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INTERNATIONAL ENERGY AGENCY
Energy Conservation in Buildings and Community Systems
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IEA ANNEX 24: Heat, Air and Moisture Transfer through new and retrofitted Insulated Envelope Parts (Hamtie)

TECHNICAL REPORT

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1. BACKGROUND

One of the important means to realise energy conservation in the build environment is: thermal insulation. In many countries, compulsory directives exist introducing a minimum insulation quality for new and retrofitted constructions. Because of the permanent constraint in the industrialised world to lower the use of non-renewable energy sources and in view of the expected greenhouse effect, caused by excessive consumption of coal, fuel and gass, a further upgrading of the insulation standards may be expected or is under way.

However, the real thermal quality of highly insulated envelope parts is not straight forward. In fact, the lower the U-value, the more important secundary effects as enthalpy transfer, latent heat flow.. etc. These effects are to a large extend coupled to the combined Heat-Air-Moisture (HAM) transfer in the envelope parts and not taken into account in the traditional U-value definition and evaluation.

HAM also fixes the hygric behaviour of the envelope parts and influences the durability.

In spite of its importance, the way HAM is introduced in design, consultancy and envelope part development is still poor, most knowledge staying at laboratory level, without translation into users friendly tools, sound performance rules and good codes of practice. This was confirmed by an enquiry in 10 IEA-countries at the start of the new Annex 24.

However, in the laboratories, remarkable developments in material property description and testing, in modelling and in building part testing are underway. The results introduce new design rationales for highly insulated walls, flat roofs, pitched roofs and floors, combining an optimal thermal insulation with a correct hygric performance and good durability.

The Annex has therefore as first and overall motivation to intensify these developments and the dissemination of the results through a broad international cooperation.

2. ANNEX OBJECTIVES AND STRUCTURE

The general objectives of the Annex are to model and study in a fundamental way the physical phenomena behind and the consequences of Heat-Air-Moisture transfer through new and retrofitted, well insulated envelope parts. As agreed during the take off meeting in Paris (9th-11th April 1991), well insulated in the frame of the Annex means:

$$U_{\underline{norm}} < 0.3\ W/(m^2.K)$$

A special emphasis is put on the energetical quality in dependance of the air tighness, on the hygric behaviour and on the durability. The knowledge gained will be applied on performance formulation and checking, on design and in the production of new and retrofitted parts and buildings.

To reach the objectives, simulation tools must be developed and evaluated, the environmental conditions analysed , material and layer properties gathered and measured, HAM experiments on envelope parts done and performance rules and checks for the design of new and retrofitted, highly insulated, hygrically sound, durable envelope parts produced.

The Annex therefore is structured in 5 tasks:

- Task 1: algorithm and model development
- Task 2: environmental conditions
- Task 3: material properties
- Task 4: experimental verification
- Task 5: performances and practice.

2. FIRST ANNEX RESULTS

2.1 Task 1: Modelling (leading country: Belgium)

An enquiry is finished on existing models. On october,15, 1991, information on 19 models was received.

Overview:

	COUNTRY	INSTITUTE	MODEL NAME	TYPE of TRANSFER
1.	Belgium	KU-Leuven.LB	Wand	Heat+Moisture
2.	Belgium	KU-Leuven.LB	Konvek	Heat+Air+Moisture
3.	Belgium	Physibel	Glasta	Heat+Moisture
4.	Canada	University of Saskatchewan	HAMPI	Heat+Moisture
5.	Canada	CMHC	WAllDRY	Heat+Air+Moisture
6.	Canada	CMHC	WALLFEM	Heat+Air+Moisture
7.	Canada	TROW-CMHC	EMPTEDD	Heat+Air+Moisture
8.	Denmark	TU-Denmark Therm. Insul. Lab.	MATCH	Heat+Moisture
9.	Finland	VTT-Lab. of Heating and Ventilation	TRATMO2	Heat+Air+Moisture
10.	Finland	VTT-Lab. of Heating and Ventilation	TCCC2D	Heat+Air+Moisture
11.	France	INSA Dep Genie-Civil Toulouse	LTMB	Heat+Moisture
12.	France	Institut de Méca-nique des fluides Toulouse	CHEoH	Heat+Moisture
13	France	idem	TONY	Heat+Moisture
14.	Germany	Fraunhofer Institut für Bauphysik	WFTK	Heat+Moisture
15.	Germany	idem	WUFIZ	Heat+Moisture
16.	Germany	TU-Cottbus Fachber. Physik+Werk-stoffe	JOKE	Heat+Moisture
17.	Germany	TU-Cottbus Fachber. Physik+Werk-stoffe	COND	Heat+Moisture
18.	Netherlands	TNO-Bouw, afdeling BBI	HYGRO	Heat+Moisture
19.	UK	BRE Scottish Laboratory	BRECON 2	Heat+Moisture

At the Zürich meeting (oct 23-25 1991), 2 others were added.

A first classification in order of complexity gives 6 types of models:

TYPE 1
Simple or simplified models, inspired by the steady state Glasers scheme, with as only link between the thermal and hygric part the p'(T) equation of state:

1.	Belgium	KU-Leuven,LB	Wand
3.	Belgium	Physibel	Glasta
18.	Netherlands	TNO-Bouw, afdeling BBI	HYGRO
19.	UK	BRE Scottish Laboratory	BRECON 2

TYPE 2
Non steady state models, taking into account heat and vapour transfer, with as link between the thermal and hygric part the p'(T)-equation of state, the latent heat transfer and the moisture dependance of properties:

4.	Canada	University of Saskatchewan	HAMPI
17.	Germany	TU-Cottbus Fachber. Physik+Werk-stoffe	COND

TYPE 3
Non steady state models, taking into account heat, vapour and liquid transfer, with as link between the thermal and hygric part the p'(T)-equation of state, the latent heat transfer and the moisture dependance of properties

8.	Denmark	TU-Denmark Therm. Insul. Lab.	MATCH
11.	France	INSA Dep Genie-Civil Toulouse	LTMB
12.	France	Institut de Méca-nique des fluides Toulouse	CHEoH
13	France	Institut de Méca-nique des fluides Toulouse	TONY
14.	Germany	Fraunhofer Institut für Bauphysik	WFTK
15.	Germany	Fraunhofer Institut	WUFIZ

		für Bauphysik	
16.	Germany	TU-Cottbus Fachber. Physik+Werkstoffe	JOKE

TYPE 4

Steady state models, taking into account heat, vapour and air transfer with as link between the thermal, hygric and air part the p'(T)-equation of state, the latent heat and the enthalpy transfer

2.	Belgium	KU-Leuven,LB	Konvek
7.	Canada	TROW-CMHC	EMPTEDD

TYPE 5

Non steady state models, taking into account heat, vapour and air transfer with as link between the thermal, hygric and air part the p'(T)-equation of state, the latent heat and the enthalpy transfer

5.	Canada	CMHC	WAllDRY
10.	Finland	VTT-Lab. of Heating and Ventilation	TCCC2D

TYPE 6

Non steady state models,taking into account heat, vapour, liquid and air transfer with as link between the thermal, hygric and air part the p'(T)-equation of state and the latent heat and the enthalpy transfer

6.	Canada	CMHC	WALLFEM
9.	Finland	VTT-Lab. of Heating and Ventilation	TRATMO2

A net fact in the classification scheme is that models including the whole complexity of HAM are more common in countries with a timberframed wall tradition than in countries with a stony wall tradition. Other remarks are:

- Most models are developed to simulate the hygric behaviour, not the Heat-AM- behaviour. To fit them in the Annex, the thermal output must be updated;

- most models are research tools, easy to use for the researcher who developed the model, difficult to use for third parties. Only 2 of the 19

3.	Belgium	Physibel	Glasta
8.	Denmark	TU-Denmark Therm. Insul. Lab.	MATCH

are already available on a commercial basis, that means, are sold to interested users, and one is in a final phase for commercialisation:

19.	UK	BRE Scottish Laboratory	BRECON 2

In task 1, also interesting discussion papers were introduced, one of them being the report by M. Hagentoft of Sweden, given as add 1. This report introduces a first guess of the thermal importance of enthalpy and latent heat flow.