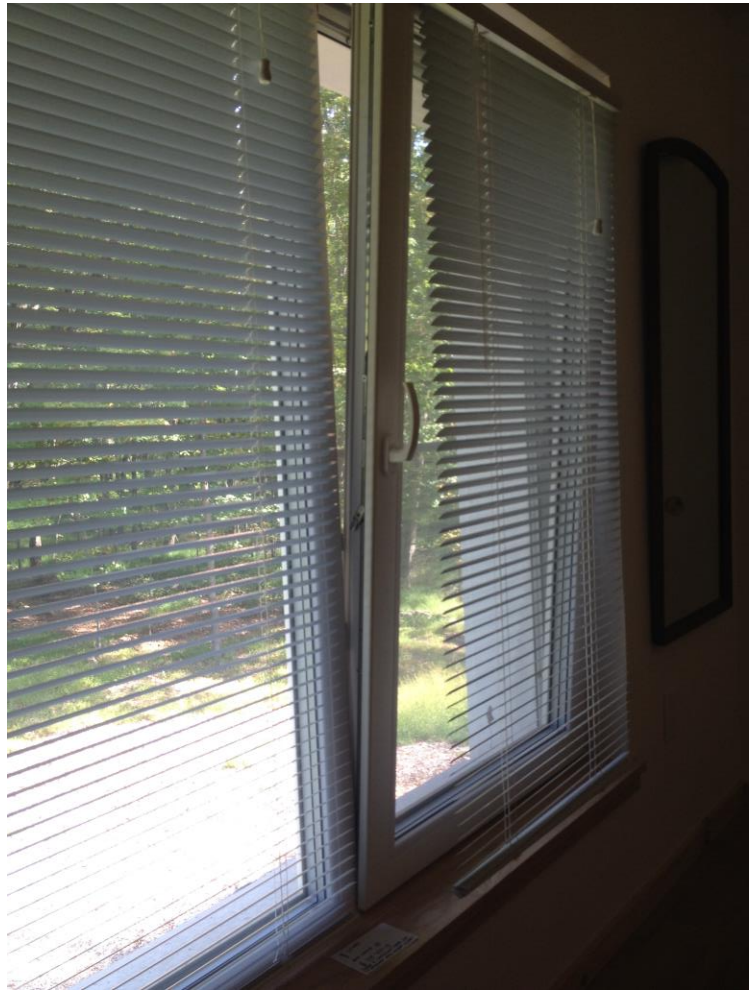
Woodstock is a popular tourist destination; guests can visit Woodstock, and experience the qualities of a Passive House and autoclaved aerated construction.

Most love the house—yet actively sabotage its performance.

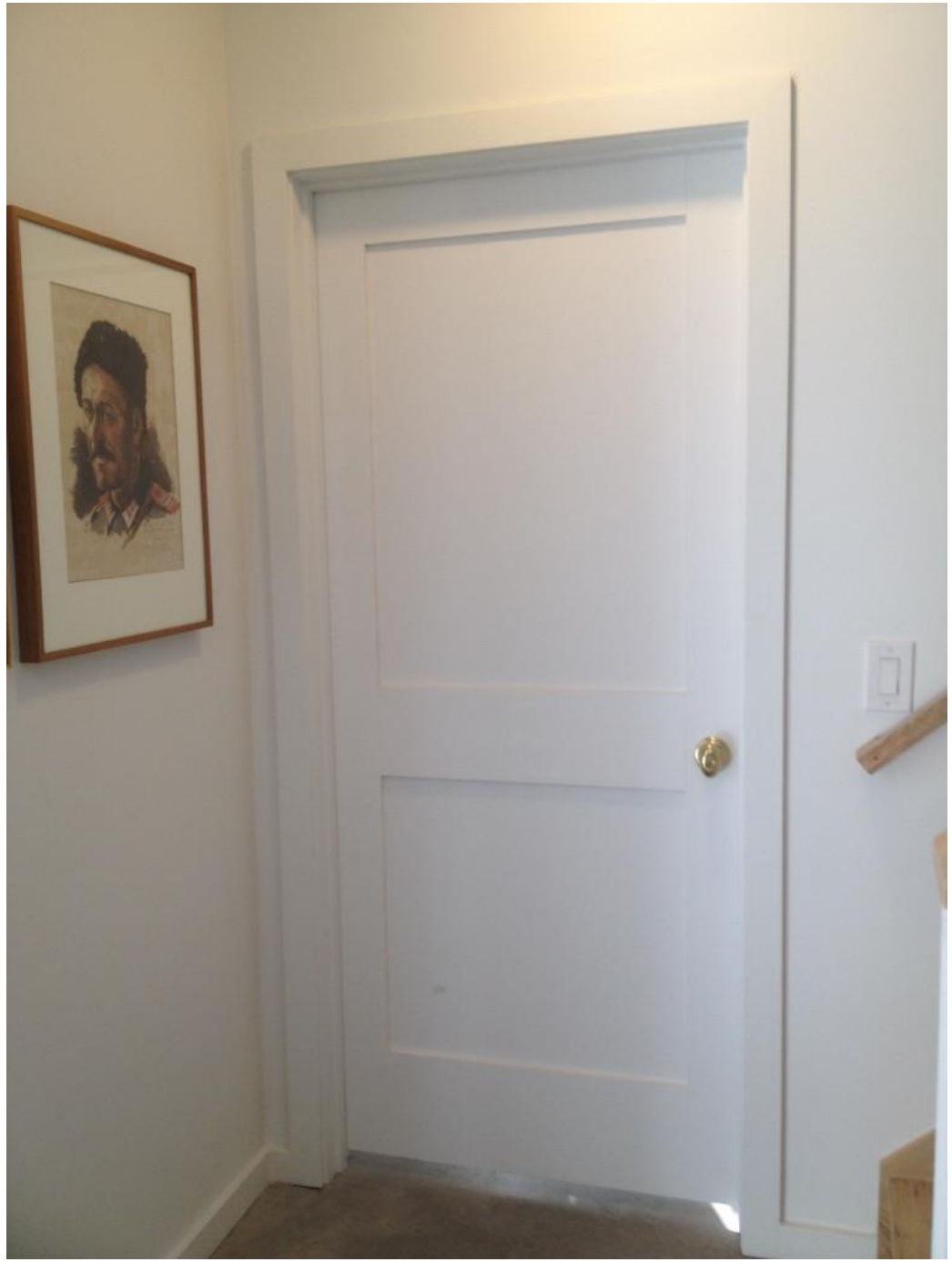
It has taken me some time to understand what occurs.

Reactions to Heat Pump Water Heating

REACTIONS TO WINDOWS



Indoor temperature is quite constant



TEMPERATURE & INTERIOR DOORS

FLOORING: THERMAL MASS vs. COMFORT

CLOTHES DRYING
Whirlpool Heat Pump Dryer; Happy Endings

The BEAUTY:
a century of faultless performance

WHIRLPOOL steps up

I reached the head of Whirlpool's laundry equipment division.

They will be dismantling my dryer to investigate what went wrong.

DISHWASHER vs. HAND WASHING

ELECTRICAL USAGE

A 7.56 kW photovoltaic system serves both the house and the apartment.

(24 LG 315 W panels.)

There is a fixed service charge of $24.50 per meter to be grid tied.

CAR CHARGING
BEGAN
SEPTEMBER 6, 2017

April 22, 2016 Solar system start and 1 year rental started.

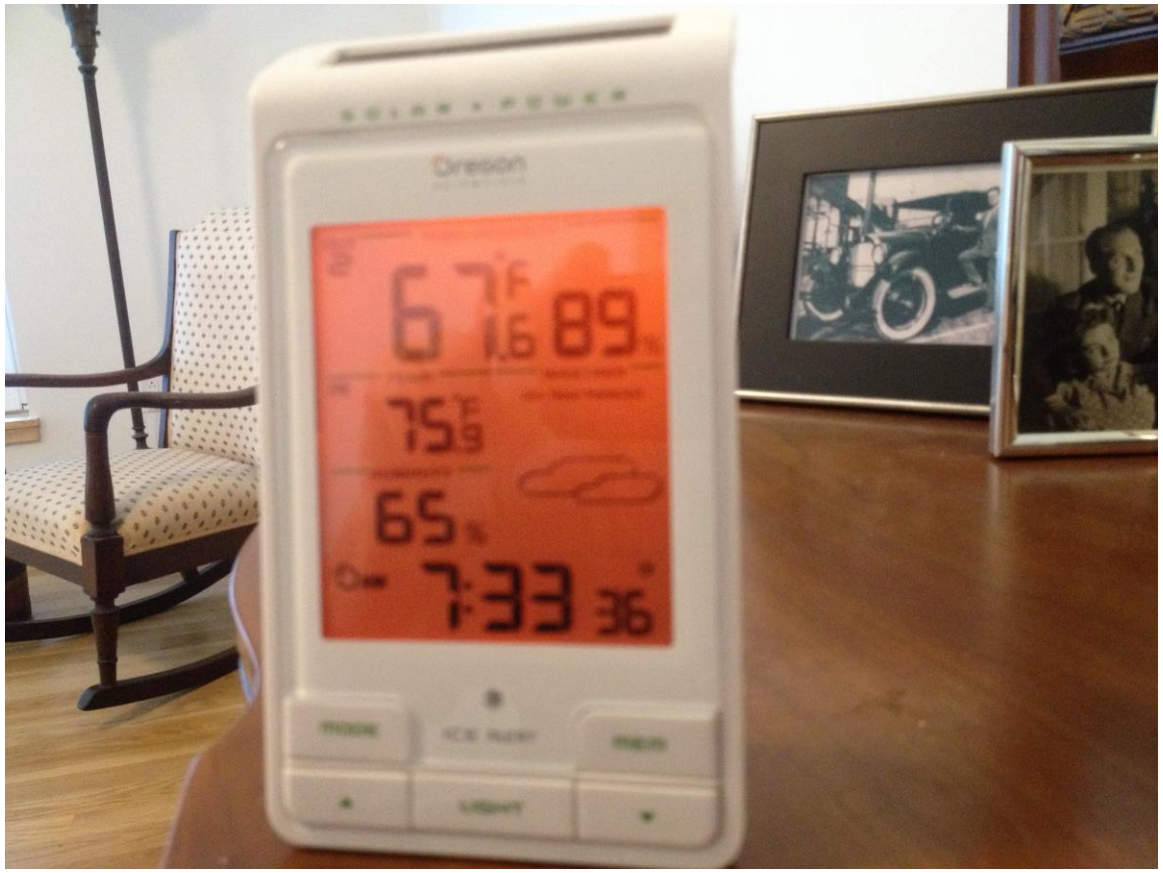
4/21/2017: Central Hudson 3680
9/18/2017: 2056
Drop of 1,624 kWH or
320 kWH/month
Not winter!

AirBnB began at end of 1 year rental.
Hybrid auto charging began 9/6/2017

Solar output average since start:
750kWH/month

CHRISTINA

Cool morning; apartment windows open. 89% relative humidity outdoors, during summer air conditioning season.



BERNICE

August 20-22, 2017; guest in the house.

Bernice knows my homes will be very comfortable, insulated and air sealed, with energy recovery ventilation.

She kept the window open each night.

I asked why.

BERNICE: explanations

“For me as a musician and an avid outdoorsperson, it would be incredibly uncomfortable, particularly in the spring and summer, to not have access to ambient sound…

If I lived here I’d consider putting a daybed on the porch, and I might sleep out there.

I need to hear the birds.

Maybe I could keep the windows closed in the winter, when there isn’t as much outdoor sound.”

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