

Ventilative Cooling Components An Overview

Dipl. Ing. Dr. 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 Ventilative Cooling Components

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A Airflow guiding ventilation components:

- Windows, doors and rooflights
- Flaps, grilles, louvres and dampers
- Terminals

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Typologies of Ventialtive Cooling Components

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A Airflow guiding ventilation components

B Airflow enhancing ventilation components

- Powerless ventilators
- Chimneys
- Mechanical ventilators

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Typologies of Ventialtive Cooling Components

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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

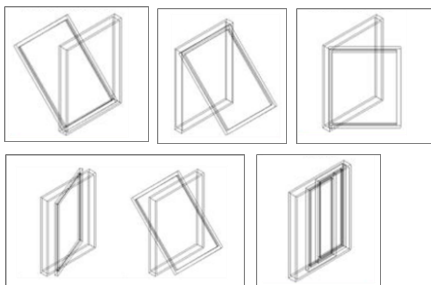
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Airflow guiding ventilation components

Windows, Doors and Rooflights

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



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

- Highly effective and cheap
- Manual use as well as automated
- Weak in case of driving rain, burglary, dust, insects and noise
- In case of uni-directional flow:

$$\dot{V} = C_d \sqrt{\frac{2}{\rho}} \sqrt{\Delta p} A = C_F \sqrt{\Delta p} \quad (\text{m}^3/\text{s})$$

Discharge Coefficient: $C_d = 0,6 \div 0,7$

e.g.: $A=1 \text{ m}^2$, $\Delta p=1 \text{ Pa} \rightarrow V=3.000 \text{ m}^3/\text{h}$

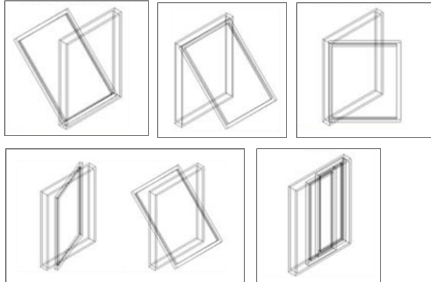
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Airflow guiding ventilation components

Windows, Doors and Rooflights

bottom hung (transom), top hung, side hung,
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See Ventilative Cooling Sourcebook (Annex 62)
Formula according to EN 16798



**CONTROLLED WINDOWS FOR
VENTILATIVE COOLING**
Peter Foldbjerg, Velux, DK

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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

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**APPLICATION OF LOUVRES TO
SUPPORT VENTILATIVE COOLING**
Ivan Pollet, Renson, BE

Airflow guiding ventilation components

Terminals

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



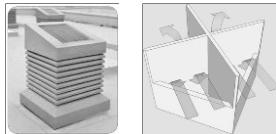
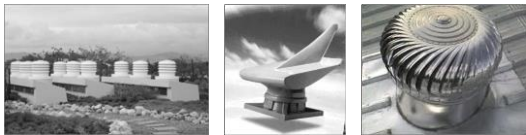
- Regarding trickle vents: Good integration in the window, available with sound attenuation functionality, wind pressure dependent pressure drop, integrated sound damper and insect mesh. Indicative airflow of 25 to even 50 m³/h per meter at 1 Pa
- Regarding disc valves: covering airflows from 30 m³/h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

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 $\Delta p = \left(\frac{1}{30}\right)\Delta T h$

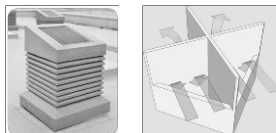
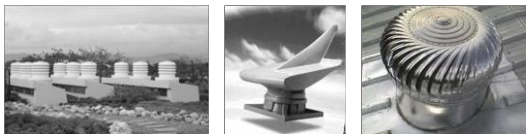
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- EXAMPLES OF AIR FLOW ENHANCING AND NATURAL COOLING COMPONENTS**
Nick Hopper, Monodraught, UK
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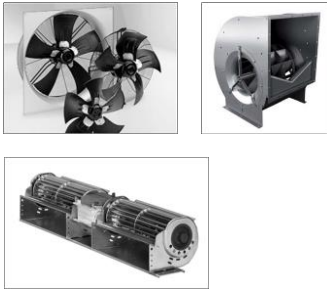
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Airflow enhancing ventilation components

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 $\Delta T=2K$ carries a cooling load of roughly 0,7 kW. An axial vent at $\Delta p=300$ Pa already consumes 0,3 kW and heats up the airflow already by 1K.
- Still, Ventilative cooling with mechanical cross flow ventilation and 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.

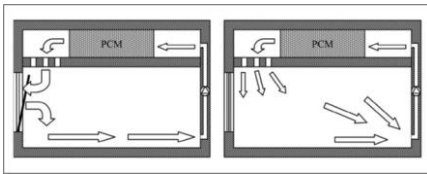
See Ventilative Cooling Sourcebook (Annex 62)
Pictures from lampsplus and Stadler

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Passive cooling ventilation components

Evaporators and Phase Change Material



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

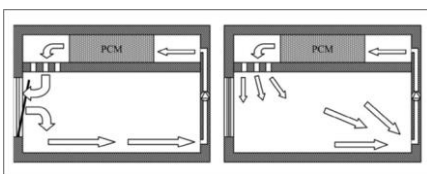
- Regarding Evaporators: Good performance of indirect evaporative cooling. Upcoming interest in ambient cooling, using mist nozzles, dry mist nozzles and dry mist fans. Both systems are limited to sufficient water supply. 1 kW evaporative cooling load causes a water demand of >2 l/h.
- Regarding PCM: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

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Passive cooling ventilation components

Evaporators and Phase Change Material



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

- 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.

**EXAMPLES OF AIR FLOW
ENHANCING AND NATURAL COOLING
COMPONENTS**

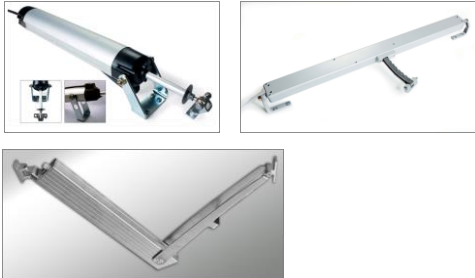
Nick Hopper, Monodraught, UK

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Automation Components

Actuators

Linear actuators, chain actuators,
folding and rotating arm actuators



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

- 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

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Automation Components

Sensors

Temperature,
radiation,
humidity,
occupancy,
CO₂,
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. 19

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Automation Components

Controllers

Local controllers or central controllers



**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/>
- peter.holzer@building-research.at

Thank you