IMPACT ON THE FORMATION OF MOLD IN THE PERIOD OF SUMMER, THAT INDICATES CHANGE IN EXISTING HOUSING ACH. CLIMATE ZONE D1

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ABSTRACT

The north of the Iberian Peninsula is characterized by a high level of humidity during the summer. In this climate zone ventilation plays an important role in exercising control over the indoor humidity level of housing and limits the possible formation of surface condensation.

In this article we try to study on a house, the impact that the substitution of a ventilation profile for the summer period set in DB HE 1, 2013 for a constant ventilation profile fulfilling the statutory requirement under the current Hygiene, Health and Environment, Air Quality, DB HS-3, can have on the risk of formation of surface condensations.

The study is set in the climate zone of a coastal province capital with mild summers (zone D1).

KEYWORDS

Ventilation, indoor humidity, condensation.

1 JUSTIFICATION

The Spanish Energy Saving rules, Energy economy and heat retention Document DB HE 2013 climate zone is defined as follows: the area for which the common purpose of calculating the energy demand external stresses are defined. It is identified by a letter, from A to E, corresponding to the severity of winter climate; and a number from 1 to 4, to characterize the severity of summer climate.

The summer period is considered between the months from June to September inclusive; while it is considering winter period, the time between the months from October to May.

In humid climates with mild summers, as may be the area D1, hygrothermal conditions inside the home are highly influenced by external environmental conditions. For these areas, the varying levels of ventilation can cause significant changes in the hygrothermal conditions and therefore, the modification of comfort conditions and the impact on the possible formation of surface condensation.

2 METHODOLOGY

For the study a software tool has been developed. This tool allows scheduling an hourly energy balance, playing indoor temperature and humidity conditions for certain weather conditions.

For outdoor climatic conditions, meteorological climates of the capitals of reference published by the Ministry of Industry, Energy and Tourism of Spain (http://www.minetur.gob.es) have been considered.

To determine the indoor humidity, the criteria set out in the Supporting Document, check limitations of surface and interstitial in the enclosures condensation (DB-HE DA / 2) have been followed.

The climatic zone selected for the study is the area D1, having been regarded as the capital of reference, the city of San Sebastián.

An existing single-family dwelling with unfavorable north orientation has been used as a building type. A value of 0.27 kg / h, has been considered as internal conditions of vapor formation.

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In the study two profiles ventilation for the summer period (June-September) are contrasted:

Profile 1: it is the established by the DB HE 2013. It consists in: 4 ACH for the hours between 01:00 h and 08:00 A.M, while a constant ventilation equal to minimum required by the Hygiene, health and the environment, Air Quality Document DB HS-3 of the Building Cod is maintained for the remaining hours of the day.

Profile 2: A constant ventilation level is introduced throughout the day, according to the requirements set in Document DB HS-3.

Once the model has been introduced in the computer tool, the interior temperature and humidity time are obtained and the results are compared.

For the specific case of the building being studied, for verification of surface condensation limiting the number of hours that within the relative humidity is above 80% is taken into account.

3 NORMATIVE CRITERIA

The Building Code establishes, in the current Energy economy and heat retention Document 2013, that the risks related to processes that produce a significant reduction on the thermal performance or elements of the thermal envelope life, have to be limited, such as condensation. While interstitial condensation affect the thermal behavior of the enclosure, surface condensation essentially represent a risk in relation to health, by the formation of mold, and its demand is reflected in the DB HS-3.

The criteria to limit the formation of surface condensation are set out in the Supporting Document to the DB-HE: Limiting testing surface and interstitial condensation in the walls, DA DB-HE / 2:

In that document it is stated that the formation of surface condensation in the walls and interior partitions that make up the thermal envelope of the building, will be limited, so as to avoid the appearance of mold on its inner surface. Therefore, in wall inner surfaces that can absorb water or those susceptible to degradation, especially in thermal bridges thereof, the monthly average relative humidity will be less than 80%.

4 BUILDING DATA

The building considered in the study is an existing single-family building with a net surface of 79.5 m^2, total height from flooring to ceiling is 2.7 m. The volume of the building is a parallelepiped, facing north.

The building has two double bedrooms, one single bedroom, a living room, a kitchen and two bathrooms.

The ventilation level obtained according to the criteria of the current Document DB HS-3 is 0.8 ACH (47 l/s).

The construction characteristics of the building are those defined in Table 1:

Table 1. Composition of building's envelope

	Composition	**Width (m)**	**Conductivity (W/m·K)**
Façade walls	Solid brick wall	0.115	0.991
	Cement mortar render	0.015	0.55
	Not ventilated cavity	0.05	-
	Rockwool insulation board	0.06	0.031
	Gypsum board	0.01	0.25
Roof	Gravel layer	0.15	2.00

	XPS insulation board	0.06	0.034
	Felt	0.005	0.05
	Waterproofing membrane	0.005	0.23
	Lightweight mortar	0.10	0.41
	Ceramic pot and beam slab	0.30	-
	Unventilated air space	0.01	0.15
	Gypsum board suspended ceiling	0,01	0.25
Suelo	Ceramic tiles	0.02	1.00
	Cement mortar render	0.03	0.55
	EPS insulation board	0.04	0.029
	Reinforced concrete	0.20	2.30
	Gravel layer	0.20	2.00

5 RESULTS

The results that were obtained from temperature, indoor humidity and increased vapor pressure, for one month, in this case August, are the following:

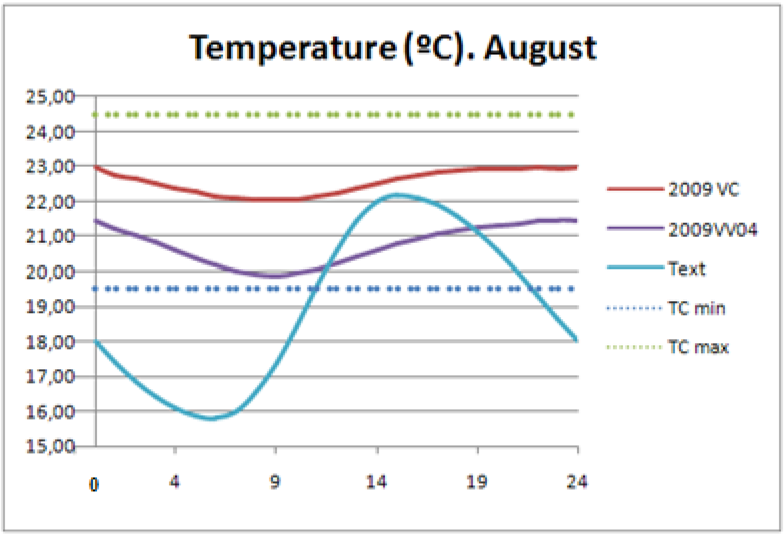

Figure 1.1. Indoor and outdoor temperature conditions.

In the graph of Figure 1.1, it can be observed that for the case in which a constant ventilation profile 2, (2009 VC, red line), is used, the temperature inside the module housing is higher. In both cases they are within the comfort range.

Where,

2009 VC, red line;	Indoor temperature conditions corresponding to profile 2.
2009 VV04, purple line;	Indoor temperature conditions corresponding to profile 1.
Text, blue line;	Outdoor temperature.
TC min, dot line green;	Minimum comfort temperature.
TC max, dot line blue;	Maximun comfort temperature.

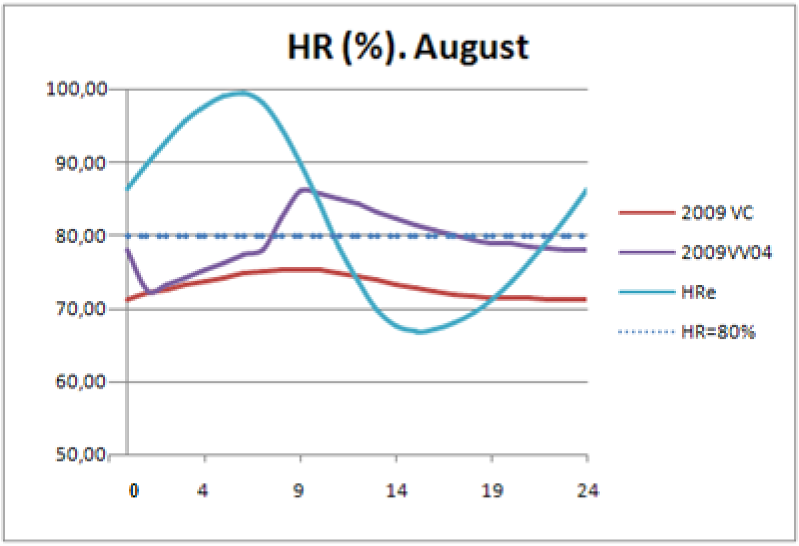

Figure 1.2. Indoor and outdoor relative humidity conditions.

In the graph of relative humidity of Figure 1.2, it is seen how with the profile 1, the indoor relative humidity is over 80% relative humidity, during a certain number of hours.

Where,

2009 VC, red line;	Indoor relative humidity conditions corresponding to profile 2.
2009 VV04, purple line;	Indoor relative humidity conditions corresponding to profile 1.
HRe, blue line;	Outdoor relative humidity conditions.
HR=80%, dark blue line dot;	Limit line to indoor relative humidity conditions.

6 CONCLUSIONS

General conclusions are the following:

- In the provincial capital studied, San Sebastián, belonging to the climate zone D1, for the summer period considered, using a constant ventilation throughout the day (profile 2) limits the risk of formation of surface condensation than profile 1.

- Both profiles considered are out of the comfort range, considered for the indoor relative humidity.

7 REFERENCES

*Código Técnico de la Edificación (*Building Code*).Ministerio de Fomento*. On line. http://www.codigotecnico.org/web/recursos/documentos/ [Consulted 18/06/2015].

Gavira, M., Linares, P. et al (2005). Comportamiento higrotérmico de la envolvente del edificio según el CTE. Soluciones alternativas: sistemas de ventilación por caudal variable *(Hygrothermal behaviour of the building envelope according to CTE. Alternative solutions: variable flow ventilation systems)*. I Jornadas de investigación, 2, 739-756.

Patologías asociadas a la rehabilitación energética: comportamiento higrotérmico *(Pathologies associated with energy rehabilitation: hygrothermal behavior)*. LARRUMBIDE

GÓMEZ-RUBIERA, Enrique. Revista Conarquitectura de Hispalyt, número 53/marzo 2015, Páginas 76 a 81. Depósito legal: M-14395-2001. ISSN: 1578-0201. http://www.hispalyt.es

La problemática de las condensaciones intersticiales en la rehabilitación energética y su aplicación en el DB HE 2013 para las diferentes zonas climáticas peninsulares *(The problem of interstitial condensation in energy rehabilitation and it's application in the DB HE 2013 for different climate zones peninsular)*. Jornadas Internacionales conmemorativas del 80 aniversario del IETcc. Conservar, rehabilitar, innovar. IETcc-CSIC, noviembre de 2014. LARRUMBIDE GÓMEZ-RUBIERA, Enrique; GAVIRA GALOCHA, et al. Libro ponencias: ISBN: ISBN: 978-84-7292-381-2. CD: ISBN: 978-84-7292-382-9. Págs: 10.

Patologías Asociadas a la Rehabilitación Energética *(Energy associated pathologies Rehabilitation)*. Curso de Especialización del CSIC Evaluación, Intervención y Mantenimiento de Edificios y Estructuras. Cursos Avanzados Eduardo Torroja. Seminario 11: La Habitabilidad en el CTE: Novedades y Aplicación a Edificios Existentes. Junio de 2013, IETcc-CSIC. LARRUMBIDE GÓMEZ-RUBIERA, Enrique; Libro ponencias: Págs: 127-126. ISBN: 978-84-7292-414-7.

La problemática de las condensaciones en las islas Canarias, referidas a edificios existentes *(The problem of condensation in the Canary Islands, referred to existing buildings)*. Jornadas Internacionales de Investigación en Construcción: Vivienda, pasado, presente y futuro. IETCC-CSIC, noviembre de 2013. LARRUMBIDE GÓMEZ-RUBIERA, Enrique; et al. Libro resúmenes ISBN: 978-84-7292-421-5. CD ISBN: 978-84-7292-422-2. Págs: 7.

Clima Alfa: una nueva zona climática de invierno para las Islas Canarias *(Climate Alpha: a new Winter climate zone for the Canary Islands)*. Jornadas Internacionales de Investigación en Construcción: Vivienda, pasado, presente y futuro. Junio de 2013, IETcc-CSIC. LARRUMBIDE GÓMEZ-RUBIERA, Enrique; et al. Libro resúmenes ISBN: 978-84-7292-421-5. CD ISBN: 978-84-7292-422-2.

Patologías de Humedad por Condensación Intersticial *(Moisture conditions for interstitial condensation)*. Curso de Sostenibilidad: Eficiencia Energética, Evaluación de Edificios y Estructuras. S5E. Seminario 9: Intervención en Edificios Existentes. Criterios de Seguridad y Habitabilidad. IETcc-CISDEM-CSIC, junio de 2012. SÁNCHEZ RAMOS, Virginia; MARTÍN CONSUEGRA, Fernando; LARRUMBIDE GÓMEZ-RUBIERA, Enrique. Libro de ponencias: Pág: 65-72. ISBN: 978-84-695-3612-4. Págs: 8.

Orden FOM/1635/2013, de 10 de septiembre, por la que se actualiza el Documento Básico DB-HE «Ahorro de Energía», del Código Técnico de la Edificación, aprobado por Real Decreto 314/2006, de 17 de marzo.

Documento de Apoyo al Documento Básico DB-HE Ahorro de Energía (DA DB-HE/2), Comprobación de limitación de condensaciones superficiales e intersticiales en los cerramientos. 2013. Ministerio de Fomento.