

Quality assurance and declaration of Vacuum Insulation for building application

Presented by
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based on work done in the VIP-QS-Project lead by Hans Simmler

Contents

- Background
- Quality label project for VIP
 - Initial testing
 - nominal values for thermal conductivity
 - internal testing
 - external testing
 - declaration
- Thermal Bridge Catalogue
- Summary

Standards EN 13162 to EN 13171

Thermal insulation products for buildings - Factory made products **require**

an ongoing production control by manufacturer

- a list measurement procedures, measurement interval and further details.
- information on dimensional tolerance and dimensional stability (mostly).
- determination of compression behaviour (partly)
- that 90% of the production shall not exceed the **declared thermal conductivity** at standard room condition **over 25 years** .
- determination of a supplemental value for insulation with aging effects (Example EN 13165 for polyurethane foam.)

Standards EN 13162 to EN 13171

Thermal insulation products for buildings - Factory made products (continued)

- Except for fire behaviour, no continuous **independent** testing is required. (criticized in most central European countries)
- In Switzerland (SIA 279), the **nominal value** is to be used as **dimensioning value**, when a yearly independent test is performed. (otherwise higher values listed in SIA 2001)
- In Germany, even half yearly independent testing is required. Otherwise 20% is added.

VIP-QA General

- For VIP with pyrogenic silica core, the (Swiss) SIA 279 commission suggests an analogue procedure to the EN wherever applicable.
- The resulted documents from the (Swiss) VIP-QA Project is a discussion basis for the (German and Belgian) manufacturers.
- RAL has created a VIP-Quality testing procedure.
www.gsh.eu -> Product-groups-> Vacuum Insulation Panel



VIP Initial testing

- Thermal conductivity
 - to be performed by a certified body with appropriate competence
 - Sample taking at production site ... 10 of different sizes
- Inspection of production statistic / internal quality control
- Measuring thermal conductivity, initial values of 3 thickness
- Characterisation of core properties
 - at higher internal pressure (50-100mbar) $\lambda_p = \Delta\lambda/\Delta p$
 - at normal pressure
 - at higher humidity content X_w , determination of $\lambda_{X_w} = \Delta\lambda/\Delta X_w$
- Measuring sorption isotherm $X_w(\varphi)$
 - drying at 105°C, equilibrium humidity content at 30, 50 and 80% r.H.

informal translation

VIP Initial testing (continued)

- Measuring internal pressure of all samples (before aging)
- Aging at 23°C 50 % r.H. 6 month
 - 2 x 3 samples (lower thickness range, 2 dimensions)
 - determination of yearly increase of pressure p_a , and humidity content X_{w_a}
 - determination of dimensional dependence
- Determination of nominal value of thermal conductivity

Further properties

Fire behaviour, compression strength... by manufacturer or test centre

VIP Nominal / dimensional values of Thermal conductivity

- Determination of long term values :

$$\lambda_{90,90,t} = \lambda_{90,90,0} + \lambda_p \cdot p_a \cdot t + \lambda_{X_w} \cdot X_{w,eq} (1 - \exp(-t/\tau))$$

- $\lambda_{90,90,0}$ = 90-%-fractile value factory statistic (non aged), min 10 measurement, 90% confidence interval
- $X_{w,eq}$ = equilibrium humidity content at 23 °C, 50 % r.H.
- $\tau = X_{w,eq} / \dot{X}_{va}$, time constant for reaching humidity equilibrium
- $\lambda(t = 25 \text{ a})$, dependent on VIP dimensions
- Measurement or Calculation Ψ -value of VIP edge
 - Measurement on 4 Samples with ca. 250 x 500 x 20 mm³
- Standard value for metallised laminates
 - with $\Sigma d_{Alu} < 0.3 \text{ } \mu\text{m}$: $\Psi_{Rand} = 0.01 \text{ W/(m K)}$
- Nominal Value $\lambda_D = \lambda_{90,90,25 \text{ a}} + \Psi(d) \cdot d \cdot U/A$, rounded up to 0.001 W/(m K)

VIP internal quality control

- raw material: barrier, core material, evt. more (details factory or quality association defined) - incoming inspection
- length, width (without flap) - daily
- thickness (without flap) - daily
- evenness - daily
- bulk density (supporting shell / core) - daily
- thermal conductivity (after production) - daily
- Internal pressure
 - a) minimal control frequency per day
 - 1 when daily production less than 10
 - every 10th when daily production is 10 to 100
 - 10 when daily production is more 100

VIP internal quality control (continued)

- Internal pressure (continued)
 - b) after occurrence of an over limit (internal pressure >5 mbar)
Continuous control until 70 units. In case no over limit occurs, control frequency can change back to a) otherwise, cause has to be clarified and corrected. Following continuous control until 70 units. Except for obviously damaged VIP's
 - c) The yearly statistics must show a failure frequency <1%
- Aging
 - storing of min. 1 retain sample out of production - monthly
at room climate, storing for min. 12 months
 - measuring internal pressure before and after storing
- Compression strength at 10 % compression - weekly

VIP external quality control

- Accomplished by certified body with appropriate competence
- Frequency: once yearly
- impartial sampling: by third party (test centre or designee)
- at production site: inspection of internal quality control
- Properties to test (1 measuring result each):
 - length, width
 - thickness
 - bulk density
 - thermal conductivity (after delivering and with higher int. pressure)
 - internal pressure: measuring retain sample of manufacturer, including given production date an initial value of manufacturerin case of deviations, follow EN 13172 Annex A. If declared properties are not fulfilled, therefore a repeated external quality control within 4 weeks shall take place....

VIP Declaration

only for the
swiss version

On every Product or label or Packaging unit

- Product name or other Identification
- Name and address of manufacture or his designee
- Production date and Location or traceable code
- Class of fire behaviour (Swiss BKZ, envelope and core)
- U - nominal value of thermal resistance (incl. aging and edge effects)
- λ - nominal value of the thermal conductivity (incl. aging and edge eff.)
- Nominal thickness at centre of panel (including barrier)
if relevant: additional thickness at edge
- nominal length and nominal width (including edge range)
- In case of Covering layer: type, and if relevant, λ and thickness

VIP Declaration (continued)

only for the
swiss version

Technical documents (published or available on request at manufacturer)

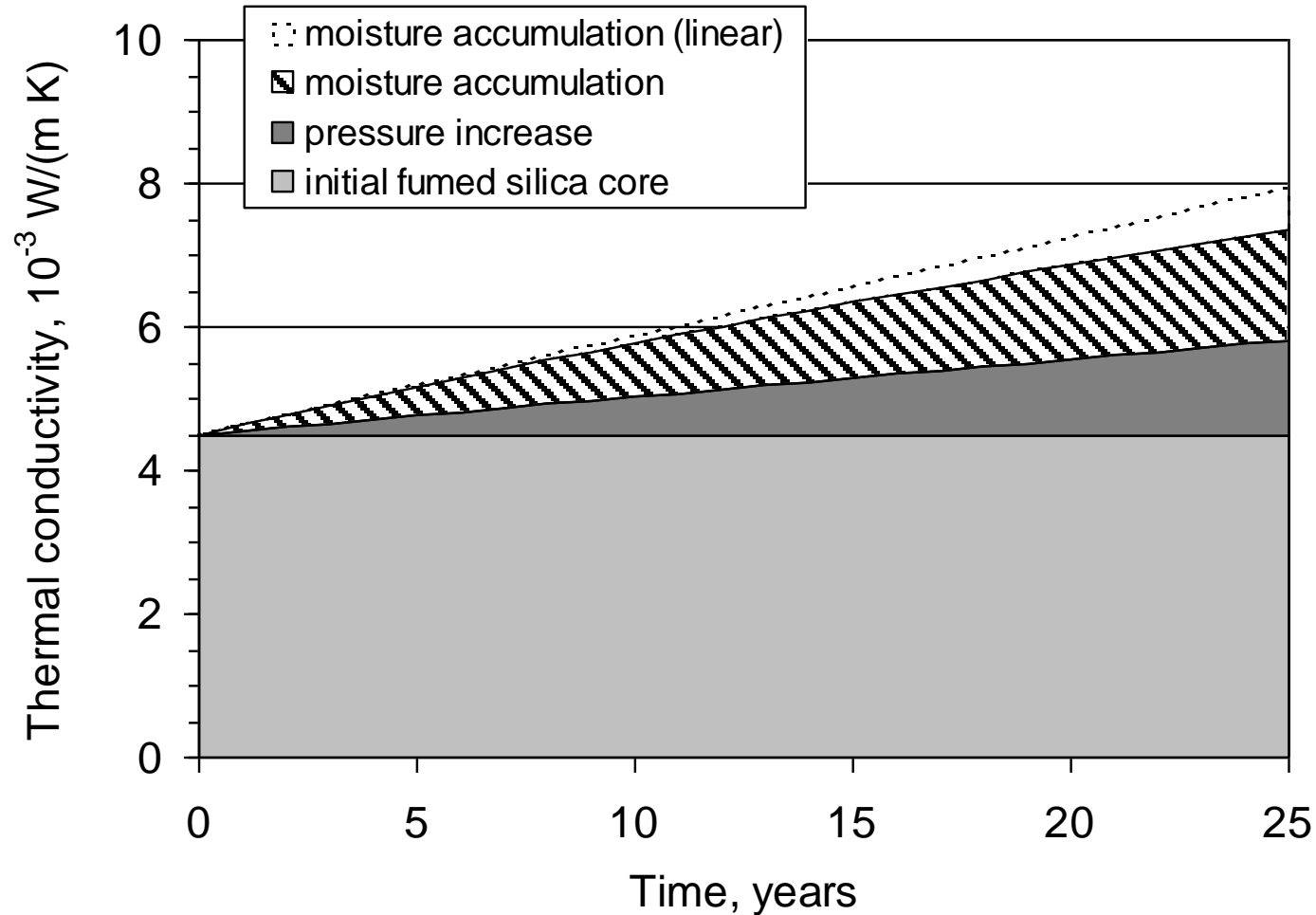
- Thermal capacity (e.g. out of Literature)
- Temperature/ Humidity application range
- Apparent density
- Compression strength at 10 % compression
- creep behaviour, allowable permanent load (if installed in floors)
- Shear loads: remark, that component specific System test are required

VIP Declaration (continued)

only for the
swiss version

- Tolerances: length, width, thickness, rectangularity
- Covering (if applicable)
- Core material: Main components (e.g. pyrogenic Silica with IR- Absorber) more precise composition to be deposit at certified body.
- Barrier: Laminates metallised or if with aluminium foil thickness declared
- Chemical resistance: e.g. pH-range, remark about solvent free adjacent material.

Example of a graph in the test report



Other aspects of Swiss QS and declaration project

- Measuring VIP Quality (internal pressure) on 130 units at 1) Production 2) delivered and 3) at Installation (ongoing part of project under lead of Markus Erb)
- **Thermal Bridge Catalogue** for VIP (in German only [1]) finalised and published part of project under lead of Markus Erb expanding the general Thermal Bridge Catalogue (in German only [2]).

[1] http://www.energie-plattform.ch/hlwd/forschung-entwicklung/vip-waermebrueckenkatalog_schlussbericht.pdf

[2] www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_382360937.pdf

as software on www.bauteilkatalog.ch (in German and French)
and Minergie-P low energy houses

http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_738333750.pdf

Summary

- **a pre-normative method** for the determination of the long-term thermal conductivity design value of vacuum insulation panels (official Swiss calculation value)
- the goal is to **get in line with** European product standards EN 13162 to EN 13171 which demand initial testing (by an independent lab), and a regular production control by the manufacturer
- There is a **thermal bridge catalogue** for estimating the values of the additional heat loss with the practically needed precision.

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