NEW GENERATION OF BUILDING ENVELOPE COMPONENTS: THE WAY TO “NET- ZERO ENERGY” HOUSE

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BUILDING ENVELOPE – THE MOST IMPORTANT ASPECT OF ACHIEVING NET-ZERO ENERGY CONSTRUCTIONS

EU ENERGY POLICY FOR WINDOWS

<table>
<thead>
<tr>
<th>Heat permeation (W/m²*K)</th>
<th>ENERGY SAVING</th>
<th>PASSIVE</th>
<th>ZERO</th>
<th>PLUS</th>
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<td>0.8</td>
<td>0.4</td>
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<tr>
<td>GLAZING</td>
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<td>0.6</td>
<td>0.2</td>
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<tr>
<td>FRAME</td>
<td>1.2</td>
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<td>0.4</td>
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Window thermoinsulation standards

SUPER WINDOWS
ENERGETIC VISION
HISTORY OF GLAZING

- **Ordinary single glazing**: U= 6.2 W/m²K
- **Quadruple glazing**: + Argon + 3x Low E
  - U= 0.3 W/m²K
- **Modern box window + 2x double glazing + Argon + 2x Low E**
  - U= 0.8 W/m²K
- **Double glazing + Argon**
  - U= 2.6 W/m²K
- **Triple glazing + Argon + 2x Low E**
  - U= 0.7 W/m²K
- **Double glazing + Argon + 3x Heat Mirror**
  - U= 0.3 W/m²K
- **Standard double glazing**
  - U= 2.9 W/m²K
- **Casement box window**
  - U= 6.0 W/m²K
- **Double glazing + Argon + Low E**
  - U= 1.6 W/m²K
- **SUPERWINDOWS INVIS160 stack + Argon + 10 Ultrathin Glass**
  - U= 0.15 W/m²K
- **SUPERWINDOWS INVIS160 tweed + Argon + 10x Ultrathin Glass**
  - U= 0.05 W/m²K
INSULATED GLASS TRENDS

- Layer multiplication and IGU thickening
- Vacuum insulated glazing
- Glazing with aerogel translucent insulation
Heat Mirror – IGU with stack of low-e-coated PET films

low e-coating on outer and inner glass pane

Intrapane 1-3 polymer film layers

PROBLEMS

unwanted multiple reflections

darkening of the view due to absorption

wrinkling of the films
Visionwall glass curtain wall system
Triple glazing in window with large interpane distance

The wall insulation thickness (200mm) is undisturbed on entire cross-section.

Ac. J. M. Schultz 2002
OMAtalo Finndomo quadruple glazed box windows
New trend: very thick 4-pane glazing fixed windows/glass curtain wall
Trimo Qbiss Air curtain wall panel system
The world’s first, developed in Poland, aluminum system employing silica aerogel with extremely low values of thermal conductivity.

$U_f = 0.5 \text{ W/m}^2\text{K}$!
Can elastic, non-photodegradable, invisible ultra-thin glass film revolutionize IGU construction?
HOW IT WORKS

INNER "WARM" SIDE

Low-e coated panes

Stack of AR coated film/thin glass

MULTI-LAYER CONVECTION SUPRESSING SYSTEM IN VERY THICK FRAME

OUTER "COLD" SIDE

CONVENTIONAL DOUBLE INSULATED GLAZING IN STANDARD FRAME
View of the Kraków King’s Castle in through our 12-panes IGU prototype
CAD details of two-layerd transformable window hardware prototype design

Pair of contactless coaxial hinges: hidden scissor-type with virtual axis and plait hinge with physical axis.

Pair of movable sash-integrating hooks and a sash/frame bolt.
Thermoinsulating aerogel bars
Termoizolacyjne aerożelowe kształtki
vacuum bars
Termoizolacyjne kształtki próżniowe
12-parallel SUPER WINDOW

AEROGEL BARS

INVIS 160 stack

SUPER WINDOWS ENERGETIC VISION
HOW IT WORKS

INNER “WARM” SIDE

INCLINED LAYER INSULATION - CONVECTION BLOCKING SYSTEM IN VERY THICK FRAME

Low-e coated panes

CONVENTIONAL DOUBLE INSULATED GLAZING IN STANDARD FRAME

OUTER “COLD” SIDE

coated film/thin
INCLINED, AR-COADED PET 10-FILM STACK IN IGU PROTOTYP E (≠160 MM)
Stack of inclined ultra-thin glass sheets with double-side AR coating (≠160 mm)
THERMOISULATING DOUBLE-SKIN FACADE EXTREME: OUR PATENT-PENDING PERISCOPIC WINDOWS (Ug<0.02!)
With the new requirement and trend towards Net-Zero-Energy homes with highly insulated walls, VIP may have a big role to play…

…..But before we must overcome several problems:

• limited space for VIP installation = limited thickness of panels = R value restricted
• puncture-sensitive envelope
• edge effect - linear thermal bridges
• limited service life due to air and moisture penetration
• each panel must be pre-sized before sealing, on-site reshaping and sizing is excluded as well as drilling
Permeation-protection and thermal bridge elimination

Whole set of VIP installed in wall must be integrated with aerogel drainage edge strips into bigger segment of insulating unit, fully covered with secondary hermetic envelope (much stronger and thicker then individual VIP-s) prepared, sealed and evacuated on-site.
Heuristic way to „Toy brick” Dewar flask
• The thickness of VIP is proportional to R value, but space is limited – so.... we need some tricks for „virtual” multiplication of panel dimension, but not necessary for whole panel area....in case of our flat glass/INOX „Lego Dewar Flask” with soft MLI core, we can extend exclusively anti-implosive pillars up to whole building wall thickness

• Each point-supporting anti-implosive pillar (as well as linear edge seal and spacer) not only can be physically longer then panel thickness, but additionally can be extended virtually several time by telescopic multiplication of thermal solid conductive path

• Pillars play a double role also as bolts/pins for easy integration of VIP as external cladding with building construction by compatible nest perforations, drilled or pre-casted in solid wall
The thermoinsulation „Holy Grail” - our patent-pending solutions

• The „Holy Grail” of building envelope thermoinsulation - each VIP unit can be fully cuttable and drillable on site into desired shape and size without R value degradation

• Solution is simple but tricky: key is in topological and fractal hierarchy of VIP core structure from nanoscopic to macroscopic scales

• Preparation of „Binary Topological Foam” of our VIP core are little bit sophisticated procedure but raw materials are cheap and non-toxic
THANK YOU FOR YOUR ATTENTION

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