VENTILATION

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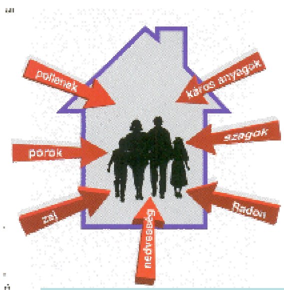
VENTILATION

1. Vocabulary:

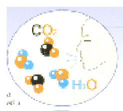
- **Air:** colourless, odourless gas mixture (N_2,O_2,CO_2,H_2+gázok)→**always humid**
- **Characteristic values of air:**
  absolute pressure = 1.013x10^5Pa
  degree of relative humidity φ = …%
  saturated air: can not absorb more humidity / water φ = 100%



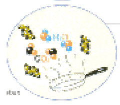
Effects on a room: pollen, dust, noise, humidity, radiation, smells, harmful materials

2. Why do we need ventilation?:

- **Human activity** →less O_2, more CO_2 more dust = air quality gets poor
- **Result** → stale air, increasing response time, accident danger, → result: **ventilation need**
- **comfort requirement:** cosy, draft free (tight) and energy efficient



Breath: CO_2



Cooking, drying, plants H_2O

Aim of ventilation: to change the existing air with good quality fresh one

3. Air change rate: → stale and fresh air in m^3, options:

m^3/hour/person: f.i.: in flat 20, in school 25, in hospital 50

air volume of a room – **how many times per hour:** flat 1-2x, school 5x, kitchen 20x

Control of ventilation:

based on the condition, which requires the highest air-change rate (concentration of pollution, temperature, humidity)

Ventilation based on comfort: for human dwelling area permitted concentration of CO_2 max. k = 0.14 volume%

in open air k = 0.04 volume%

1 person produces **0.02 m^3/h CO_2**

Decision of the ventilation method has to be based on the function, size of the room: natural or artificial, air-change rate, method of blowing in/out, construction

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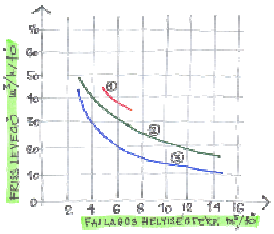
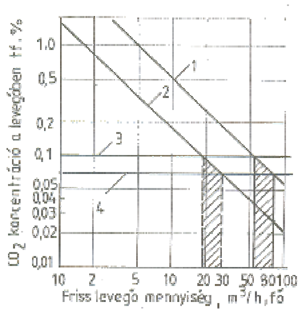


1 heavy physical work
2 children in school
3 adults

Fresh air need per person



1. medium intensive work calorific output 340W
2. calorific output of a still human body 110 W
3. 0,1% permitted level
4. recommended level for human dwelling area

Fresh air need based on the CO_2 concentration

4. Assorting of ventilations:

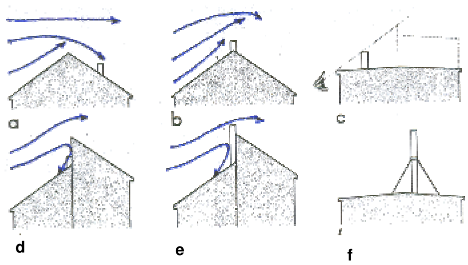
- **Natural** → density-difference + wind = driven by natural forces

  If not planned: „**filtration"** (through breaches),

  If planned „natural ventilation"
- **Artificial**→ force is based on electric power

5. Forces in case of natural ventilation:

- density difference of fresh and stale air
- Wind caused draught pressure / aspiration



Influence of the wind

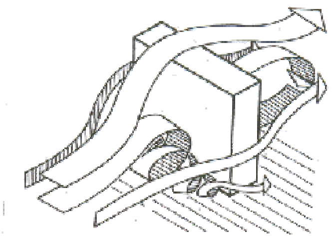
Influence of the wind:

a.),d.) Into the stack under the pitch the wind pushes back the smoke / stale air
b.), e.) theoretically correct solution
c.) viewing angle and the hight of the superstructure: min. 1,2 m
f.) if superstructure is higher (from roof) than 1,5 m horizontal support / reinforcement is necessary

Wind flow / turbulences around building:

- In front of the building overpressure as turbulences, next and behind the building depression

- Above the vertical stacks the stream causes depression

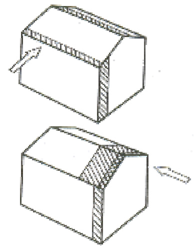


Wind flow / turbulence around building

6. Natural ventilation

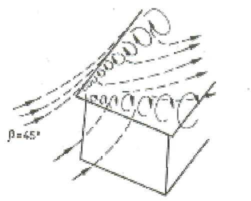
Filtration:
- at well sealed windows through every 1 m breach 0,5 m3/hour air is let trough at a 10 Pa pressure-difference (light wind)

Critical period of the year: Spring and Autumn, when there is no high temperature-difference between the interior and the open air
Working of the natural ventilation must be aided in these periods (additional heat load, fan, …etc.)



Areas of depression on a building

Influence of neighbouring building



Turbulence on flat roof

7. General rules of ventilation:

Facts influencing the draught:
- **1** temperature conditions
- **2** wind conditions
- **3** material of the vent stack
- **4** cross section of the vent stack
- **5** temperature of the stack surface

Solutions is correct if:
- **1)** the incoming air is clean, dust free and odourless (quality of air by DIN.: **new units**:
- **olf**→ 1olf – odour pollution emission from 1 person

- **felt quality of the air is the decipol** → 1 decipol is the pollution, caused by 1 olf (1 person) strong emission at a 36 m^3/hour ventilation
- **2)** the fresh air must reach every part of the room
- **3)** stale air must leave the room on the shortest way
- **4)** air stream must not cause harmful draught

Calculation of the air amount (artificial):

V = 10 x G / ci – ce [l/s], **A= V / 3600 x v**
G – total pollution [olf]
ci – required air quality [decipol]
ce – fresh air quality [decipol]
A - vent cross section [m^2] ,
v = air speed [m/sec]

sitting person 1 olf
Smoker 25 olf
Physical activities 4-20 olf
materials in office 0.5 olf/m^2 floor

Pollutions [olf]

In mountains 0,01 decipol
Town 0,2-0,8
Smog 1

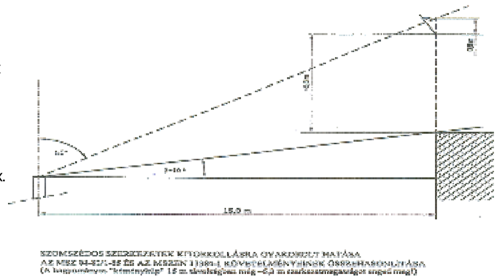
Quality of fresh air

Suggested air speed in a room
0,1-0,2 m/s

8. Rules of driving out the stale air

Rules for Stacks of natural ventilation:

- **must be driven into the open air**
- the spare chimney flue must not be used as vent stack
- you can connect into the same stack only **the rooms with same pollution level**
- the horizontal projection of the offset can be max. **2 m**
- a, b, are the sides of the stack: **a ≤1,5 x b**
- **rules for the height above the roof: the same, as the chimney**
- between the chimney flue and the vent stack there must be a **25 cm thick** solid brick wall, or other construction with equivalent fire protection level and air-tightness
- above the upper connection the stack must be at least **2 m** high
- If the internal space of the room is **>20 m^3, artificial ventilation is a must**



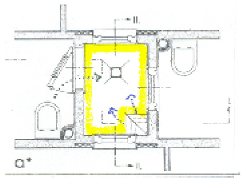
Existing rule of smoke outlet

9. Constructions of ventilation

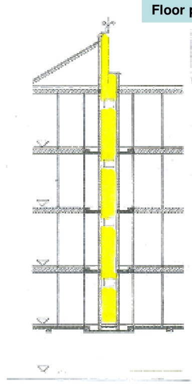
The natural ventilation can be **direct** → (through windows, doors) or **indirect** → through ventilation systems

Indirect systems:
- air shaft
- air duct
- vent pipes

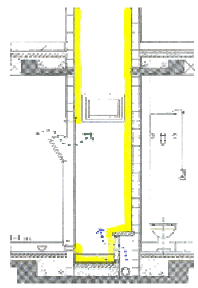
Air shaft (with windows - larger):
- with fresh air inlet at the bottom, at least 0,5 m2
- historical solution
- for internal rooms (side rooms)



Floor plan of the airshaft



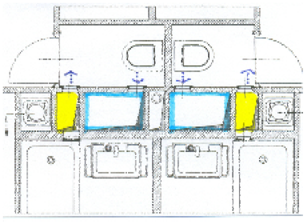
Section of the airshaft



Fresh air inlet

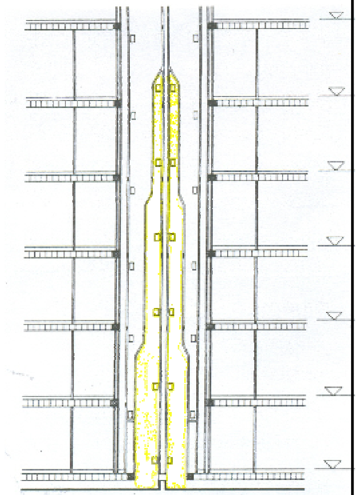
Air duct (with air grids):

- Instead of windows air grids
- rooms connected only with the same function
- single duct: drives only the stale air out
- the cross-sectional area is constant
- double duct: both for stale air outlet and fresh air inlet
- the total cross-sectional area is constant, getting higher the **fresh air duct grows narrow, the stale air duct broadens**
- this is the ancestor of the later coming harboured single pipe vent. system (above the fresh air inlet there is the stale air outlet in the same floor plan position)
- min. 0,96 m2 floor size, side ratio ≤ 1 : 1,5, fresh air inlet (at the bottom) min. 0,25 m2



floor plan – double duct system

single duct



Section of a double duct system

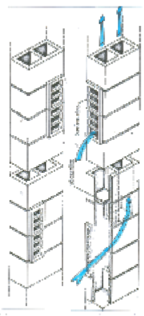
Ventilation pipes:

Assorting by construction

- single pipe, or collecting pipe system
- the single pipe system can be harboured: above the fresh air inlet (coming from the bottom of the building) there is the stale air outlet (driving it up to the roof) in the same floor plan position

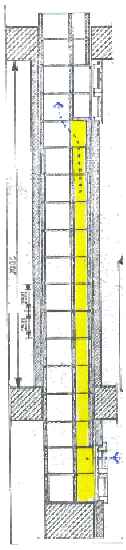
Assorting by material

- silicate (concrete blocks or laid from concrete bricks)
- metal (up-to-date „pipe-in-pipe" collecting system, or single pipe)
- plastic (mostly working with humidity controlled air-space unit

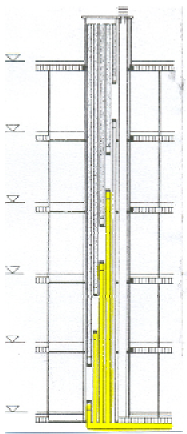


Single pipe system made of concrete blocks

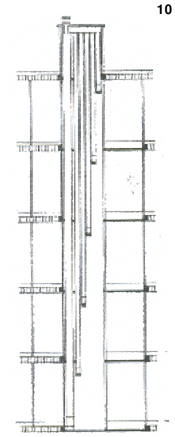
Single pipe horizontal arrangement



Section of collecting system



Harboured single pipe system



Single pipe system metal

Head / cover stones:

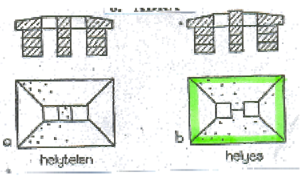
- there must be inclination on top (3-5%),

- with drip-nose,

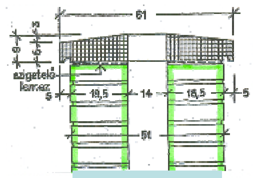
- from frost-resistant material

- **material:** either from good quality monolithic concrete (C-20) sprayed with cement powder before smoothing
  or concrete core (C-12) covered with monolithic artificial stone
  or prefabricated concrete / artificial stone
  or sawn hard natural stone (normally frost resistant limestone)

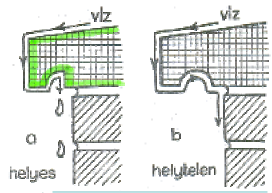
- under the headstone a separating membrane should be built in to protect the wall under the stone from humidity (1 layer bituminous liquid-membrane)



incorrect geometrical shape correct



Laying of headstone



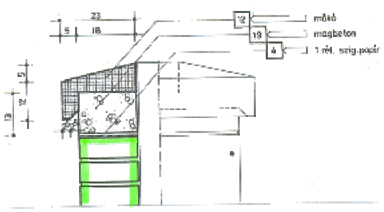
correct drip nose incorrect

Headstone 2:

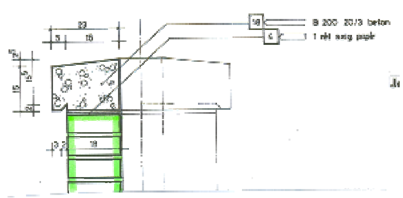
- the prefabricated headstone is glued with mortar of quality
H10, 15 min.

- to be better adhered under the stone sanded bituminous membrane should be used

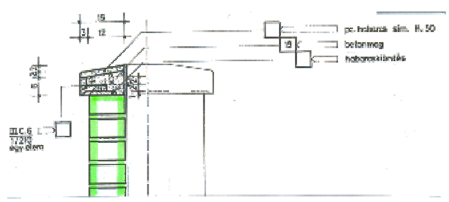
The artificial stone:
- on a concrete core 2-3 cm thick crust made with white cement and natural stone chips
- there is reinforcement in the core
- mixture of the crust: hard lime stone, or **granite, or marble, or basalt** chips + 400 kg/m^3 white cement
- colourant can be mixed to the cement



Prefabricated artificial headstone



Monolithic concrete headstone



Headstone: monolithic concrete with watertight plaster

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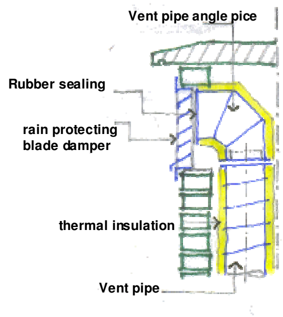
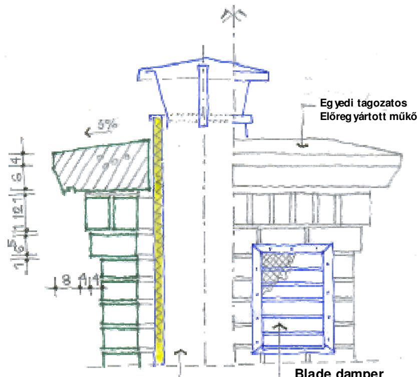
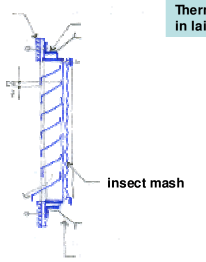
Above the roof:
- every not insulated pipe must be covered with thermal insulation
- at the level of the highest floorconstruction the shaft must be closed with fire resisting material, and thermal insulation must be put on

Vent pipe outlet through laid brick shaft wall





Thermal insulated chimney in laid brick shaft wall



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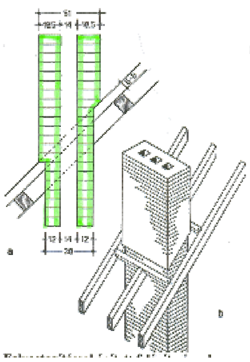
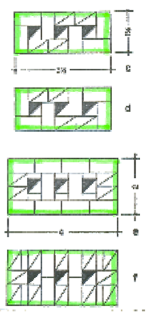
Bricklaying of shaft/chimney wall:

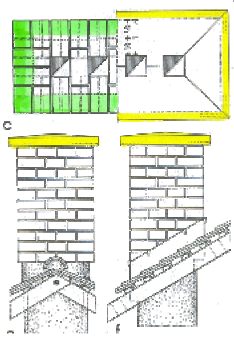
- rules are the same as in case of walls
- above the roof ¼ brick thicker + thermal insulation
- traditionally above the roof **¾ or 1brick thick wall** (without thermal insulation)
- covered by artificial stone headstone



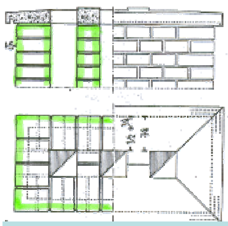
Wall thickening above pitchroof



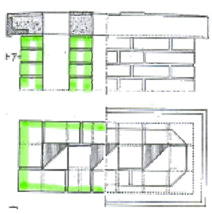
Bonding of ¼ brick thickening



Bonding of 1 brick thick chimney wall



Bonding of ¾ brick thick chimney wall



Bonding of ½ brick thick chimney wall

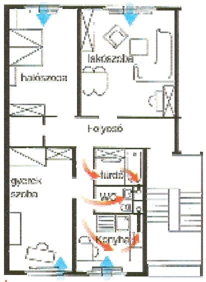
11. <u>Fresh air inlet (</u>HELIOS)

Explanation:

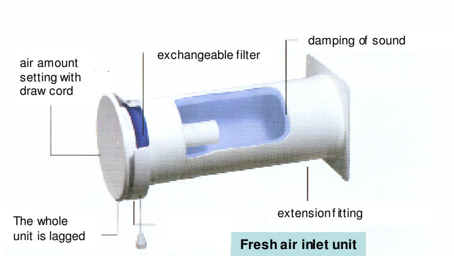
- airtight windows, if opened, smog, dust, noise comes in
- without ventilation the air quality is poor, not comfortable micro climate, the traditional heaters, furnaces work with safety hazard

Solution:

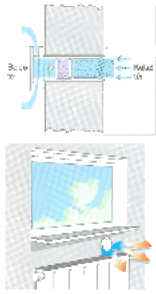
- fresh air inlet unit behind the heater (heated up) in the domestic rooms, the air is filtered,
- the stale air is extracted where it is produced,
- between the inlet and the extraction into the walls / doors grates must be built in (100-150 cm²)
- the extraction must be executed



Air circulation in the flat



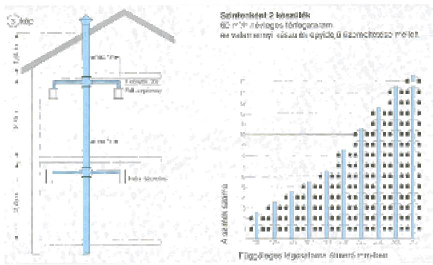
Fresh air inlet unit



Fresh air inlet unit built into the wall

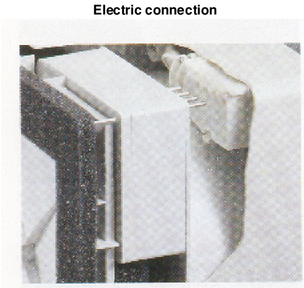
Extraction:

- air delivery of the ventilator **60-100 m³/h** (electricity consumption 16-20W)
- in front of the ventilator filter, conditioning of humidity is built in

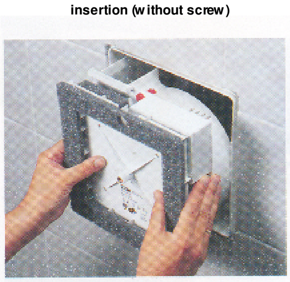


Collecting vent stack

Electric connection



insertion (without screw)



Front cover

Humidity controlled air-space unit:
(AERECO)
Working method:

Humidity controlled fresh air inlet

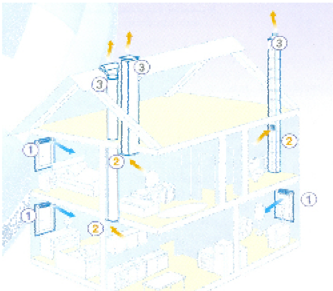
- The too high ventilation level results heat loss, the too low level ventilation results poor comfort level. The humidity level controlled air-space unit – built into the windows - offers good compromise.

- as the humidity level rises, synthetic fibres are elongating, communicate a movement to a blade damper within the unit. The blade damper controls the air stream. (The higher the humidity level is, the more opened the blade damper is.)

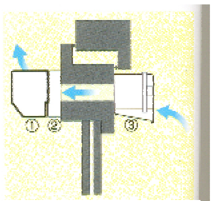
- The suction can be produced either by a gravity ventilation,

- or by gravity ventilation helped with special draft-increaser unit,

- or by a fan exhaust (see at artificial vent.)

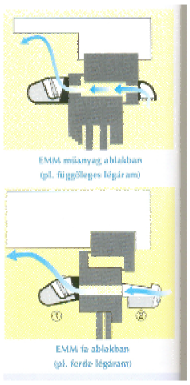


Working method of gravity ventilation



Noise insulation levels

①= 37 dB
①+②= 41 dB
①+③= 40 dB
①+②+③= 44 dB

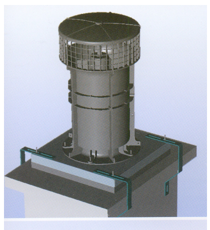


Fresh air inlet in windows

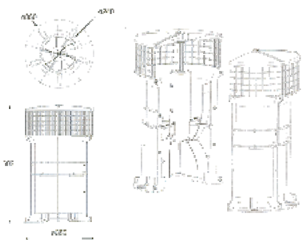
- for the periods, when the int./ext. temperature-difference is low (gravity ventilation is not sufficient) we can built in onto the top of shaft / stack / vent pipe a low-pressure, draft-increaser ventilator (4-14W)
- max. air delivery 250 m^3/h
- can be built in onto a collecting system as well
- resistance to air flow of the unit is low, even if it is off

Artificial ventilation

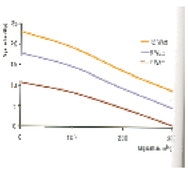
- the air-change-rate is assured by a local fan or central ventilator.
- The fan can be switched with the light (with caster effect),
- or by humidity control,
- or CO2 control.
- The suction (a blade damper) can be controlled by movement detector,
- or by humidity control.
- the central ventilator can be situated in an attic / inside the flat above suspended ceiling / above the roof.



draft-increaser ventilator

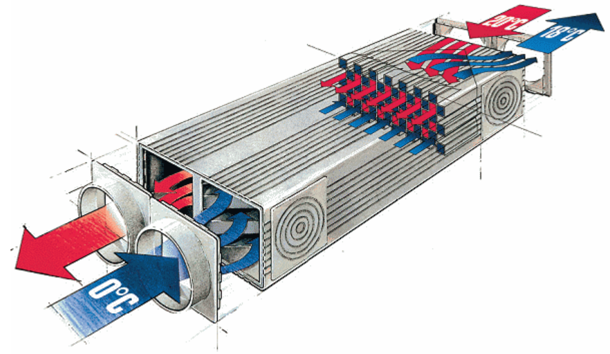


Blades on the blade wheel are parallel with the central axis, the top is covered, so
- the stack is protected from vertical „blow-in" wind,
- horizontal wind rises the draft, helps the ventilation



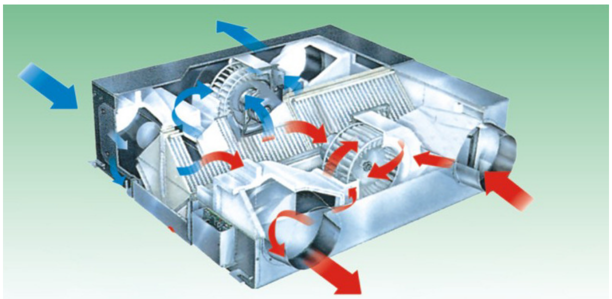
Air delivery depending on the consumption

Energy-sufficient ventilation



Heat exchanger

The thermal energy of the exhausted air is transferred into the incoming air.



Sulution for one room

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Ventilation for a whole flat

Elements of the vent. system for one flat

- Dust in it?
- (Mould? Insects?)
- Cleaning? (Kitchen!!)

Preheating

Before coming into the building the air can be filtered, cleaned.

Exhaust fans on a cross-ventilated barn by Kevin Janni – University of Minnesota