PROGRESS AND TRENDS IN AIR INFILTRATION AND VENTILATION RESEARCH

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Paper 1

ANNEX 14 - CONDENSATION AND ENERGY

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1. INTRODUCTION: MOTIVATIONS FOR THE ANNEX

Annex 14 -Condensation and Energy- started in April 1987, with a take of meeting in Utrecht, The Netherlands. The annex itself was born after a moisture-workshop in September 1985 at the Laboratory of Building Physics, KULeuven, Belgium.

Motivations from the beginning were a widespread feeling that badly balanced energy conservation actions in the seventies and early eighties had increased the number of moderate to severe mould complaints in dwellings, with all possible nuisance, health and financial consequences, the fear that this could enhance each energy conservation policy, and the conviction that the mould reality was socially inacceptable, especially because of the problem being most pronounced in the low income housing sector.

Nevertheless, a convincing argument for the first motivation was and is difficult to find. A Belgian enquiry of 1986 in 5000 social dwellings showed a mould problems level of some 20% [1]. The Netherlands reported ± a same percentage in the subsidised building market [2]. The U.K. spoke of ± 25 to 30 % of dwellings affected in the low income, rented housing [3]. Only this year, a more convincing argument was advanced by the U.K., where a new enquiry showed a net increase in mould and a clear growth in severe mould problems (Oral information at the Leuven meeting, may 1989). But still here, the question remains if that isn't a result of 10 years conservative government, with a lower interest in overall social policy, rather then of a conscious but badly balanced energy conservation policy.

The paper starts with focusing on the so called first order surface condensation theory. Then a short shift to the energetical links follows. After that, the organisation and progress of the work is explained, and we end with an overview of the results.

2. A FIRST ORDER THEORETICAL APPROACH [4],[5]

Surface condensation starts when the relative humidity (RH) on a surface reaches 100%, t.m.,when the vapour pressure p in the air against the surface equals or becomes higher then the saturation pressure p' on it:

$$p \geq p' \qquad (1)$$

Introducing the hypothesis of ideal mixing of the air in each zone (= a simplification of reality), the vapour pressure against the surface doesn't differ from the overall value in the zone and (1) can be reformulated as:

$$pi \geq p' \qquad (2),$$

the vapour pressure in the zone (**pi**) equal to or higher then the saturation pressure on the surface, or:

$$Td \geq Ts \qquad (3),$$

the zonal inside dewpoint (Td) equal to or bigger then the surface temperature (Ts).

The condition for **mould growth** is much more complicated. As a first order rule, we accept mould becomes possible when the relative humidity (= the water activity) on a surface remains higher then a threshold value a. Accepting ideal mixing of the zonal air, this condition simplifies to:

$$pi \geq a*p'/100 \qquad (4)$$

The saturation pressure on a surface is exponentially linked to the **surface temperature** Ts, given by:

$$Ts = Te + \tau * (Ti - Te) \qquad (5)$$

with τ the temperature ratio of the surface, **Ti** the inside reference temperature and Te the sol-air outside temperature.

For a flat wall in steady state thermal conditions (= mean thermal situation), τ equals:

$$\tau = 1 - U/hi \qquad (6)$$

with U the thermal transmittance of the wall and **hi** the thermal film coefficient against the surface.

In non steady state, the temperature ratio becomes a time function, dependant of the course of the in- and outside temperature, of the film coefficient and of the thermal inertia of the wall.

For two- and three-dimensional configurations (= thermal bridges) the temperature ratio can only be calculated, using a suitable software package.

The mean **inside vapour pressure pi** is related to the outside vapour pressure pe, the moisture production φp, and the ventilation rate ß, according to the formula:

$$pi = pe + [R*(Ti+273.16)]* \varphi p / (\beta*V) \qquad (7)$$

with R the gas constant of vapour (462 J/K) and V the zonal volume.
This simple relation only holds for a 1-zonal situation, if no surface condensation is taking place. It also supposes ideal

mixing of the zonal air.

The simple formulas (2) to (7), combined with statistical data on the outside climate and the relation inside temperature-outside temperature, enable to study, for a given case and outside climate, the relations 'outside temperature-temperature ratio-maximum inside R.H.- minimum ventilation rate'for different levels of the inside moisture production, so, that mould problems or surface condensation should be prevented.

Figure 1 shows the results for a sleeping room (V= 35 m3, φp= .96 kg/d), figure 2 for a day-zone (V= 100 m3, φp= 3.6 kg/d) (Calculations done with as mould condition: a= 0.85).
Both figures indicate that the ventilation rate needed to prevent mould germination and growth is significantly higher in mean-season as it is during cold winter periods. They also show that the overall relation is not a linear one.

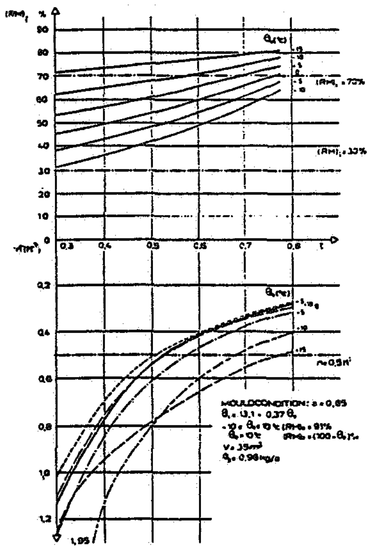

fig. 1: SLEEPING ROOM
RELATION (RH)$_i$ - τ - θ$_e$ - n

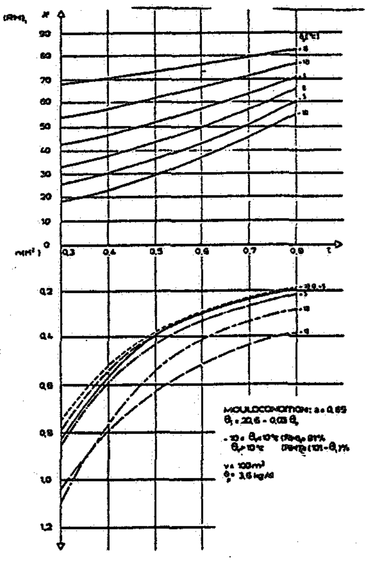

fig. 2: LIVING ROOM + KITCHEN
RELATION (RH)$_i$ - τ - θ$_e$ - n

In general, the chance on mould/ surface condensation heightens, the lower the surface temperature Ts and the higher the inside vapour pressure pi

The first order theory now im- and explicitly learns that both conditions depends of:

- the outside climate

the temperature: the lower Te, the more probable mould and surface condensation...
the vapour pressure: the lower pe, the more probable ...
A low temperature and a high vapour pressure are mutually conflicting: they cannot occur together

the wind: the lower the wind velocity, the lower for natural ventilation the ventilation rate ß.
The lower ß, the more probable...

- the building fabric

the volume: the smaller, the more probable ...

the thermal quality: the lower the temperature ratio, the more probable ... A low temperature ratio is directly linked to high U-values and low film coefficients hi, t.m. a poor heat flow to the surface by convection and radiation

the airtightness: the lower ß, the more probable .. Specifically the basic ventilation rate is a direct result of the airtightness of the fabric

the inside environmental temperature: is a weighted combination of the air and the radiative temperature. The last is to a significant amount influenced by the overall thermal quality of the fabric and the 'outside wall surface-total wall surface'-ratio,in the sense of:the worsen the thermal quality and the higher that ratio,the lower the radiative temperature and the more probable..
Also the air temperature is coupled to the fabric: if badly insulated, maintaining a high enough air temperature may turn out being too energy consuming and through that too expensive. The lower the air temperature, the more probable...

the vapour production: the higher φp, the more probable .. A high vapour production may be a consequence of other moisture problems

the internal finishing: some materials, paints, wall papers are more sensitive to mould then others. Through that, the threshold relative humidity a can be lowered by the choice of the finishing...

- the inhabitants behaviour

the inside environmental temperature: depends on heating habits. The less heating, the lower Ti and the more probable..

the ventilation rate: the lower ß, the more probable..Inhabitants have a substantial effect on excess ventilation

the moisture production: the higher φp, the more probable..Living in and using a dwelling inevitably means moisture production. Using it in a non adapted way, may result in too much vapour ...

These rather complicated and interrelated influencing parameters are summarised in figure 3. This figure doesn't give any qualitative information on how important the respective parameters are.

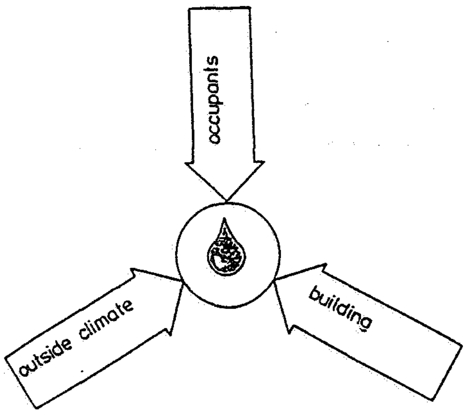

Fig.3: influencing factors

3. LINKS WITH ENERGY DEMAND AND USE FOR HEATING

From the review of parameters, it may be clear that mould and surface condensation are most likely in non-insulated dwellings, t.m. in houses with a high basic energy demand.
More, avoiding mould in these energetical ruins, asks for a substantial ventilation rate, especially when, because of intensive use, the moisture production is high. This counts for an important extra increase in energy demand.
Also, the possible heating economy by lowering the mean inside temperature is partly counteracted by a compelling necessity for more ventilation, the lower this inside temperature.

Insulated houses give complaints as far as problematic thermal bridges are left. These have a net energetical impact, heightening in negative cases the conductive heat losses through the envelope as much as 30 %.
At the same time, to avoid mould on these spots with low temperature ratio, a substantial ventilation is requested, pushing on its turn the energy demand for heating to still higher levels.

To illustrate the importance of these effects,the results of some energy demand calculations on a small house are summarised in table 1 and figure 4:

Assumptions:

house= 1 thermal zone
intensive use ($\varphi p = 12$ kg/day),
inside temperature= 16.9+ 0.17*Te (a)
13.5+ 0.17*Te (b)
energetical year for Belgium.

lowest temperature ratio:

non-insulated (Um=1.7 W/(m2K) : 0.3 (1)
insulated, thermal bridges (Um=0.56 W/(m2K) : 0.5 (2)

insulated, no thermal bridges (Um=0.44 W/(m2K) : 0.7 (3)

(1) behind cupboards against outside walls
(2) lintels, thresholds ...
(3) design value

Results:

Table 1

	Um W/(m2K)	τ -	En avoiding mould kWh/y	En n=0.5h-1 kWh/y
Ti=(a)	1.7	0.3	45670	39360
(b)	1.7	0.3	36620	25040
Ti=(a)	0.56	0.5	15430	14810
Ti=(a)	0.44	0.7	10620	11990

or, no insulation or, an insulation with thermal bridging, are triple punished: higher to high conductive losses, more ventilation losses, less economy when maintaining lower inside temperatures.

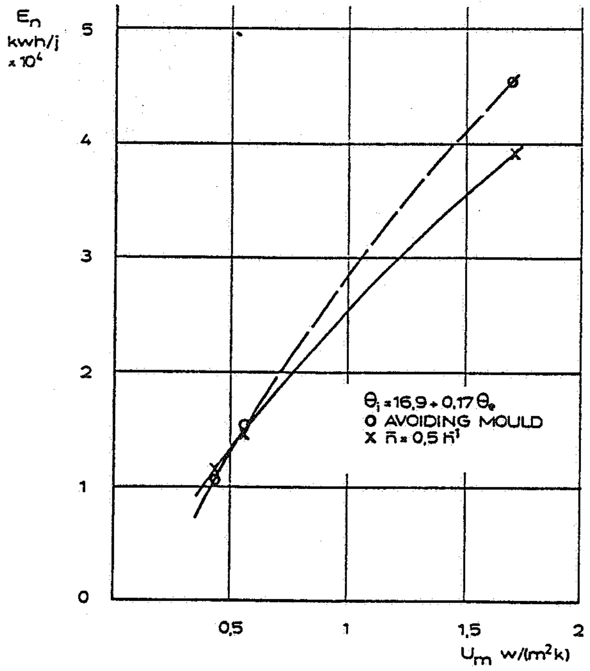

fig. 4: ENERGY DEMAND FOR HEATING
. $\bar{n}$ = 0,5 h^{-1}
. $\bar{n}$ = NEEDED TO AVOID MOULD (a = 0,85)

There is only one disturbing element in this straight on 'energy demand-mould'-relation: the role of the inside surface coefficient. The lower hi,the lower the temperature ratio of that surface but the better the insulation value, t.m. the lower the conductive losses!
This is illustrated in fig 4 for a badly insulated cavity wall.

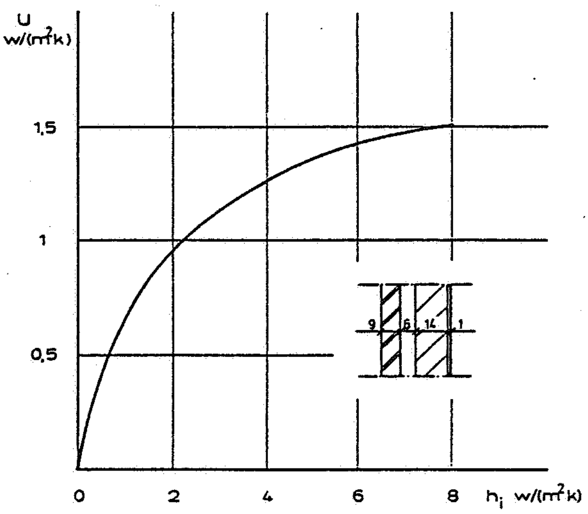

fig. 5: U-VALUE OF A NON-INCULATED CAVITY WALL AS FUNCTION OF THE INSIDE FILM COEFFICIENT h_i

4. THE WORK IN THE ANNEX

4.1 Principles and scope

From the start, the principles backing the international cooperative effort, called Annex 14, were:

not - to set up basic work in the field of the biology of mould;
- to develop new overall calculation models on the heat-air-moisture transfer in buildings, introducing as boundary conditions the avoidance of mould;
- to streamline and push all national programs on mould, surface condensation and moisture transfer in a well defined direction, with the danger of killing much creative and fundamental research,

but - to gather as much as possible existing information: mould, material properties, case studies a.o.
- to apply the knowledge on heat- air- and moisture transport on the complex phenomenon of mould and surface condensation, with the specific aim of broadening the understandings of the static and dynamic physical context. This may include limited modelling;
- to develop a common experience by exchanging information, running case studies and performing common exercises;
- to inspire national research.

Scope is to produce a source book on mould, surface condensation and energy, including data on mould and materials, the physics involved, case studies and performance formulations for practice.

4.2 Organisation

The work was structured in 3 major parts:

- gathering data;
- studying models and confronting them with case studies;
- search for solutions

These 3 parts were split in 9 steps, each of them being the responsibility of one, two or all participating countries:

Table 2

STEPS		NL	FRG	UK	I	B
DATA	1. material properties					■
	2. mould			■		
MODELS	3. thermal aspects		■		■	
	4. hygric aspects					■
	5. combined heat-air-moisture	■				
	6. boundary conditions		■			
CASE STUDIES	7. monitored case studies	■	■	■	■	■
	8. common exercises	■	■	■	■	■
SOLUTIONS	9. practice	■	■	■	■	■
	practice source book					■

Being in charge of a step included

- taking the initiative of gathering information;
- drafting that part of the final report.

The cooperation was materialised in working meetings.

The first 3-days meetings had a more scientific aim, promoting an exchange of past research and case studies, focusing on a specific key-note address, creating time to present fresh papers and presenting progress reports on the case studies.
The last ones were more concerned with the joint project, discussing the results of the common exercises, reading the drafts of the specific chapters of the final source book, and looking to practice.
Place, date and major topic of the meetings:

PAST

Utrecht, NL,	6-7 apr 87	take of state of the art in the 5 countries

		elaboration of the working scheme of table 2
Stuttgart, FRG,	12-14 oct 87	case studies
Glasgow, UK,	11-13 apr 88	mould analyses
Torino, I,	17-19 oct 88	modelling 1 first common exercise
Leuven, B,	8-10 may 89	modelling 2 second common exercise first drafts of the source book
FUTURE		
Den Haag, NL,	23-25 oct 89	case studies: final reports second drafts of the source book practice
?		
Rotterdam, NL,	3-6 sept 90	international CIB-symposium Energy, moisture, climate Presentation of the source book

5. PRELIMINARY RESULTS

5.1 Material properties (B)

Array of properties

All physical properties of materials, of importance in mould and surface condensation analysis, have been putted in an array code, referring to the fundamental difference between capacitive properties, transfer properties, combined properties with a specific physical meaning and properties, being a consequence of..:table 3
This array is far more complete than the lists, found in national codes or standards.
For each property, also the influencing material linked and environmental parameters have been defined and brought together.

Table 3

	1.CAPACITIVE	2.TRANSFER	3.COMBINED	4.CONSEQUENCE
T. THERMAL				
H. HYGRIC				
A. AIR				

f.e. T.2. thermal conductivity
H.1. hygroscopic curve, capillar moisture content...
A.2. air permeance...

data

Most numerical values were measured at the labs, involved in the annex or are taken from literature.

catalogue

The catalogue proposes calculation values. These coincide, if enough data available, with the 5 or 95% limit of the measured values. Otherwise, the few results are averaged or standard list information is used. If known, parametric relations between the property and the most important influencing parameters are also given.

5.2 Mould (UK, NL, B, FRG)

- the number of mould species is enormous and their biology, with the germination, linear growth and sporulation phases, rather complicated. Nevertheless, as far as building mould problems are concerned, it seems reasonable to focus on aspergillus, penicillium and cladosporium and their germination conditions;

- as part of these conditions, temperature and free water activity (= RH) are of mayor importance. They are interrelated in that sense that a lower or too high temperature asks for a higher RH, with the optimal combination (lowest RH) around 25 degC;

- most experimental data on germination and growth rates are gained from cultivation on special substrates. The resulting 'temp.-RH'-couples seem too pessimistic for use as design values for mould germination on finishing layers present in buildings;

- a realistic 'temp-RH'- formula could be:

$$RH = 5.3E\text{-}2 * T^{\wedge}2 - 2.7 * T + 113 \quad (\%)$$

or

$$a = 5.3E\text{-}4 * T^{\wedge}2 - 2.7E\text{-}2 * T + 1.13$$

Against a wall, RH is the local relative humidity value and T the wall's surface temperature.

This result strengthens the fact that mould germination is a moderate cold, wet weather problem (autumn, springtime)

5.3 Modelling

THERMAL ASPECTS (NL, FRG, I, B)

- with the software available on the market, calculating the temperature field in and heat flow densities in and through thermal bridges is no longer a problem. Nevertheless, the result depends strongly on subtile section specification differences and on the thermal conductivity values used, but, especially and by far the most on the inside surface film coefficient;
- the choice of a representative couple 'surface film coefficient -reference temperature' remains a difficult question.
  In fact, surface heat transfer is the result of joined convection and radiation. Convection is linked to the local air temperature, radiation to the so called radiative temperature of the surroundings, as seen by the surface involved. Both differ from point to point, and, in non steady state, from moment to moment.

  In energy calculations, so called overall mean standard values

  f.e. vertical surfaces : hi= 8 W/(m2K)
  horizontal surfaces, : hi= 6 W/(m2K)

  have been introduced, linked to the air or the comfort temperature. There, that seems a reasonable way of handling the problem.

  To predict mould and surface condensation, they are useless. In fact, here, we have to know the correct local values.

  The problem can be solved:
  or by calculating for each case as precise as possible the surface heat transfer using the theory of convection and radiation Calculations in that sense have been performed by Belgium;
  or by accepting a so called reference temperature and searching design values of hi for critical situations (by calculation or measurement).

Until now,different methodologies for the last possibility have been proposed. All show, independent of the choice of the reference temperature, surface film coefficients, much lower then 8 W/(m2K), to a great amount influenced by the number of outside walls (the more, the lower hi) and decreasing with a better insulation.
The Netherlands go as low as 2 W/(m2K) for outside wall surfaces, against which cupboards could be postioned.

At least one guess remains: the value of the convective surface film coefficient.

HYGRIC ASPECTS (NL, FRG, B)

The most important achievement here is a better understanding of the hygroscopic influences. This has been realised by measurements and calculations:

- hygroscopicity dampens and shifts the inside RH- fluctuations. On daily basis, only the first mm of all inside surfaces are active (t.m. the wallpaper and a thin layer of plaster). On yearly basis, the whole envelope has some influence;

- furniture, books, draperies, carpets have a mayor influence on the hygroscopic inertia. Indeed, they often or always are made of very hygroscopic materials and have a very high specific surface in contact with the air;

- because of the hygroscopic inertia, the RH against a surface becomes to some extend uncoupled from the vapour pressure in the room and from the surface temperature. In fact, it turns to be more dependant from the surface materials RH, self coupled to the surface layers hygroscopic moisture content.
  This results in a non response to short RH-peaks in the air and may explain why, as long as no surface condensation exists, these don't cause mould problems.

- hygroscopic inertia also strongly reduces the positive effect of peak ventilation, except if this coincides with peaks in moisture production. Otherwise, as soon as the ventilation stops, the inside RH returns to his pre-peak level...

- hygroscopic moistening of wall paper goes on 2 to 3 times quicker then hygroscopic drying. Once moist, a surface seems to persist in being moist. This experimental fact sustains the opinion that the real important thing is to maintain a mean relative humidity, low enough to avoid mould germination!

· HEAT-AIR-MOISTURE TRANSFER (NL, B)

Apart of a detailed study on the air-moisture balance in a single and multiple zone situation with ideal zonal mixing, experimental

work on the spread of vapour,produced locally, in a room, between rooms and in dwellings has been performed.
The development of a vapour front clearly reflects the convective air circulation and exchanges: in a room from the bottom up to the ceiling and back to the floor, between rooms from downstairs to upstairs locations.

BOUNDARY CONDITIONS (FRG)

Information has been gathered and ordered on:

- vapour production in dwellings;
- climatic data;
- ventilation rates;
- heating habits.

5.4 Case studies, common exercises

CASE STUDIES

As case studies have run/ are running:

COUNTRY	CASE	SPECIFIC ELEMENTS
B	Zolder	miners estate, build shortly after world war 2, retrofitted in the early eighties. Since,very severe mould problems. Causes: poor ventilation possibilities,ruinous thermal design Monitoring before and after remedial treatment (air dryers, ventilation system, in- and outside insulation, loft space insulation (or, or)) Monitoring results used as input for the first common exercise.
NL	Pijnacker case	end of a row one-family dwelling Insulated, but, with thermal bridges left. Moderate mould growth. The monitoring gave no conclusive information on the cause of the mould presence. It seemed as if past circumstances were responsible..
	Alexander Polder	appartment block, not insulated. Diffuse mould growth in a first floor flat. The monitoring gave no conclusive information on the cause of the mould presence. It seemed as if past

		circumstances were responsible.. The case generated a discussion on the monitoring difficulties. It was used as input for the second common exercise.
I	Leuman villagge	brick made flathouses, build 1896-1925, retrofitted 1978-1980. Severe moisture and mould problems The monitoring revealed wet basement walls (t.m. extra moisture production) and a poor ventilation.
	IACP-building	a 10-storied flat building, not insulated, single glazed. Widespread mould problems. The monitoring revealed as causes a poor ventilation and thermal bridging
U.K.	Edingburg	large scale investigation on the relation between damp houses and lower respiratory symptoms in children, living in these. Confusing results in the sense that a parents survey gave a strong relation but a monitoring campaign a less convincing relation.

COMMON EXERCISES

- the first common exercise was focused on calculated predictions of mould and surface condensation situations, using the Zolder case study as input.
  The results revealed a widespread ability of handling the problems but major differences in the quantitative aspects. Causes have to be sought in material property values, in the use of other film coefficient values, in the sophistication of the models a.o.;

- the second common exercise looked to the diagnostic abilities. Starting point was the Alexander Polder case study,a damage exemple without clear cut cause. This was reflected in the diagnostics offered, some being a too slavish application of national codes, others really focusing on the specific case. Perhaps the most important result was the commonly accepted conclusion that mould growth may have two distinct causes:

  . a long lasting too high relative humidity on a surface (cfr the a-value);
  . short periods of surface condensation, alternating with dry-

ing in such a frequency, that the wetted surface remains wet enough to unable mould germination.

6. REFERENCES AND LITERATURE

1. WTCB/CSTC Enquete 5000
   Results, discussed at the Den Haag meeting

2. Oral information

3. Oral information

4. Tammes E., Vos B.H., vochttransport in bouwconstructies,
   Kluwer Technische boeken NV, Deventer-Antwerpen 1980

5. Hens H., Bouwfysica 2, Warmte en Vocht, praktische problemen
   en toepassingen, Acco, Leuven 1982

6. List of IEA-Annex 14 reports: see add. 1

7. ACKNOWLEDGMENT

This interesting international cooperation on condensation and energy has been possible thanks to the enthousiasm, knowledge and experience of:

I	Politecnico di Torino Dipartimento di Energetica	prof. C. Lombardi
FRG	Fraunhofer Institut fuer Bauphysik, Stuttgart	dipl.ing. H. Erhorn
	Dornier Systeme gmbh	
UK	BRE, Scottish Laboratory	dr C. Sanders
NL	Rijksgebouwendienst	ir. P. Van der Laan
B	KULeuven, Laboratorium Bouwfysica	ir. E. Senave
	Physibel adviesbureau	

IEA ANNEX XIV
CONDENSATION AND ENERGY

LIST OF IEA - ANNEX XIV REPORTS update: 01/06/89

1. Material properties

B-T1-01/1988 : Material Properties: first text proposal
B-T2-02/1988 : Material Properties: additions to the first text proposal

2. Mould

NL-T2-04/1988 : Summary of mould research
B-T2-05/1988 : Summary of mould research
UK-T2-06/1988 : Summary and bibliography of UK research on conditions for growth of moulds and control strategies
UK-T2-07/1989 : Mould: First text proposal

3. Thermal modelling

B-T3-01/1988 : Combined conduction-convection-radiation in a room
D-T3-02/1988 : Basic discussion text topic 3.2
D-T3-03/1988 : Wärme und Feuchteübergangskoeffizienten in Außenwand ecken von wohn bauten
B-T3-04/1989 : Combined conduction-convection-radiation in a room Final Report
D-T3-05/1989 : First text proposal topic 3.2
I-T3-06/1989 : First Text Proposal topic 3.1
NL-T3-07/1989 : Surface Heat Transfer Coefficients - related to calculation systems and measurements

4. Hygric modelling

B-T4-01/1988 : First text proposal: Modelling: some hygric aspects
NL-T4-02/1988 : A Second Order Model for the Prediction of Indoor Air Humidity
B-T4-03/1989 : Second text proposal

5. HMA modelling

NL-T5-01/1988 : Vapour distribution in dwellings
D-T5-02/1988 : Building energy and hygric analysis simulation model (BEHAS)
NL-T5-03/1988 : Inventory of models for intra and interroom moisture transfer
NL-T5-04/1989 : Extended Content Proposal
NL-T5-05/1989 : Inventory of models for the distribution of water vapour in buildings: Final Report.

6. Boundary conditions

D-T6-01/1988 : Basic Discussion text
D-T6-02/1989 : First text proposal

7. Case studies

B-T7-01/1987 : Generalities
B-T7-02/1987 : Review of 3 previous case studies
D-T7-06/1987 : Review of previous case studies
UK-T7-07/1987 : Review of previous case studies
UK-T7-08/1987 : Questionnaire forms
B-T7-09/1987 : First results of the Zolder case study
B-T7-15/1988 : Subsequent results of the case study at Zolder
B-T7-16/1988 : Mould research in Zolder
NL-T7-17/1988 : Case study Pijnacker TNO/IBBC
NL-T7-18/1988 : Case study Cauberg Huygen
I-T7-19/1988 : Case study 1: Leumann Village
I-T7-20/1988 : Case study 2: IACP Torino
UK-T7-21/1988 : UK case study: first report
NL-T7-22/1988 : Review of previous case studies
NL-T7-23/1988 : Case Study Pijnacker: 2nd report
NL-T7-24/1988 : Mould and surface condensation in Dutch dwellings, a case study (Cauberg-Huygen): Final Report
NL-T7-25/1988 : Study of methods for measuring atmospheric humidity
D-T7-26/1988 : Case study of mould growth in a bathroom
I-T7-27/1988 : Case study 2: IAPC Building: thermal bridges
UK-T7-28/1988 : UK case study: second report
B-T7-29/1988 : Case Study Zolder: Planned measurements and measures
UK-T7-30/1988 : Zolder, condensation case study
NL-T7-31/1988 : Working Paper Case Studies
► NL-T7-32/1989 : Case Study Pijnacker: Investigation on the causes of moisture and mould problems: Final Report
NL-T7-33/1989 : Case Study Alexanderpolder: Final Report

8. Organisation

B-OR-01/1987 : distribution/classification system
B-OR-02/1987 : list of standard symbols
B-OR-03/1988 : working paper for the Glasgow Meeting
B-OR-04/1988 : First integration exercise
NL-OR-05/1988 : Annual report 1987
NL-OR-06/1988 : Projectdescriptions / Reporting format
B-OR-09/1988 : Working paper for the Torino Meeting
I-OR-10/1988 : Solution for the first integration exercise
B-OR-11/1988 : Solution for the first integration exercise
NL-OR-12/1988 : Solution for the first integration exercise
UK-OR-14/1988 : Solution for the first integration exercise
NL-OR-15/1988 : Second Integration Exercise
B-OR-16/1988 : Project desciptions : International : First Report
B-OR-17/1988 : Results of the first integration exercise
NL-OR-18/1989 : Dutch Project Descriptions: Second report
B-OR-19/1989 : Solution for the second integration exercise
NL-OR-20/1989 : Solution for the second integration exercise
D-OR-21/1989 : Solution for the second integration exercise
I-OR-22/1989 : Solution for the second integration exercise
UK-OR-23/1989 : Solution for the second integration exercise
NL-OR-24/1989 : Results of the second integration exercise
B-OR-25/1989 : Project desciptions : International : Second Report
NL-OR-26/1989 : Description of Annex XIV database : concept
D-OR-25/1989 : German Contribution to the Leuven Meeting (*)

9. Proceedings

NL-PR-01/1987 : Utrecht T.O.-meeting (6-7 April 1987)
B-PR-02/1987 : Stuttgart meeting (12-14 October 1987)
B-PR-03/1988 : UK meeting (11-13 April 1988)
B-PR-04/1988 : Torino meeting (17-19 October 1988)
B-PR-05/1989 : Leuven meeting (8-10 may 1889)

(*) Out of this report (handed at the Leuven meeting) we distillated 2 other reports:
D-T3-05/1989 : First text proposal topic 3.2
D-T6-02/1989 : First text proposal