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Ventilative Cooling Components
An Overview

Dipl. Ing. Peter Holzer

Institute of Building Research
Subtask Leader in Annex 62 Ventilative Cooling (finished)
Operating Agent in Annex 80 Resilient Cooling (ongoing)

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components:
- Windows, doors and rooflights
- Flaps, grilles, louvres and dampers
- Terminals

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components

B Airflow enhancing ventilation components

- Powerless ventilators
- Chimneys
- Mechanical ventilators

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components

B Airflow enhancing ventilation components

C Passive Cooling ventilation components

- e.g. Comfort ventilators
- e.g. Evaporators
- e.g. Phase Change Materials

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Typologies of Ventialtive Cooling Components

- **A** Airflow guiding ventilation components
- **B** Airflow enhancing ventilation components
- **C** Passive Cooling ventilation components
- **D Automation components**
  - Actuators
  - Sensors
  - Controllers

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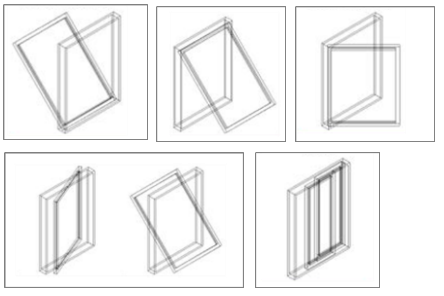
Airflow guiding ventilation components

Windows, Doors and Rooflights

bottom hung (transom), top hung, side hung, pivot hung, sliding (sash)



- Highly effective and cheap
- Manual use as well as automated
- Weak in case of driving rain, burglary, dust, insects and noise
- $\dot{V} = C_d \sqrt{\frac{2}{\rho}} \sqrt{\Delta p} A = C_F \sqrt{\Delta p}$ (m³/s)

  Discharge Coefficient C_d = 0,6 ÷ 0,7

  1 m², 1 Pa → 3.000 m³/h

See Ventilative Cooling Sourcebook (Annex 62)
Formula according to EN 16798

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Airflow guiding ventilation components

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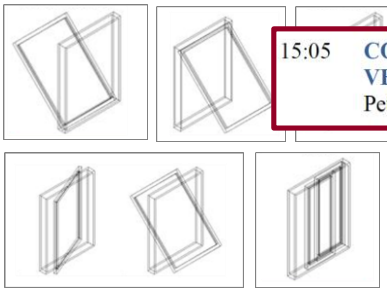

15:05 CONTROLLED WINDOWS FOR VENTILATIVE COOLING
Peter Foldbjerg, Velux, DK

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- Manual use as well as automated
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Formula according to EN 16798

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Airflow guiding ventilation components

Dampers, Flaps, Louvres, Grilles

- Manual use as well as automated
- Partly protective against burglary, dust, insects and noise. Generally: the higher protective, the lower effective
- Range of C_d 0,2-0,7
  Net geometric free area ratio 40-60%
  Recommended design Δp 1-3 Pa

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Duco, Passivent, Gaugele
Values from merging design information from different manufacturers.

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Airflow guiding ventilation components

Dampers, Flaps, Louvres, Grilles

14:25 APPLICATION OF LOUVRES TO SUPPORT VENTILATIVE COOLING
Ivan Pollet, Renson, BE

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Airflow guiding ventilation components

Terminals

Window ventilators (trickle vents or slots), discular diffusers (disc valves)

- Regarding trickle vents: Good integration in the window, available with sound attenuation functionality, wind pressure dependent pressure drop, integrated sound damper and insect mesh. Indicative airflow of 25 to even 50 m³/h per meter at 1 Pa
- Regarding disc valves: covering airflows from 30 m³/h up to > 1.000 m³/h per unit. Indicative pressure drops of 10 to 40 Pa.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Renson and saiductfab.

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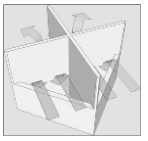
Airflow enhancing ventilation components

Powerless ventilators

Venturi ventilators, Powerless rotating ventilators, windcatchers and supply air windscoops, Ventilation chimneys







See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Passivent, HASEC, industrialairventilator, monodraught

- Regarding Venturi Vents: Indicative negative pressure drop of 4 Pa at undisturbed wind speed of 2.5 m/s, up to 60 Pa at 10 m/s.
- Regarding Powerless rotating ventilators: Indicative airflow of 800 m³/h (300 mm diameter) up to 5.000 m³/h (900 mm diameter) at undisturbed windspeed of 1,5 m/s and very low pressure drop.
- Regarding Chimneys: Buoyancy driving force is low, equaling $\Delta p = (\frac{1}{30})\Delta Th$

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Airflow enhancing ventilation components

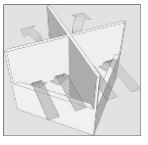
Powerless ventilators

Venturi ventilators, Powerless rotating ventilators, windcatchers and supply air windscoops, Ventilation chimneys

14:50 EXAMPLES OF AIR FLOW ENHANCING AND NATURAL COOLING COMPONENTS
Nick Hopper, Monodraught, UK







See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Passivent, HASEC, industrialairventilator, monodraught

- Regarding Venturi Vents: Indicative negative
a at undisturbed wind
to 60 Pa at 10 m/s.
rotating ventilators:
Indicative airflow of 800 m³/h (300 mm diameter) up to 5.000 m³/h (900 mm diameter) at undisturbed windspeed of 1,5 m/s and very low pressure drop.
- Regarding Chimneys: Buoyancy driving force is low, equaling $\Delta p = (\frac{1}{30})\Delta Th$

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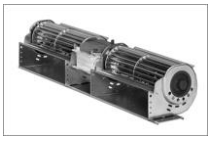
Airflow enhancing ventilation components

Mechanical ventilators

Axial, radial and tangential fans



- Ventilative Cooling with mechanical ventilators are highly effective as regards secured airflow.
- Ventilative Cooling with mechanical ventilators is limited by the acceptable pressure drop in the system:
  1.000 m³/h at ΔT=2K carries a cooling load of roughly 0,7 kW.
  An axial vent at Δp=300 Pa already consumes 0,3 kW and heats up the airflow already by 1K.
- Still, Ventilative cooling with mechanical cross flow ventilation an heat recovery is a good option.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Rosenberg and EBM Papst

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Passive cooling ventilation components

Comfort Ventilators

Ceiling Fans, Personal Fans

- Air movement is a highly effective means of personal comfort. An air speed of roughly 0,8 m/s raises the acceptable temperature by roughly 3K.
- Equipped with modern EC motors the effectivity outreaches the effectivity of AC systems by a factor of 2-3.
- In open floor offices there's the shortcoming of incoherent personal comfort expectations, between cool breeze and draft.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from lampsplus and Stadler

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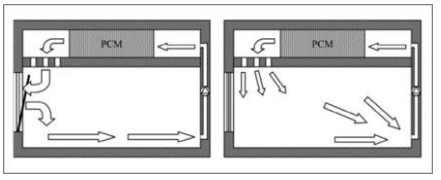
Passive cooling ventilation components

Evaporators and Phase Change Material



- Regarding Evaporators: Good performance of indirect evaporative cooling. Upcoming interest in ambient cooling, using mist nozzles, dry mist nozzles and dry mist fans. Both systems are limited to sufficient water supply. 1 kW evaporative cooling load causes a water demand of >2 l/h.
- Regarding PCM: Diurnal heat storage with PCM may increase the effectivity of night ventilation.

See Ventilative Cooling Sourcebook (Annex 62)
Picture from Transsolar at Mandai Zoo, Singapore

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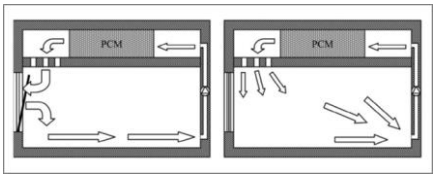
Passive cooling ventilation components

Evaporators and Phase Change Material

14:50 EXAMPLES OF AIR FLOW ENHANCING AND NATURAL COOLING COMPONENTS
Scott Paton, Monodraught, UK



- Regarding Evaporators: Good performance of indirect evaporative cooling. Upcoming interest in ambient cooling, using mist nozzles, dry mist nozzles and dry mist fans. Both systems are limited to sufficient water supply. 1 kW evaporative cooling load causes a water demand of 1,6 l/h.
- Regarding PCM: Diurnal heat storage with PCM may increase the effectivity of night ventilation.

See Ventilative Cooling Sourcebook (Annex 62)
Picture from Transsolar and Monodraught

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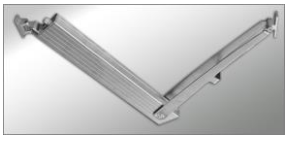
Automation Components

Actuators

Linear actuators, chain actuators,
folding and rotating arm actuators



- Relevant criteria in the selection of actuators are:
  Stroke, Force,
  space needed, visual appearance, water protection, insulation class
  Sound emission
  Durability, robustness
  energy consumption in operation and standby
- Linear actuators offer high stroke and force
- Chain actuators offer efficient use of space

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from ultraflexgroup and simon-rwa

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Automation Components

Sensors

Temperature,
radiation,
humidity,
occupancy,
CO_2,
air velocity

- Relevant criteria in selection of actuators are
  accuracy and reproducibility
  measurement/operating range
  response time
  linearity deviation and hysteresis
  stability for a period of at least 5 years
  no interference with other sensors
  stable output signal with minimal noise
  Low cross-sensitivity
  energy consumption in operation and standby

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Automation Components

Controllers

Local controllers or central controllers

- Control of Ventilative Cooling is essential and tricky, since Ventilative cooling components can be seen, heard and “felt”. Weakness in control not only causes malfunction but instant annoyance.
- User information is an essential aspect of Ventilative cooling, e.g. informing the users about the actual mode of operation.
- It pays to install DDC systems, which are reely programmable, especially regarding parameter setting and derived variables
- Aspect of relevance: entrapment protection.

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Automation Components

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15:20 VENTILATIVE COOLING INTEGRATED DESIGN
Jannick Roth, WindowMaster, DK

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Further Readings and Invitation

Picture from Transsolar at Mandai Zoo, Singapore

- Annex 62 Ventilative Cooling Proceedings https://venticool.eu/annex-62-publications/deliverables/
- Annex 80 Resilient Cooling Information https://annex80.iea-ebc.org/

Thank you