CO2olBricks

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Ventilation, air conditioning, relevant questions

Summary of answers from a group of Finnish professionals

1. **Best indoor air conditions for users of various spaces of the building? Best indoor air conditions for building materials, paintings, decorations, possible old furniture and other objects?**
   How to compromise? What are technical possibilities to fulfil different needs?

   Requirements for indoor air conditions depend on the intended use of the space. Spaces for continuous indoor working need same conditions as similar spaces in new buildings – at least minimum level of ventilation and temperature requirements according to national building codes or relevant. Spaces for temporary heavier use like assembly halls, churches etc. can utilize the thermal mass, possible high indoor air volume and interval ventilation to reduce needed system capacity.

   Museums and buildings with valuable paintings etc. need controlled moisture conditions. International recommendations expect RH 50% ± 5%. That causes problems for many heritage buildings and in many cases additional humidification has not been installed to avoid risks for structures of the building. Compromising should be made in close cooperation between designers, art and conservation experts.
   In all cases the humidity level may not exceed 60% for longer periods to prevent mould growth.
   During the summer conditions temperature may rise to 26°C maximum.

   In order to control contaminants and moisture a proper level of ventilation is required also outside occupation hours and night time.

   Solutions of air distribution in rooms might be modest compared with modern possibilities if layout of working space allows avoiding of draft etc. For instance the air volume of neighbouring spaces can be utilized to allow lower ventilation volume in certain space.

   Use of existing or renewed natural ventilation should be possible in buildings or spaces with lower human intensity.

   In very valuable heritage buildings or spaces the requirements concerning antiquity values should remain as the first preference. So the possibilities to place different activities might be limited in these buildings.

2. **Condition survey of existing ventilation, air conditioning. What should we save? How to improve the effectiveness and energy efficiency of existing systems?**

   If activities in the building remain the same before and after renovation it is recommended to make a condition survey for the systems and make only necessary changes. Ventilation units, heat recovery and controls are in most cases subjects to renovation for better energy efficiency and indoor climate demand. Especially new electric motors give higher energy performance.

   It is possible to refurbish existing masonry or concrete ventilation ducts with new pipe liner technologies also fulfilling fire safety requirements. (Trade mark example: Furanflex composite solution). New inside ducting and ceramic coating are other alternatives. Designers should keep in mind that these solutions are not reversible.

   Heat recovery of natural ventilation is practically not possible. Mechanically assisted increasing of the natural ventilation air flow is not recommended in old buildings because of the risk of contaminants from leaking structures. If building envelope is sealed to get better tightness, the supply air flow should be guaranteed. Increased underpressure may cause contaminants.

   Existing cast iron air inlets and exhaust outlets are many times worth of to remain in use. Air regulating dampers may be necessary to be installed in the ducts. In younger heritage buildings also existing sheet metal ducts are mainly usable in renovation but existing practise is to neglect those leading to unnecessary use of raw materials. Cleaning of ducts is of course a must.

   There may be also heritage values of existing old HVAC systems and equipment. Some of these would deserve preservation. That has unfortunately been done in very few cases. Practical solutions to save old equipment may of course appear difficult.

3. **Principles of how to integrate modern ac to a heritage building. Should everything be hidden and not disturbing historic atmosphere? Is it better to make systems visible and removable?**

   Main principle is to install new systems as much as possible without damaging existing structures and that installations are removable without demolishing the structures or decorations. In practise unfortunately in many cases installations are hidden by making shafts or ducts in constructions. False ceilings and walls may offer practical solutions leaving original structures untouched – but of course not visible. Details must be developed together with installations designers, architects and conservation specialists.

4. **Best solutions to save energy. Best practices in operating building systems (focus on heritage buildings). Heat recovery in different cases. Heat pump solutions.**

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First to remember: Demands of indoor conditions for occupants and heritage values of the building come first, energy efficiency solutions follow within these frames.

All what can be made by better maintenance and modern building automation are most preferred measures.

In many cases the location of supply air and exhaust air units are remote to each other. Heat recovery in such a situation is possible only with indirect liquid systems.

Ground heat pumps and air-to-air heat pumps might be efficient measures in many buildings. Especially placing of outdoor heat pump units need good cooperation between architect and installations designer.

Placing of solar collectors and solar shells need careful consideration as well.

Radiant heating is preferred solution in many cases – as well as radiant cooling when cooling loads are high.

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Air exchange and ventilation systems in historic dwellings

In project CoolBricks we concentrate on historical brick buildings, mainly on dwellings. Ventilation in historic buildings is a little researched topic in Estonia and Finland alike, although it is highly relevant issue, especially in Nordic climate. This guiding material is gathered under CoolBricks workpackage 5: education by project partners SRIK NGO (partner 10 Tarmo Andre Elvisto, Indrek Raide) and Kiinko partner no 18, Markku Rantama. In this guiding material we talk about the general principles of ventilation systems, typical solutions, common problems and misconceptions that we are faced with when renovating dwellings. Public buildings are not discussed in this material due to their individual solutions which are based on their wide range of use.
Planning and operating ventilation systems is one of the most controversial issues when improving historical buildings energy efficiency. The importance of ventilation in buildings energy efficiency is often disregarded although calculations and researches have proven, that mechanical ventilation with heat recovery is one of the most effective energy savings measure in old buildings and therefore should be prioritised. Several Tallinn University of Technology research papers state that building's energy efficiency should be dealt holistically, viewing the whole building renovation, restoration at the same time. Additionally we cannot forget the importance healthy interior climate. Therefore holistic approach to renovating dwellings is impossible without dealing with ventilation.
But in practice planning ventilation systems in historic buildings is problematic and that from technical and historical-ethical point of view. It is complicated to fit modern ventilation systems in the historical constructions and interiors. System fitting solutions in historical buildings can turn out to be expensive and technically hard to execute. Due to that ventilation systems are often neglected or implemented in unacceptable way.
Very often real estate developers but also art historians and heritage specialists see implementing highly controlled mechanical ventilation system as one of the lesser priorities in historic buildings. This measure is often the first to be discarded or only partially executed when budget needs to be tightened. Moreover it is not uncommon to see already constructed expensive systems shut off due to their high energy demand, disturbing noise from the machinery or other problems that have arisen from insufficient maintenance and caused the system not to work properly at its planned efficiency.
Another problem that should not be over looked is over drying of the interior air. Relative humidity under 30% is considered more or less harmful to humans as well to historic interiors. Especially vulnerable are wooden details, which have been historically crafted and preserved in much higher humidity. All historic dwellings with mechanical ventilation which were visited while conducting this research had problems with damage to original wooden details. Of course it is technically possible to keep air humidity at specific range but in practice it is done only in museums and art vaults not in living apartments due to their high cost.

One of the important facts we need to consider when retrofitting mechanical ventilation is that certain air tightness of the building envelope is necessary for the system to work properly. This air tightness often cannot be guaranteed with old windows and/or with insufficiently sealed renovated building envelope. Despite of existing theoretical possibilities and systems for renovating old windows and improving air tightness of

building envelope it is still prevailing common view that this is not enough for presuming airtightness level what is expected for well working ventilation systems. It is partially because of lack of experiences of restoration firms to satisfy both challenges to achieve both airtightness and keep old windows and authentic outlook of building at the same time. Very often exchanging the windows might not be accepted also by the heritage authorities.
Complications with retrofitting mechanical ventilation systems have made the option rather unappealing to historical house owners. Owners have sought solutions to ventilation problems in different fresh air valve systems, which unfortunately are not as energy efficient nor often provide enough fresh air to maintain good indoor climate.
In practice there is also another more common problem across in renovation projects. Renovated old buildings air tightness has been improved while ventilation system has not. Common mistake, which hose owners make is changing old leaky windows with new tighter ones and not addressing fresh air flow compensation. By doing that renovation results decrease interior air quality, which may lead to future possible health complication and building structural problems.
Finding working ventilation system solutions in historic buildings, especially dwellings, is an important topic that needs to be further researched and positive examples presented. For now we have to agree with Tallinn University of Technology researchers and stress the importance of approaching a building renovation as a complex and complete system. While doing that we cannot overlook the importance of working ventilation system as one of the main energy savings measure.
Below we bring out some of the pros and cons of mechanical ventilation systems (and why they often are left out of planning).
Cons:

- High initial cost of building and maintaining the system. Cost effectiveness is hard to assess.
- With wrong planning can be noisy
- Complicated to retrofit into historically valuable building while complying with heritage restrictions.
- Excessively drying air, which harms habitants and historic details.

Pros:

- Only with well working ventilation good indoor climate is guaranteed
- Only with mechanical ventilation with heat recovery maximum energy efficiency of building can be achieved

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