Guidelines for designers and workers: the Etanch'air project

Webinar

"Building airtightness and initiatives to improve the quality of the works"

Clarisse Mees, Christophe Delmotte, Xavier Loncour and Yves Martin
BBRi

Airtightness: Quality of works

Diversity…

Airtightness: Quality of works

During the construction process…

And from the pre-project !

- Architects have to deal with a large bunch of items.

Airtight zone ?

Which material ?

Piping and ducts ?

Construction details ?

Airtightness: Quality of works

A path decomposed on 10 practical steps

Step 1: Define the ambition level

EP regulation

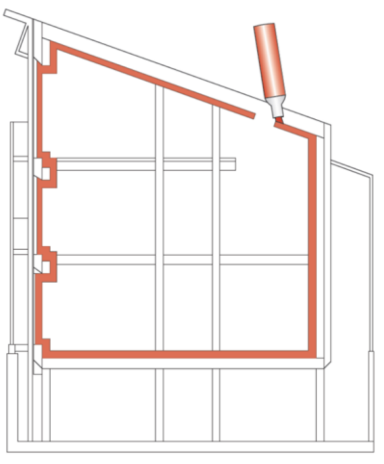
- Airtightness is taken into account in EP-calculation
  BUT there is no explicit requirement.

- Calculation is made with a default value of v_{50} = 12 m³/(h.m²)

→ <u>Objective</u>: Motivate a pressurization test to get in better value for airtightness and valorised it in the calculation of the EP

The targeted value of airtightness should be fixed as soon as the pre-project by the customer

Step 2: Define the airtight zone within the building



Protected volume
=
Isolated zone
=
Airtight zone

Step 3: Choose equipment types and their position regarding the airtight zone

- Example for heating appliance

Openings can not be sealed during the pressurization test

Step 3: Choose equipment types and their position regarding the airtight zone

- Fire safety
- Ventilation requirements

VS

- Airtightness

→ Summary tables are available as tools for designer

Equipment / rooms	Recommended position
Garages	Foresee specific ventilation system or place them outside the protected volume
Technical shafts	Depending on the fire regulations. If not applied in the considered building: inside the protected volume If applied in the considered building: outside the protected volume or provide a partitioning of the shafts
Elevator shafts	Inside the protected volume and provide a ventilation system with motorized valves Or Outisde the protected volume

Step 4: Place piping and ducts

- Passage of ducts could lead to huge air leakages

Solutions exist BUT need place !

Step 4: Place piping and ducts

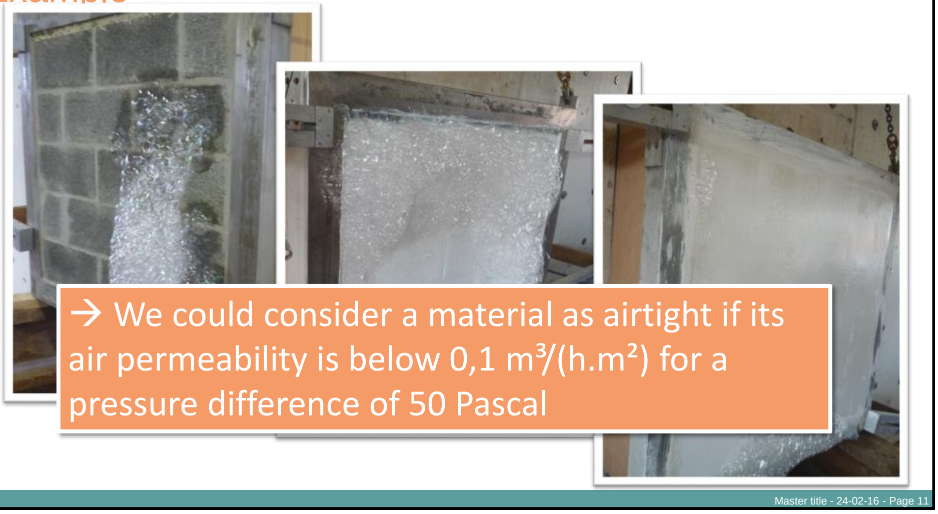
→ Architects has to:

- minimize the openings through the airtight envelope
- provide a sufficient space

Solutions exist BUT need place !

Step 5: Choose the good material to achieve an airtight envelope

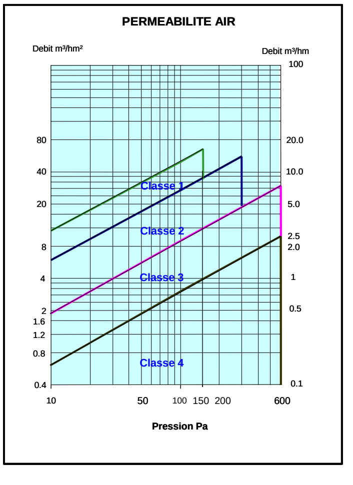
Example



→ We could consider a material as airtight if its air permeability is below 0,1 $m^3/(h.m^2)$ for a pressure difference of 50 Pascal

Step 6: Correctly choose doors and windows

Class of air permeability



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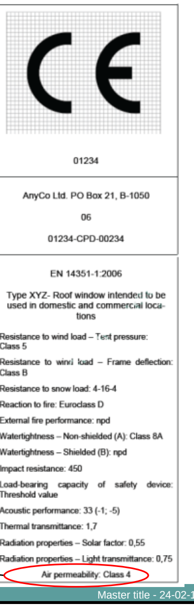


Air permeability: Class 4

Etanch'air project

- Estimation of local air leakages

→ Which constructive node has to be treated in priority ?

Step 7: Prioritize the constructive nodes

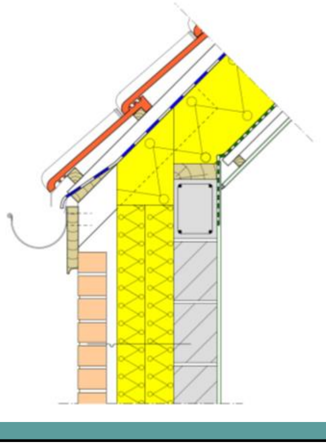
Prioritization order	
****	Priority 1
***	Priority 2
**	Priority 3
*	Priority 4

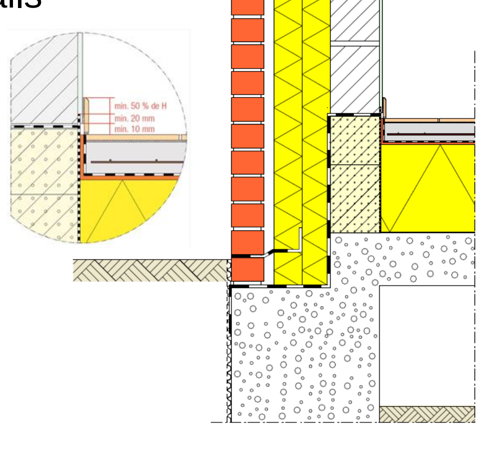
- For cavity walls

Constructive nodes	Priority
Ground bearing floor	* → **
Junction between separating wall and façade	*
Junction between intermediate floor and façade	**
Pitched roof: Purlins	*** → ****
Pitched roof : Gable	****
Pitched roof : Eaves	*** → ****
Service penetration through roof	***
Junction between window and façade	** → ***

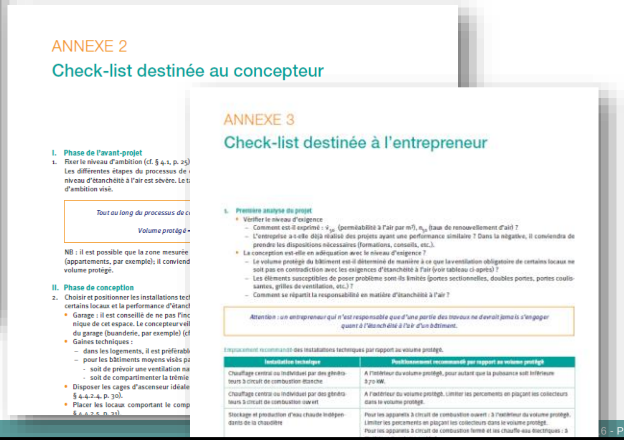
Step 8: Choose technical solutions for each constructive nodes… and implement it !

- Library of technical details





Step 9: Check the coordination and communication between all the builders


ANNEXE 2
Check-list destinée au concepteur

I. Phase de l'avant-projet

II. Phase de conception

ANNEXE 3
Check-list destinée à l'entrepreneur

Step 10: Provide an intermediate pressurization test

Thank you for your attention

QUALICHeCK
Towards better quality and compliance

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Laboratory investigation on the durability of taped joints in exterior air barrier applications

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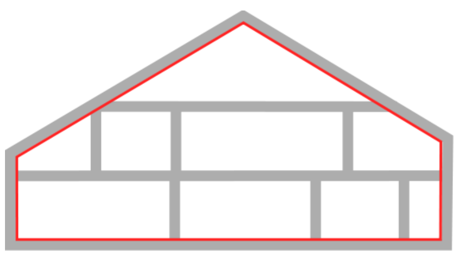
Introduction

Complex details of interior air barriers



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Introduction

- Traditional wood-frame construction: interior air barrier
  - Disadvantages:
    - Many joints make it labour intensive to seal
    - Risk of later penetration of the air barrier
    - Labour intensive

KATHOLIEKE UNIVERSITEIT LEUVEN

Introduction

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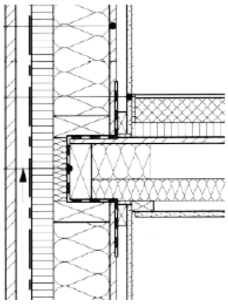
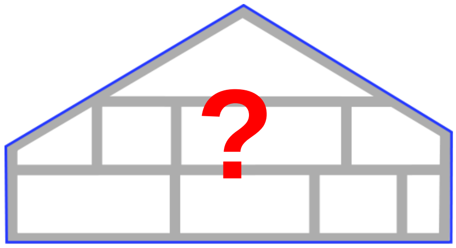


Introduction

Exterior air barriers: potential to reduce labour costs



Introduction

Introduction
Method
Test-setup
Results
Conclusions

	n_{50} (1/h)	Wind barrier
	0.8	Foil
	2	Bituminous wood fiber board
	0.28	Gypsum board + foil
	0.56	Gypsum board + foil
	0.29	Gypsum board + foil
	0.52	Bituminous wood fiber board
	0.61	Bituminous wood fiber board + foil

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Introduction

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But… exterior air barriers are exposed to more severe conditions!

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Method

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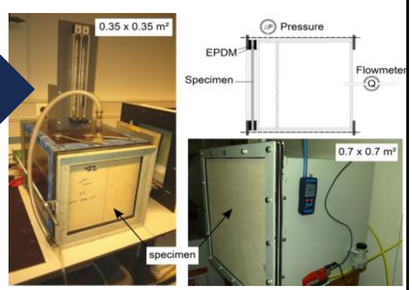
Artificial aging

Air permeability testing



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Test-setup

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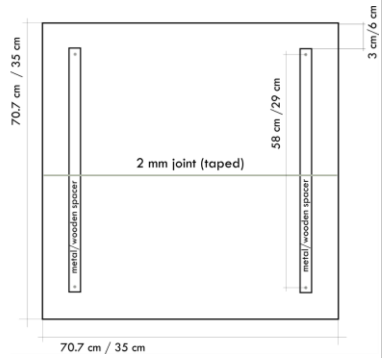
TEST SAMPLES



TEST SERIES	TAPE	Spacer
A	Tape A	Aluminium
B	Tape B	Aluminium
C	Tape A	Wood
D	Tape B	Wood

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Test-setup

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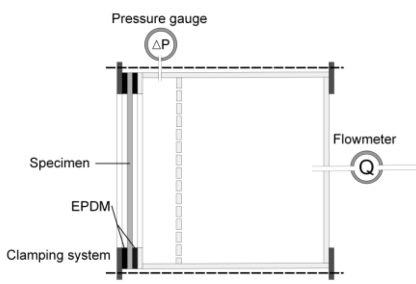
AIR PERMEABILITY TEST

27 x 27 cm²

70 x 70 cm²



$$K_{joint} = \frac{(K_{spec} - K_{mat}).A_{spec}}{l_{joint}}$$

Test-setup

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ARTIFICIAL AGING

Test	Type	Total time	Conditions
1	Temperature	2 weeks	6 x (24h 70°C and 24h 15°C @30% RH)
2	Temperature, rain, frost	12 days	40 x (3h 70°C - 1h rain - 2h repose) - 2 x (8h 50°C - 16h -20°C)
3	UV-exposure, vapour	4 weeks	56 x (8h UV (40°C) and 4h vapour exposure (60°C))

Results

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BEFORE ARTIFICIAL AGING

- TAPE A: 3.1 10^{-6} m³/m/h/Pa
- TAPE B: 3.9 10^{-7} m³/m/h/Pa

EXTREMELY LOW VALUES

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Results

- Introduction
- Method
- Test-setup
- **Results**
- Conclusions

Aluminium spacer | Wooden spacer

TEST 1

TEST 2

TEST 3

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Results

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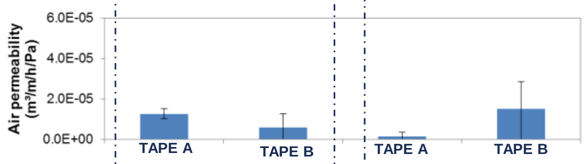
Aluminium spacer | Wooden spacer

TEST 1



TEST 2

TEST 3

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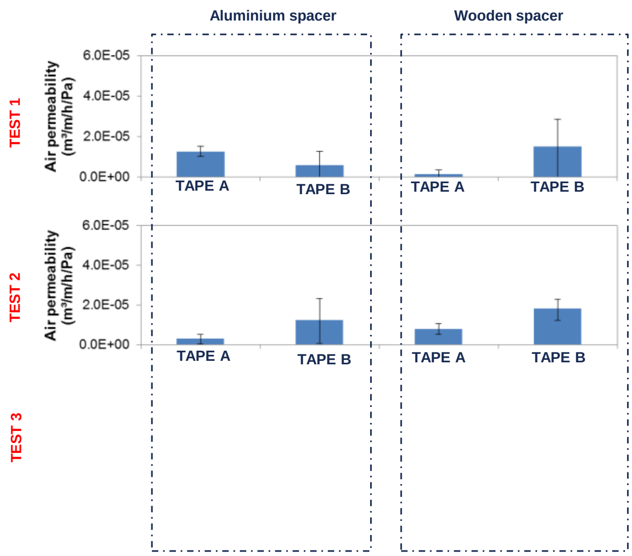

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Results

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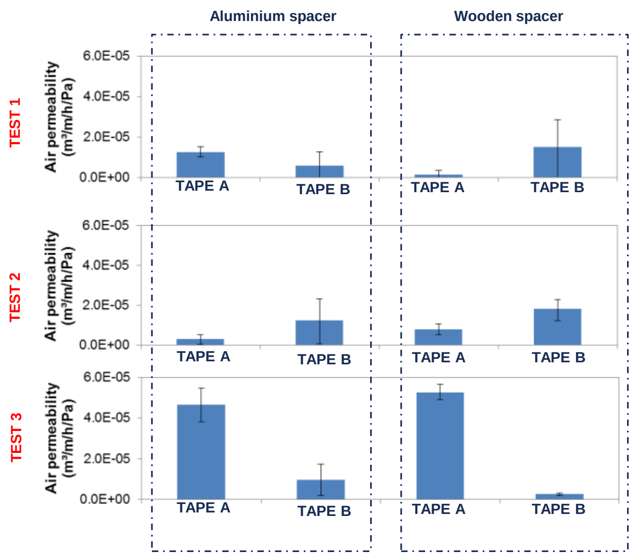

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Conclusions

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- Methodology to test the test the durability of taping products was proposed
  - Temperature cycles
  - Frost-thaw cycles
  - UV cycles

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  - Temperature cycles
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  - UV cycles
- Two tapes have been tested: **impact < 4-6 10^{-5} m³/m/h/Pa**

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n_{50}=0.003 1/h << 0.6 1/h (Passive house)

Conclusions

Limitations of current study

- Two taping products with high quality
- Application of the tape in laboratory conditions

Further research

- More products available in the market
- Application of the tapes in worse conditions (freezing, dusty,…)

System approach and on site quality control

Isov'Air Test : Airtightness evaluation

ISOVER
Une marque de Saint-Gobain

Airtightness systems

Adhésif Vario KB1
(Jointoiement des lès)

Adhésif Vario Multitape
(Jonction conformable)

Adhésif Isostrech
(Tour de conduit)

Mastic Vario Double Fit
(Jonction membrane/support)

Joint ruban Vario Protape
(Jonction membrane/support)

Adhésif Vario Double Face
(Collage membrane/fourrure)

ISOVER SAINT-GOBAIN

Service : Field of application

- **Evaluation of air tightness for private housing:**
  - **At reception of new building to evaluate the performance**
  - **In the course of the project to correct the possible defects (before installation of the facing)**
  - **At the end of the project, in order to ensure the official measurement carried out by an approved operator**

- **Evaluation in multifamily apartment on independent batches**

Control of air tightness on jobsite in a quality approach

Isov' Air Tests: the 1st workstation of self-evaluation of air tightness on sub-project

Facilitate the coordination between the different installers

+

Help to anticipate the potential issues before final measurements.

Principles?

- Air tightness of a building is measured by sealing all the air entries and air leakages envisaged and by putting the house in depressurization or surpressurisation.

- Measurement is carried out by an operator recognized by a commission and respecting a standardized testing method (European standard EN NF 13829).

- The lawful index French Q4Pa-surf quantifies the escapes of air of the building and is expressed in m3 of air per hour and m ² of cold wall (walls, roof) under 4 Pascal of difference in pressure external interior/.

iso✓'AIR Test

EXCLUSIVITÉ Brevet déposé ISOVER

- Performance evaluation of air tightness compared to a target value

- Enables to locate the defects of sealing

- Speed of implementation

- Easiness of reading

- Reliability of the evaluation
  - development resulting from the experience of Ubat Controls
  - calibration by independent organism (CETIAT)

Reminder of the requirements of label BBC Effinergie (current) and RT2012 (to be come)

- **Requirement for air tightness to 4 Pa (Q4Pa-surfing) For:**
  - **Single family housing 0.6 m3 /h/m ²**
  - **Multifamily apartment 1 m3 /h/m ²**

isoV'AIR Tests

Exclusivité Brevet déposé Isover

Characteristics

- **Surface Maximum cold wall: 700 m ²**
- **Feeding: 220 V (sector or generating set)**
- **Handiness: handle + casters any ground**
- **Ventilator monovitess with very stable flow**
- **Dimension: 60 cms X 43 cms X 63 cms /Weight: 23.9 kg**
- **Reading of the differential of pressure by**

digital display on autonomous manometer (pile)

Cover and tallies provided

Feedback : Useful in pre-control

Possible rent in the retails

Present users : big builders in particular (single family housing and multifamily housing)

Market drivers for the development and use of new building airtightness products

Tightvent

SOUDAL

Filip Van Mieghem
Senior Product Manager

12th of January, 2016

Contents

- ✓ General: (product) standards, test methods
- ✓ Sealants
- ✓ PU-foams
- ✓ Combination of products
- ✓ Innovation

Soudal : key figures

Turnhout, Belgium - Soudal Laboratory

- Soudal in numbers
  - Founded in 1966 by current owner
  - HQ in Belgium
  - 100% privately owned
  - 2,200 people – €565 million in 2014
  - 44 affiliates – export to 130 countries
  - Annual R&D budget > EUR 5 mio

R&D is part of Soudal's DNA

Turnhout, Belgium - Soudal Laboratory

- R&D is our core business
  - > 250 R&D projects p.a.
  - 50% product modifications
  - 50% new products
    - Patents
    - Vertical upstream integration
- Products meet many internat. standards

Underwriters Laboratories Inc. ISO snjf ift ROSENHEIM AAMA AENOR CSTB atg DIN

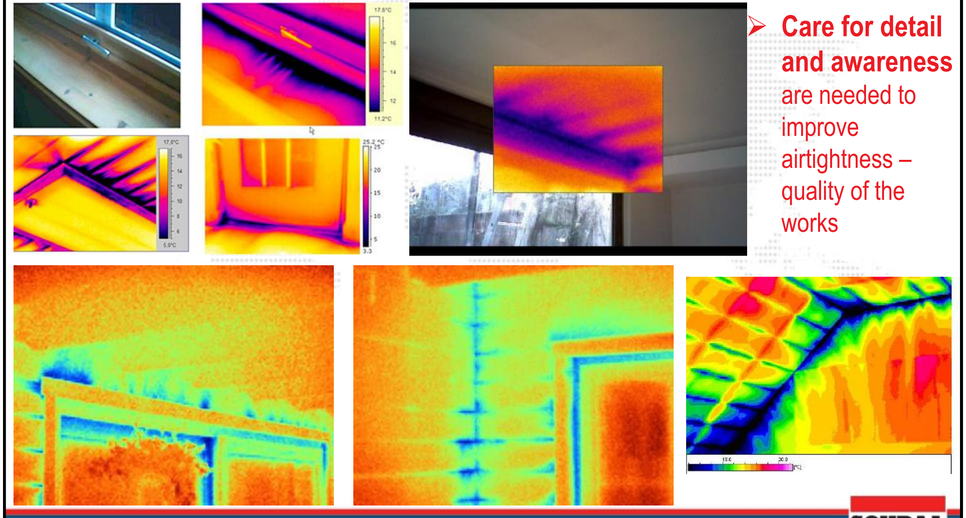
Typical jointing products: Sealing and bonding

Outside | Middle | Inside

Construction joints & jointing products

- Function/issues:
  - Weather sealing / water tightness
  - Cosmetical
  - Thermal insulation (thermal bridges)
  - Fire proofing
  - Acoustics
  - Burglar resistance
  - Airtightness
  - Vapourtightness
- And mostly a combination thereof…
- <u>Important unimportance !</u>

Construction joints and airtightness



- **Care for detail and awareness** are needed to improve airtightness – quality of the works

Airtightness of constr. materials: standards?

- Foams, sealants, adhesives:
  - Airtightness not covered in (inter)national product standards (if any)
- Precompressed (expanding) tapes:
  - DIN18542: airtight = **BG-R** (↔BG1 = water tight icw 600 Pa windpressure)
  - NF 85-570 and NF 85-571 (Classe 1)
- Membranes, tapes, vapour barriers, …
  - Membranes and flashing tapes: wide variety: laminated PE,butyl,etc
  - Vapour control barrier: flexible sheets, EPDM cladding (EN 13984)
  - Selfadhesive tapes: wide variety (carrier, adhesive)

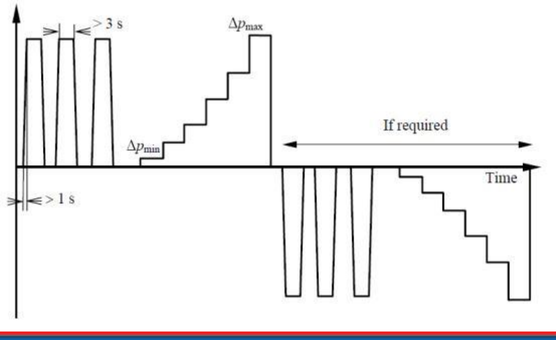
  ⇒Vapour tight = airtight (the opposite is not necessarily true)
  - Sd = μ x m
  - Estimate: Sd > 1m is sufficient

Airtightness of constr. materials: test methods

- EN 12114: Air permeability of building components and building elements (laboratory test method)
  - a-value: ≤0,1 m³/h.m at 1 daPa$^{2/3}$
- EN 1026: Windows and doors - Air permeability – Lab test method
  - Classification: EN 12207 (4 classes)
- MO-01: ift directive (Institut für Fenstertechnik)
  - Test on construction element: window-wall – combination of products
  - Airtightness (EN 12114) + watertightness (EN 1027)
  - Before and after ageing
- Sd- value: determination of water vapour transmission properties
  - EN ISO 12572: Hygrothermal performance of building materials and products
  - EN 1931: Flexible sheets for waterproofing (membranes)

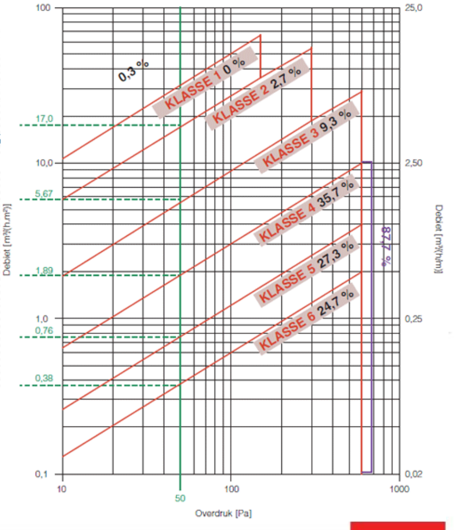
EN 12114

- Air permeability of building components/elements
- Laboratory test method
- Procedure:
  - 3 pulsations and then gradual steps; both positive and negative pressure
  - 50 Pa to 500 Pa (or even 1000 Pa) in logarithmic steps



EN 1026

- Test method for air permeability of windows and doors
  - Up to 600 Pa in steps of 50 Pa
  - Sometimes referred to for sealing products
    - ➔from m² to m: divided by 4
- Classification (EN12207)
  - Class 4: 0,6 m³/hm² at 10 Pa
    = 1,89 m³/hm² at 50 Pa
    = 0,47 m³/hm at 50 Pa
  - *Class 5: 0,18 m³/hm² at 10 Pa*
    = 0,76 m³/hm² at 50 Pa
  - *Class 6: 0,05 m³/hm² at 10 Pa*
    = ± 0,38 m³/hm² at 50 Pa



Combination of products Ift directive MO-01/1

- Window to wall connection
- Voluntary
- Airtightness (EN 12114) + water tightness (EN 1027) before and after ageing
- Ageing
  - Temperature (+60°C / -15 °C, 10 cycles)
  - Functionnality of window (open / tilt, 10.000 cycles) (EN 1191)
  - 3 pulsations both positive and negative pressure (1.000 Pa, 200 cycles) (EN 12211)

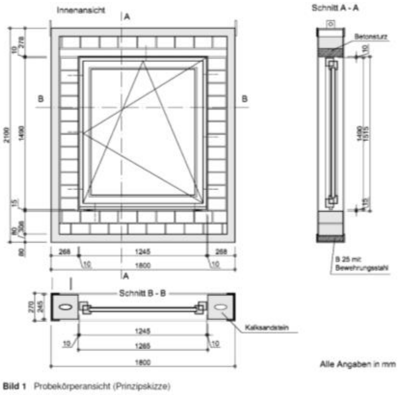


Bild 1 Probekörperansicht (Prinzipskizze)

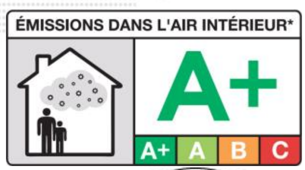
Measuring equipment

◀ Typical window test rig

▼ Lindab LT600 in lab mode

Emission: VOC

- Indoor air quality is getting more of a concern with growing airtightness levels
- Sustainability: Leed, Breeam, …(VOC content)
- France: mandatory emissions class labelling
  - All construction products used indoors
  - Highest class is A+
  - Measured after 28 days
- Germany: Emicode - voluntary
  - GEV: origin: adhesives for floor coverings
  - EC1(R), EC1 Plus are the highest classes
    - Measured after 10 or 3 /28 days
  - Harder to achieve

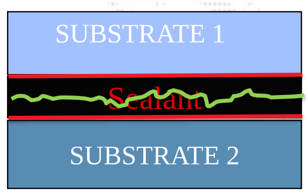


Sealants

- Silicone : AC / Alcoxy/ Oxime
- Acrylics
- Polyurethane
- Polyisobutylene
- Bitumen
- Fire rated sealants
- Fast curing
- Primers & tools

Sealants and airtightness

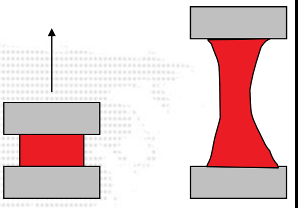
- Can generally contribute a lot to airtightness on 2 conditions:
  - Cohesion: no shear within the cured product
  - Adhesion: you also need an adhesion to the substrate(s)/supports
- Movement capacity: max % of total joint movement a sealant can permanently take without shearing (stretched)
- Some products are part of combined system test (MO-01/1)
- Sd values
  - Eg Acrylics: µ 10186, Sd 31m (2,5 to 3mm)
- Some sealants meet EC1 or EC1 Plus



BUILD THE FUTURE
SOUDAL

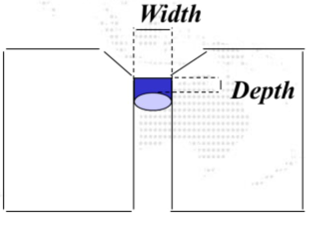
CE marking : EN 15651

- New harmonised norm EN 15651 (CE marking)
  - Mandatory since 1/7/2014
  - EN15651-1: façade (interior and/or exterior): **F**
  - EN15651-2: glazing: **G**
- F-INT
  - Min. requirements, elongation at break (CE system 4)
- F-EXT-INT: 2 possibilities:
  - Min requirements: no class (CE, system 4)
  - Classes: 7,5P, 12,5P, 12,5E, 20HM, 20LM, 25HM, 25LM (CE, system 3 with ITT) = based on ISO EN 11600 (extension CC = Cold Climate)



General rules of thumb

- Make sure supports are clean, free of dust and grease
- Which substrates?
  - Most sealants work better on specific substrates (adhesion spectrum)
  - Hybrid sealants work on a lot of surfaces, even wet
  - Typically problematic for all sealants: PE, PP, PTFE
- Prepare substrates if recommended (primer)
- Preferably use backing rod
- Check joint dimension and movement
- Watch application temperature and RH
- Respect curing time of product



Sealants : types

- Hybrid sealants: permanently elastic
  - Excellent adhesion on almost any substrate
  - Diverse, low modulus and high modulus
  - High movement capacity (20-25LM or HM – EN-ISO 11600)
  - No cracks under UV-radiation
  - Paintable
  - Adhesion on damp surfaces
- Silicone sealants: permanently elastic
  - Excellent adhesion on glass, metals.
  - Ideal for airtight glass sealing
  - High movement capacity (20LM – 25LM)
  - Very resistant to UV, excellent weatherability
  - Usually not paintable

Sealants : types

- PU
  - Excellent adhesion on mineral substrates (stone, cement)
  - High movement capacity (20-25%)
  - Mostly LM
  - Might crack under UV
- Acrylics
  - Mainly interior use/finishing
  - Paintable, “elastic and airtight extension of plaster”
  - Prevents cracks between window frame and plaster
  - New development: meets with ISO 11600 12,5E
  - Physical drying: shrinkage

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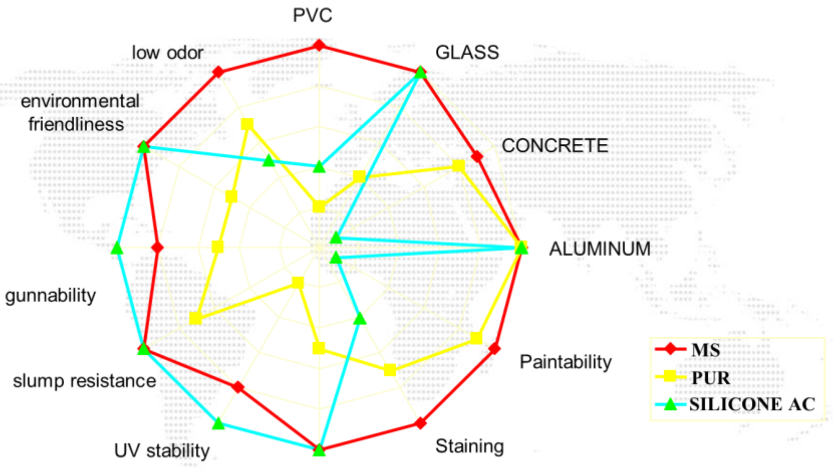
SOUDAL

Sealant profiles



Outside sealing

Inside sealing

- Airtightness in the proper sense
- Acrylic sealants
  - Mostly used (interior façade sealing) (F-INT)
  - Paintable
  - Limited movement capacity (mostly plastic, max 12,5%)
- Hybrid sealants
  - Inside and outside use (F-INT-EXT)
  - Large movement capacity (up to 25%)
  - Paintable (waterbased paints)
- Remark: paint is not flexible!!!

PU Foams

- Handheld / Gun / Click & Fix / Genius Gun
- Construction foam
- Insulation foam
- Sound proofing foam
- All season foam
- 2K-foam
- Zero % Isocyanate foam(SMX)
- Low monomeric
- PU mining foam
- Multi position foam
- Fire rated foam
- Arctic foam -25°C
- Sahara foam +40°C

BUILD THE FUTURE SOUDAL

Flexifoam = elastic foam

Flexifoam : airtight

- No product norm – but test methods issued by Feica
  - http://www.feica.com/our-industry/pu-foam-technology-ocf
- Voluntary testing on airtightness at ift Rosenheim (EN 12114)
  - A-value ≤ 0,1 m³/hm (daPa$^{2/3}$) – joint 2 (width) x 6 cm (depth)

Prüfung nach DIN EN 12114

	Breite	x	Höhe	
Probekörpermaße	1000	x	1000	in mm
	Anzahl		Länge	
Fugen längs	6	x	990	in mm
Fugenlänge	5,94	m		

DRUCK

Volumenstrom 1	Nullmessung (Fugen abgeklebt)								
Pa	50	73	106	154	224	325	473	688	1000
l/h	13,24	18,53	27,46	38,14	53,72	80,90	110,90	155,60	209,00
V in m³/h	0,0132	0,0185	0,0275	0,0381	0,0537	0,0809	0,1109	0,1556	0,2090

Volumenstrom 2	Fugen nicht abgeklebt								
Pa	50	73	106	154	224	325	473	688	1000
l/h	14,76	20,32	29,88	41,49	57,67	87,90	120,50	166,00	225,70
V in m³/h	0,0148	0,0203	0,0299	0,0415	0,0577	0,0879	0,1205	0,1660	0,2257

Volumenstrom 2 - 1	Luftdurchlässigkeit Fuge								
Pa	50	73	106	154	224	325	473	688	1000
V in m³/h	0,0015	0,0018	0,0024	0,0034	0,0040	0,0070	0,0096	0,0104	0,0167
V_0 in m³/h	0,0015	0,0017	0,0023	0,0032	0,0038	0,0068	0,0093	0,0101	0,0162
längenbezogen in m³/hm	0,0002	0,0003	0,0004	0,0005	0,0006	0,0011	0,0016	0,0017	0,0027

V_0: korrigierter Luftvolumenstrom unter Referenzbedingungen (20 °C / 50 % rel. LF / 101325 Pa Luftdruck)

Airtightness testing at Ghent university

UNIVERSITEIT GENT

Façade element	Beschrijving opstelling	Flow at 50 Pa [m^3/h/m]						
		underpressure	abs. dev.	overpressure	abs. dev.	average	Class	abs. dev
Standard	casing, empty	**30,90**	0,97	**35,23**	1,11	**33,07**	**C**	1,04
	casing, mineral whool	**2,61**	0,13	**3,31**	0,15	**2,96**	**C**	0,14
	casing, Flexifoam	**0,95**	0,09	**1,59**	0,12	**1,27**	**B**	0,10
	casing, Flexifoam, Acryrub	**0,01**	0,06	**0,00**	0,08	**0,00**	**A**	0,07
	plaster, profile, Acryrub	**0,08**	0,03	**0,06**	0,03	**0,07**	**A**	0,03
	Plaster, SWS-foil, inside	**0,08**	0,03	**0,27**	0,03	**0,18**	**A**	0,03
	Plaster, SWS-foil, side	**0,08**	0,03	**0,24**	0,03	**0,16**	**A**	0,03
Passive	Plaster, Flexifoam, dry	**0,03**	0,03	**0,00**	0,04	**0,02**	**A**	0,04

<0,4 m^3/hm (A) 0,4-2.5 m^3/hm (B) >2,5 m^3/hm (C)

PU-foams: airtight?

PU-foam can be/stay airtight !

- If used in the correct joint dimensions
- If used between 2 airtight building elements
- If correctly applied
- If flexible

… Thus combining insulation and airtightness

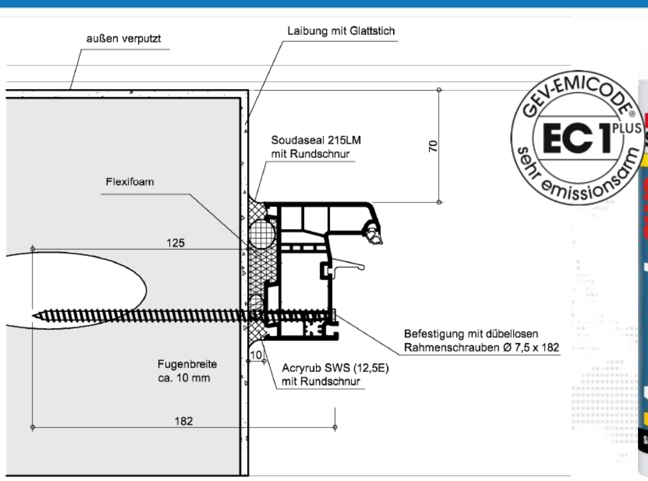
➔ Thermal insulation: λ = 0,035 W/m.K

PU-foam : moisture curing!

Without With

Combination of products: SWS

SWS SOUDAL WINDOW SYSTEM



- Voluntary MO-01 test report for elastic foam and 2 sealants (hybrid and acrylic)

Innovation: liquid membrane

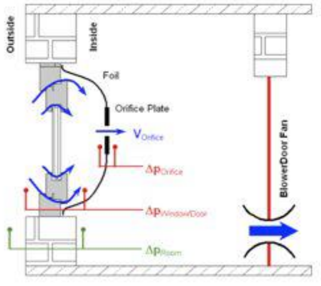
- Airtight “Liquid membrane”: application with brush
- Formula contains fibers to fill small cracks
- Window to wall: can replace membranes – ease of application

Liquid membrane

- Airtight liquid membrane applied with airless gun
- Floor to wall, wall to ceiling, etc
- Easy and fast !!

Soudatight LQ: test

- Test on construction site: 2 identical windows - façade not yet grouted - cavity wall - check reveal
  - Window with only foam filling (1);
  - Window with foam and Soudatight LQ (2)



Soudatight : on site test (part 1)

- Test according to EN 1026 and EN 12207
  - Living room: underpressure of 50 Pa with Blower Door
  - Result: 1,02 m³/hm: leaks at height of DPC foil

Soudatight LQ: test (part 2)

- Visual smoke test: Riosteam + DG700

Quality of the works?

- Manufacturer/supplier: ISO 9001 – ISO 14001
  - Support, service
- A-brands (cheaper seldom is better in the long run)
  - R&D
- Use the right product for your application
- Follow manufacturers instructions
  - Method, amount, temperature and humidity (during and after application), preparation,…
- CE marking
- Quality labels (voluntary)
- Technical approvals in case of more innovative products
- Easy of application and/or time saving:
  - Best market drivers, and better results


SOUDAL
Expert in sealants, foams and adhesives