Chapter 8
Conclusions

The problem of the proliferation of microorganisms in buildings has a profound effect on the lifestyle of the people, with health, economic and social consequences.

These organisms populate for a very long time on the buildings envelope and indoors. However, their presence has recently been exacerbated by contemporary way of constructing buildings that are directed toward a Nearly Zero Energy standard. In fact, the need to reduce energy consumption and greenhouse gas emissions has actually led many countries to adopt legislation and strategies to improve the thermal performance of buildings, mainly by reducing the thermal transmittance and air permeability of the envelope. This “sealing action” aims to minimize air leaks and consequent heat dispersions as much as possible.

The air tightness of the internal environment, if not properly managed with ventilation equipment, may lead to high internal moisture load and consequent surface condensation. A very thick insulation material on the exterior side of the envelope is more subject to exterior undercooling phenomena and consequent condensation. Moisture loads and surface condensations are the most favourable conditions for the proliferation of microorganisms, such as algae and fungi.

Consequently, despite improvement in building energy efficiency and better quality requirements for living spaces, over the last few decades the number of reports on the presence of microorganisms on building facades and indoors is still increasing.

As a result, the aesthetic quality and durability of buildings could be seriously impaired. Algae and mould on facades contribute to the defacement of paint and finishes. Mould growth indoors could become responsible for several types of illnesses and pathologies experienced by building occupants. These illnesses and pathologies are grouped under the name of “Sick Building Syndrome”.

In order to preserve buildings from the colonization of microorganisms, it is of primary importance that we have a better understanding of the principal proliferating organisms and of their main growth conditions. Moreover, there is a growing demand for calculation methods in building engineering to assess the moisture behaviour of building components and microorganism risk prediction in order to ensure a healthy environment, and to avoid material defacement, with social and economic consequences.

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Many building hygrothermal analysis methods are able to simulate the coupled transport processes of heat and moisture for one or multidimensional cases which aim to predict biological risks. Nevertheless, a more in-depth study of the growth of microorganisms under transient conditions is still required in order to be able to define the most reliable prediction model. Other further improvements could be to develop prediction models that include a spread in germination time and growth rate, a variation in material properties, moisture load, transfer coefficients and bad workmanship. To do so, additional measures in laboratory and on real buildings and components would be desirable.

Controlling and preventing the proliferation of microorganisms in buildings have become more pressing and important. Among traditional solutions, chemical treatments do not ensure long-term protection since they need re-application over time and are likely to be effective at the expense of durability and aesthetics of the substrate material. Among them, water repellents and biocides are commonly used, but nowadays it is important to control biodeterioration process with new environmentally friendly technologies.

The advantages of nanomaterials are that they can be fixed more effectively in the coating matrix, reducing their leaching out into the surrounding environment. Nevertheless, they are still at an early stage of research. The expected benefits have not been fully tested yet. Their potential health effects and ecological risk are also still not clear.

Other researches are looking towards safer and more sustainable strategies linked to a proper design, choice of materials and construction of buildings, aiming to obtain a good envelope performance without any added costs. Concerning interior finishing materials, "moisture buffering" is a very promising method which acts directly on substrates to dampen indoor humidity variations.

As regards external finishing materials, the potential of using infrared reflecting coatings and PCM to solve the exterior condensation problem, by reducing the night-time irradiation to the sky and enhancing the thermal storage capacity of the façade, looks encouraging.

In the future, all these strategies should be further investigated in order to replace chemical biocides and to improve the properties of materials. Their safety, effectiveness and sustainability are the key elements to be investigated for their real application, marketing and distribution.

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