ISHIK UNIVERSITY

FACULTY OF ENGINEERING

Department of INTERIOR DESIGN

2020-2021 Fall

INDS 414 SUSTAINABILITY and the INTERIOR ENVIRONMENT

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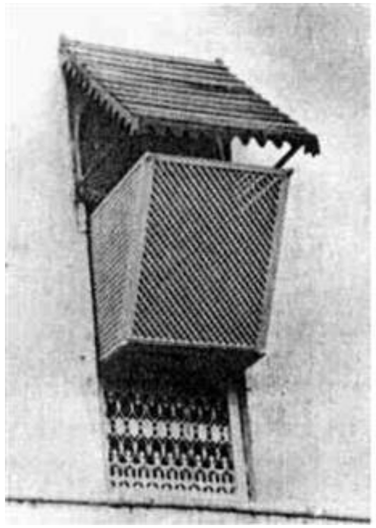
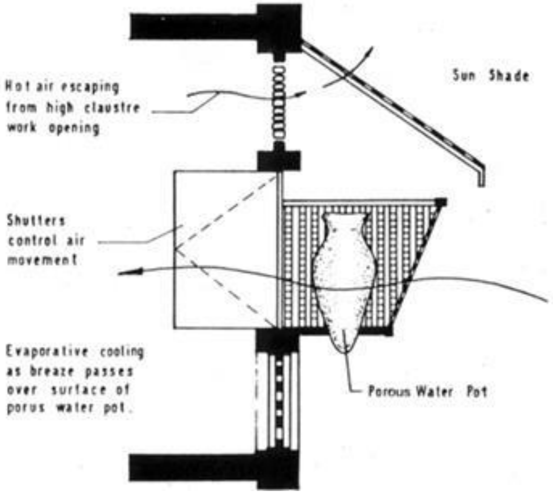
MSc in Sustainable Building Technology

Week 1 : **Passive Strategies**

<u>Passive techniques</u>

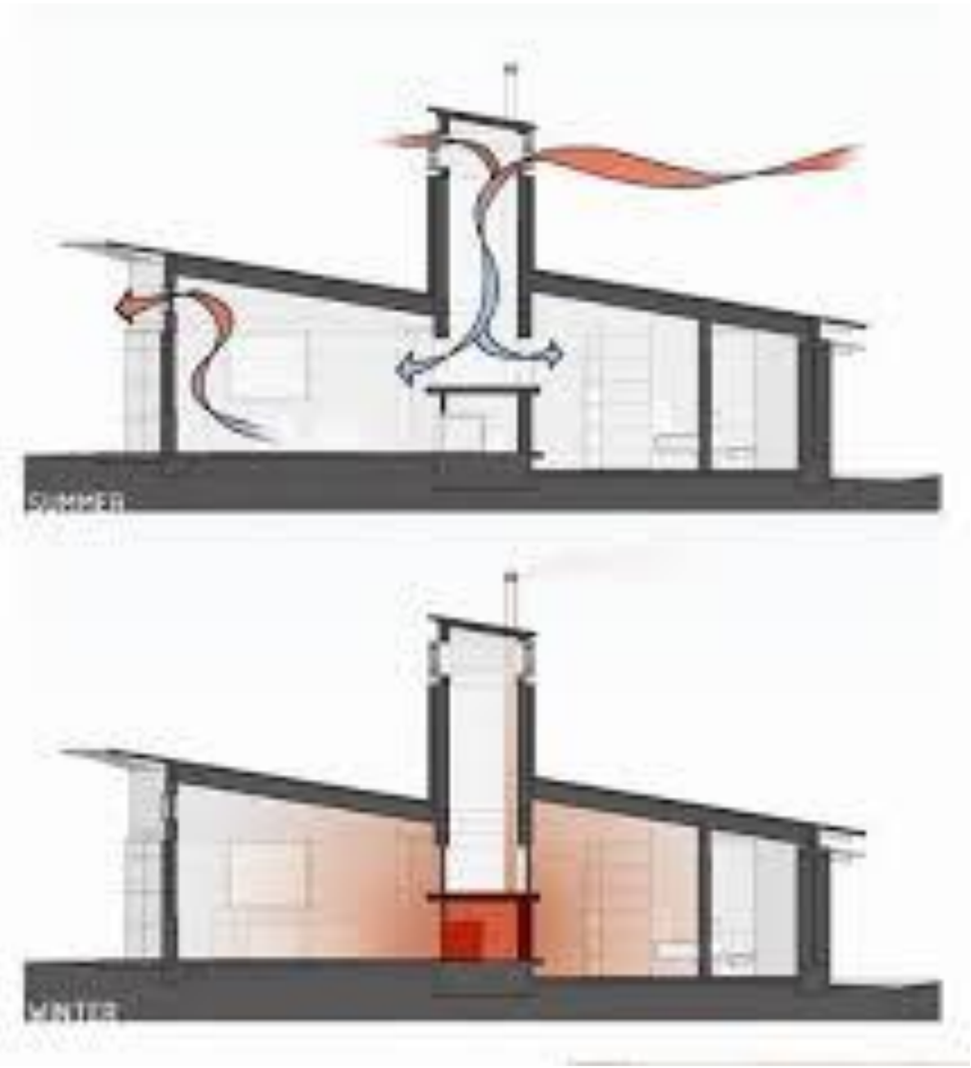
Historically, passive techniques were the only way to cool buildings, while heating could be obtained by burning wood or coal. There are now technical means that would allow building design to ignore the climate; but while this is technically possible, there are still good reasons to adopt passive techniques, not only economic, but also to promote environmental sustainability at both local and global levels.



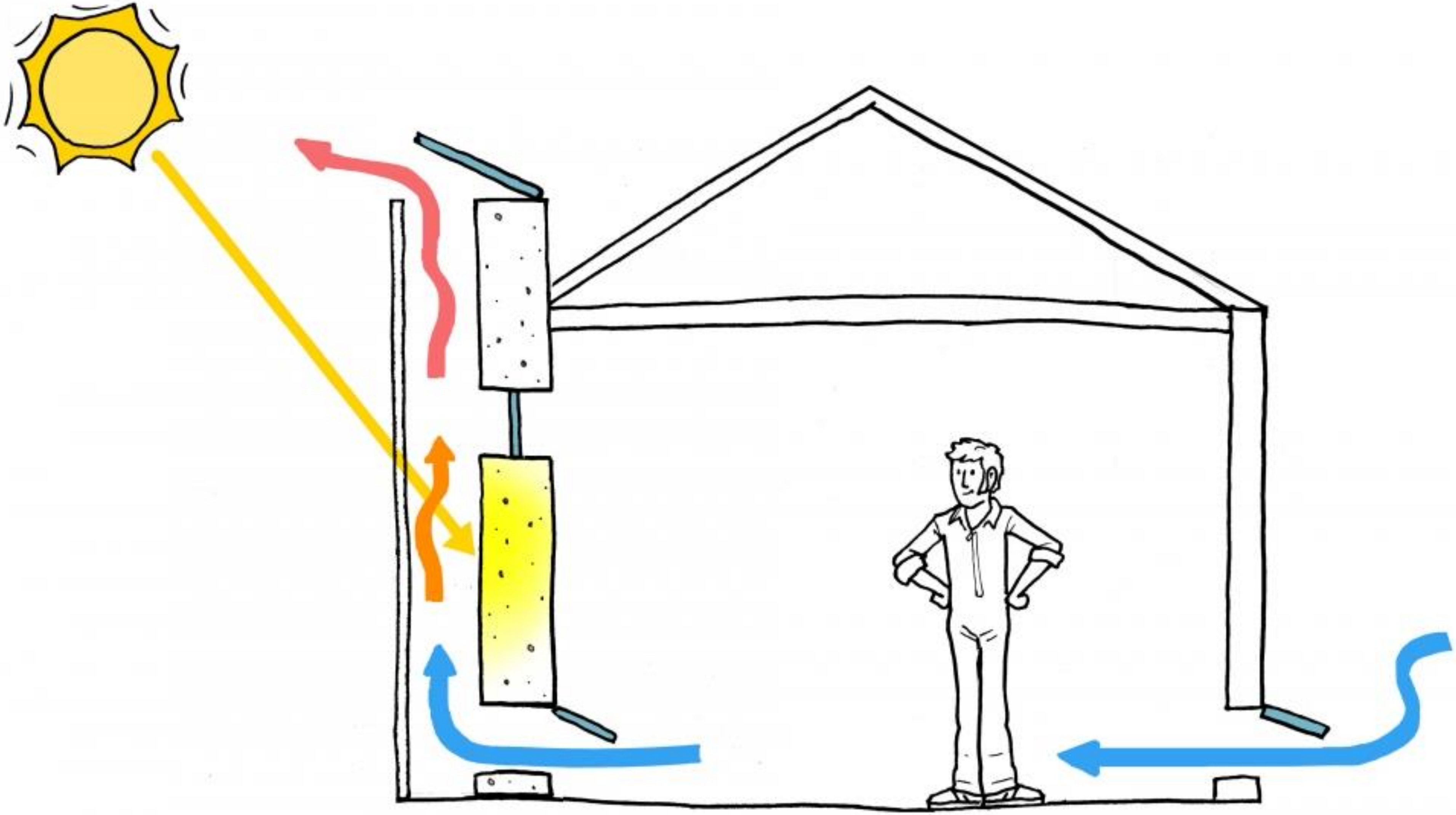


‘Passive’ has changed its meaning to include what are called hybrid techniques, i.e. the limited use of low-energy equipment such as pumps and ceiling or table fans if their COP (coefficient of performance: the relation between energy output and input) is high. Simple mechanical devices and locally available parts and skills characterize passive systems. Usually the passive system is an integral part of the structure and has multiple uses. One example is an ordinary window, which can provide view, light, ventilation and solar gain.

Passive and low energy design helps the building take advantage of the climate when it is advantageous, and protects the building from the climate when it is not. This requires good knowledge of local climate and a greater sophistication on the part of the designer. The designer must therefore have adequate tools for this sophisticated task of passive design.



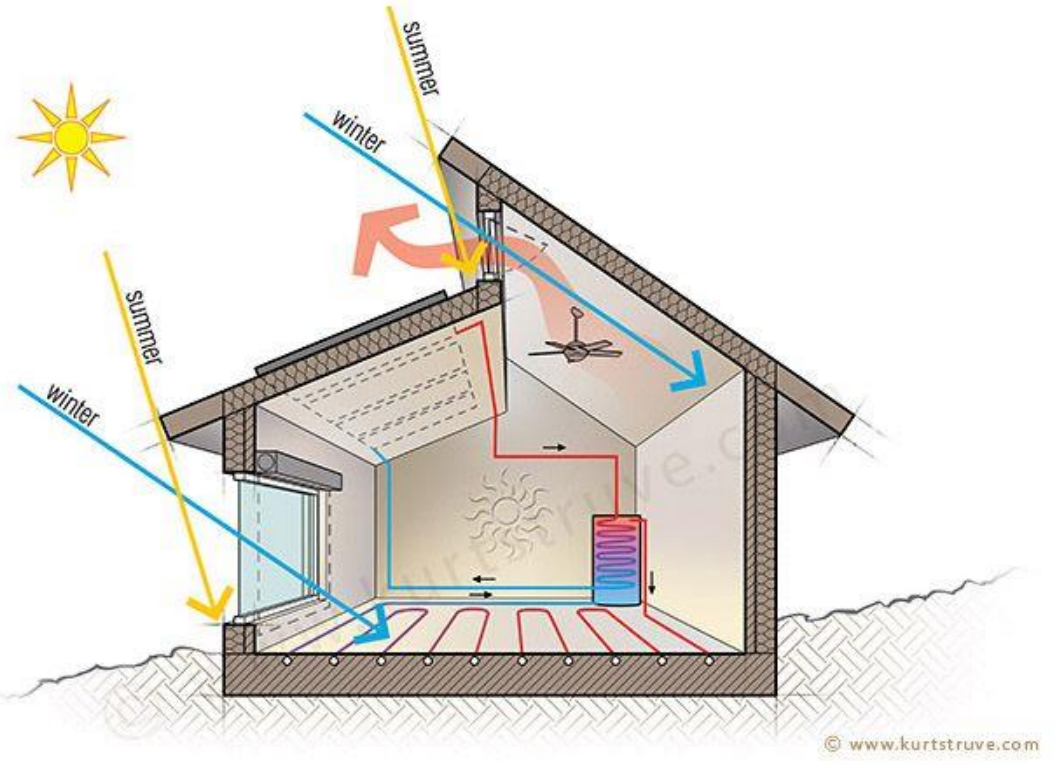
Ventilation Strategy in Winter and Summer



Trombe Wall

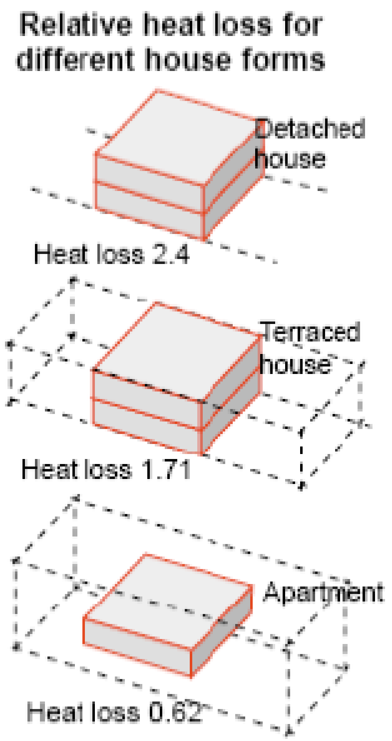
Heating and cooling

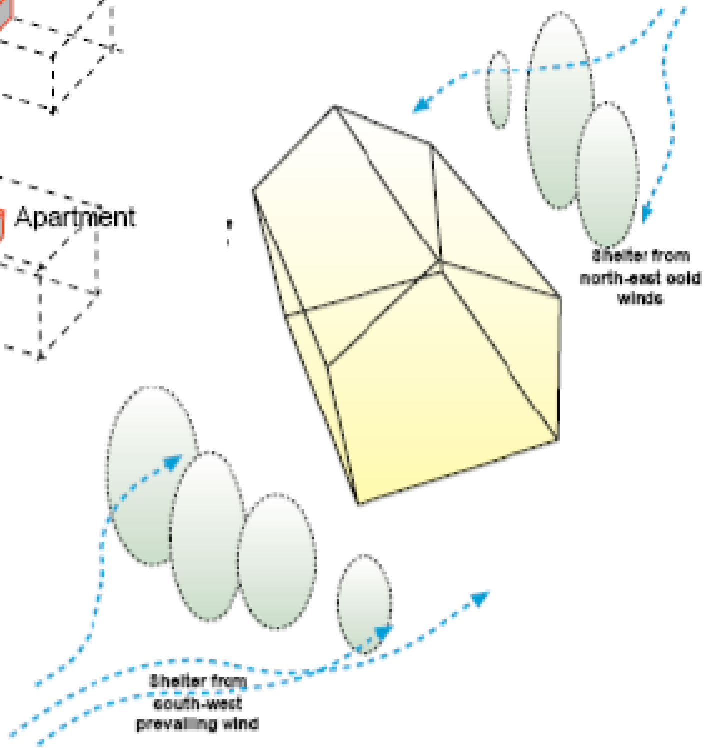
While passive heating, mainly based on solar energy, has resulted in a wide range of technical solutions such as solar heaters and photovoltaic cells, the evolution of passive cooling has been much slower. The problem is more difficult to analyze, and there are many devices, such as roof ponds and earth cooling tunnels that seem to work best in theory.



Principles of passive cooling are: shading, reflection, insulation, reduction of internal gains, ventilation, fans, and tightness of buildings. Heat reduction is best achieved by excluding unwanted heat rather than removing it later, often by air conditioning. *(Climatic Design of Buildings-using Passive Techniques)*

Form verses Energy.

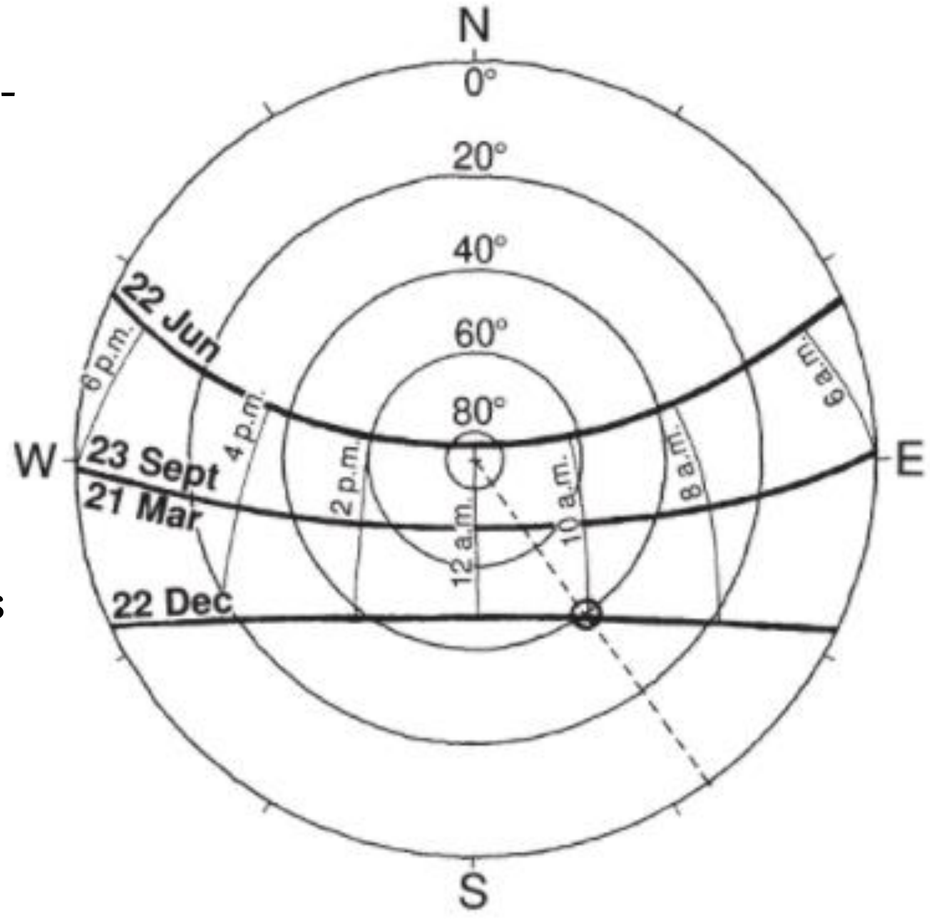




Orientation

In areas where comfort is acquired mainly by air movement, it is important to orient the building according to prevailing winds.

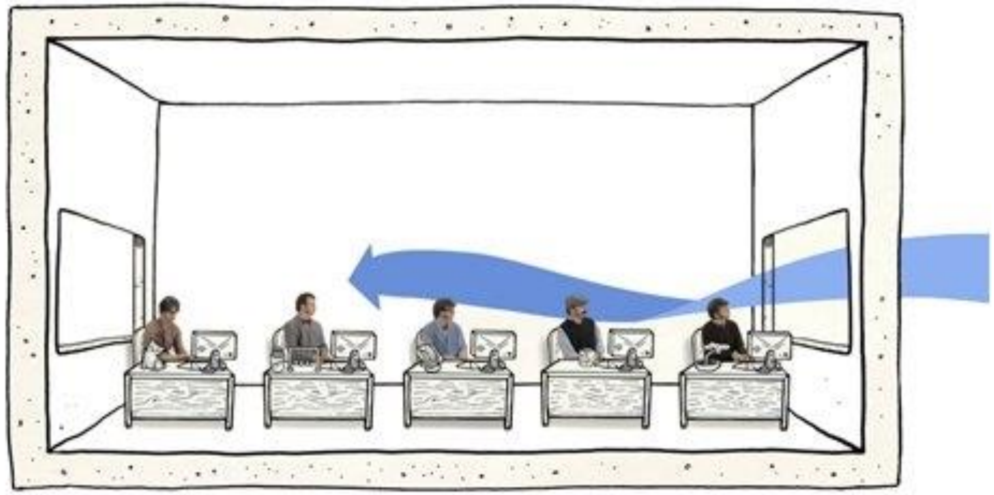
In regions where ambient temperature has greater influence on comfort than ventilation, orientation with respect to the sun is important. A north-south orientation of the main facades is preferable, since the summer sun penetrates facades and openings only marginally in these directions, while in winter when the path of the sun is lower, there is possibility of solar access.

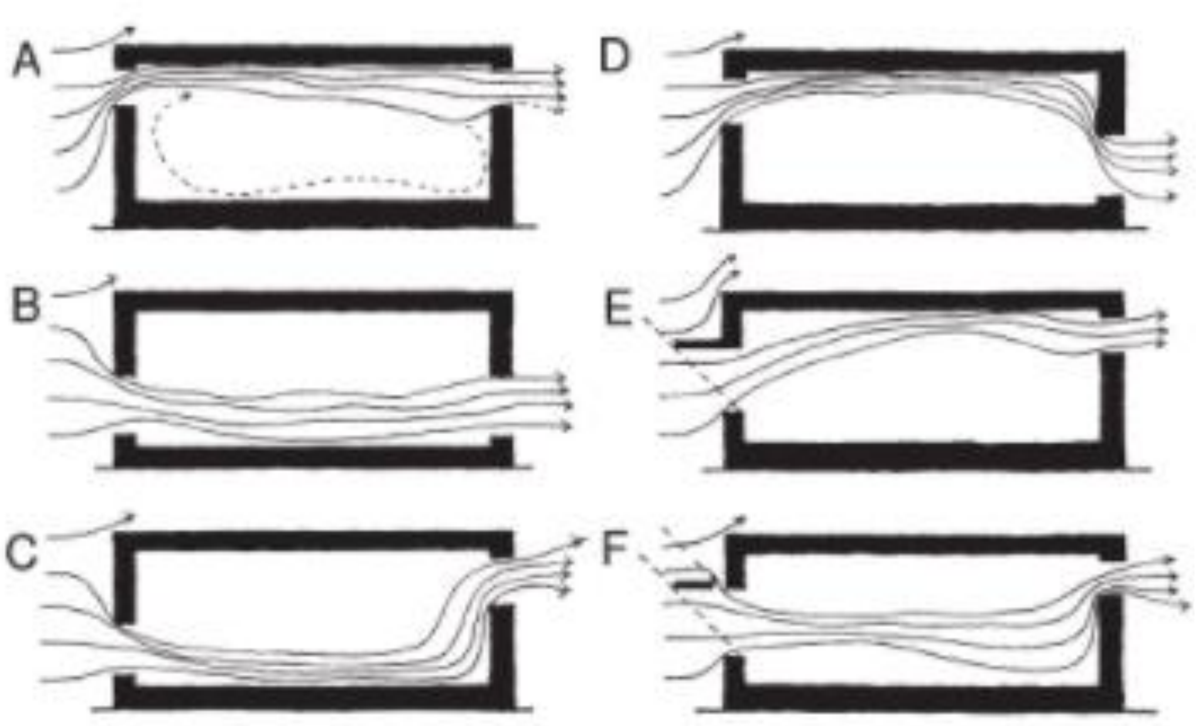


Ventilation

There are many purposes of ventilation: thermal comfort and structural heating/cooling, but also health, and moisture removal.

Thermal comfort can be created by increasing air speed through cross ventilation, which promotes evaporative cooling of moist skin. Placement of openings for inlet and outlet of air is essential for directing the air current to the occupation zone. Ventilated attic spaces, preferably with





A High inlet and outlet do not produce good air movement at body level.
B Low inlet and outlet produce a good pattern of air movement, when it is required for cooling.
C Low inlet and high outlet also produce a low level wind pattern.
D The airflow at ceiling heigh produced by a high inlet is hardly affected by an outlet at low level.
E Projection shading devices produce an upward airflow in the room.
F A slot between wall and shade results in a more direct flow of air.

Q=E′A′v

Q= Air flow (m3/s)

E= Effectiveness of the opening,

0.25–0.35 for diagonal winds

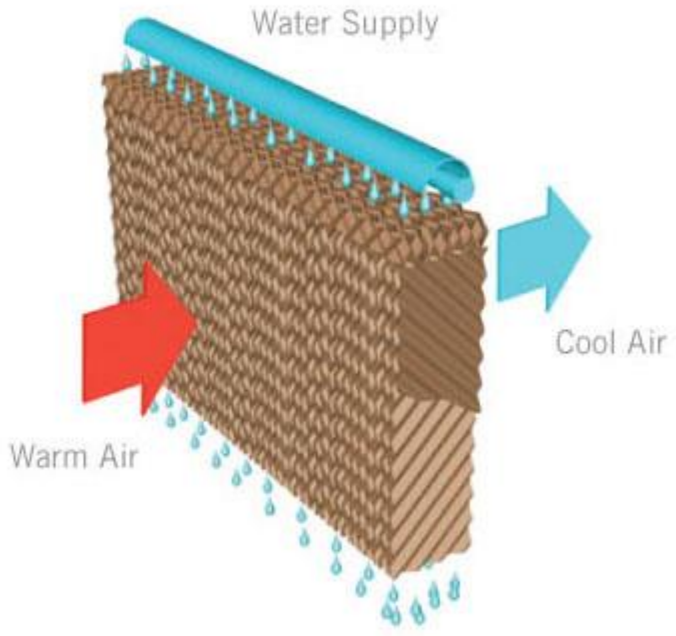
0.50–0.60 for perpendicular winds

A= Area of the opening (m2)

v= Wind speed (m/s)

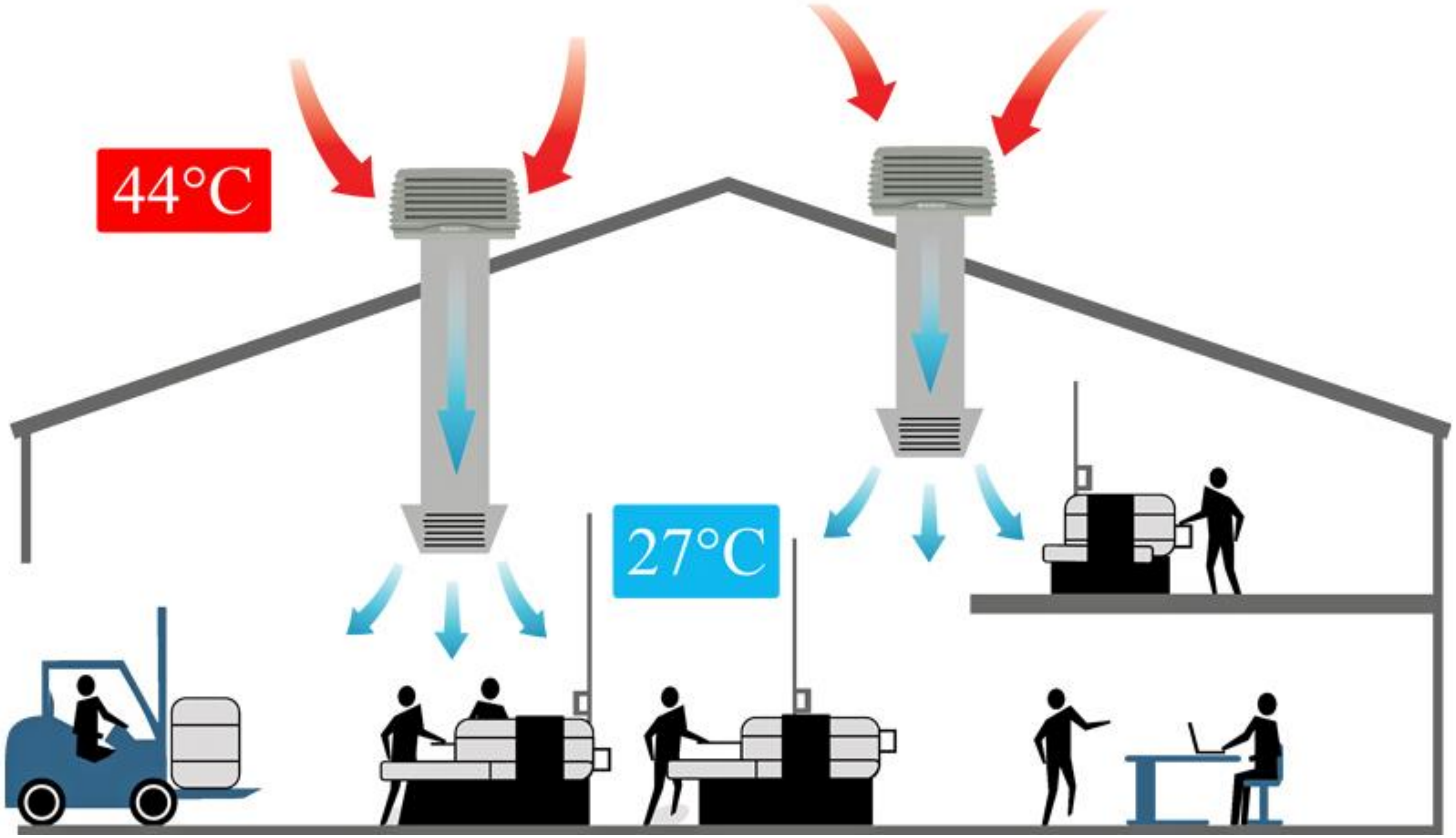
Evaporative systems

Evaporative systems can be used successfully where there is a great difference between dry-bulb (DBT) and wet bulb (WBT) temperatures. Mechanical systems (regarded as active), e.g. outdoor air sucked through wet pads by a fan, can reduce the air temperature by 70–80% of the DBT–WBT difference.

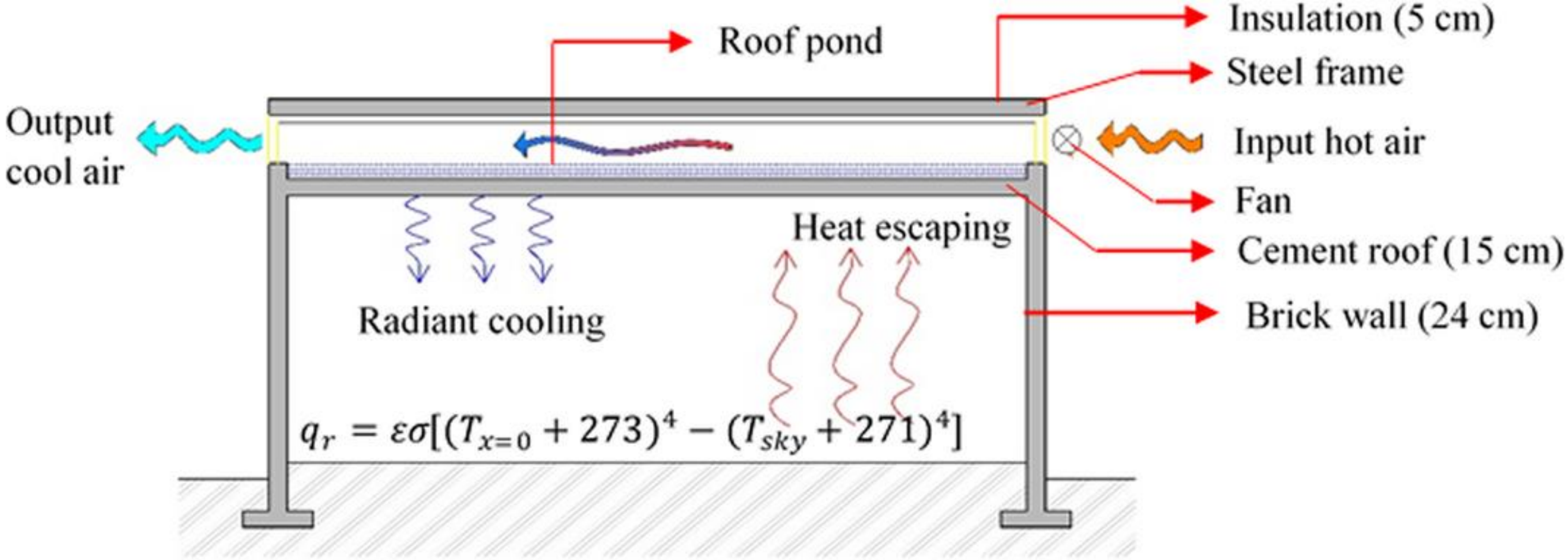


Passive direct evaporative systems involve very high rates of outdoor airflow. Pads in wind-facing large windows 50–100 mm thick can provide temperature reductions of 40–50% of the DBT–WBT difference. A downdraft cooling tower combined with a solar chimney at the opposite side of the building can give 88% DBT–WBT reduction.

Indirect evaporative cooling is by roof or ground ponds. These systems are generally less suitable for regions with limited water supply. They are also far too complicated for low-cost buildings, and roof ponds may cause leakage.



The benefits of direct evaporative cooling


Roof pond
Insulation (5 cm)
Steel frame
Output cool air
Input hot air
Fan
Cement roof (15 cm)
Heat escaping
Radiant cooling
Brick wall (24 cm)
$q_r = \varepsilon\sigma[(T_{x=0} + 273)^4 - (T_{sky} + 271)^4]$

Materials

A standard recommendation is that ‘local 'materials should be used as far as possible. However, the choice of materials should take into account, not only the production, transportation and construction costs and energy, but the life-cycle cost of the building, including the operation and the demolition and possible recycling of the material. A more ‘intermediate’ or ‘expensive 'material may in that perspective save resources compared to a ‘local’ or ‘cheap’ material.

Heating and cooling

Cooling is most important for the greater part of the year, but there may be cooler seasons requiring heating.

Orientation

Orientation according to the sun is most important, and north-south orientation of the main facades is preferable. If there is a cooler season, correctly placed and oriented windows may improve indoor comfort during winter. Solar protection is important, especially towards the west where afternoon sun coincides with high air temperatures.

If there are prevailing winds suitable for cooling they can be caught by correctly placed openings or by special devices.

Generally, building design should be passive as far as possible to minimize the need for energy input. If this solution is not fully satisfactory, complementary hybrid or active systems may be used. However, these systems should be simple and cheap to build, operate and maintain, integrated as far as possible in the building structure, and they should meet any user requirements.