LowTEMP

Ventilation Systems

Technical Introduction and Implementation

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

LowTEMP training package - OVERVIEW

Introduction

- Intro Climate Protection Policy and Goals
- Intro Energy Supply Systems and LTDH
- Energy Supply Systems in Baltic Sea Region

Energy Strategies and Pilot Projects

- Methodology of Development of Energy Strategies
- Pilot Energy Strategies – Aims and Conditions
- Pilot Energy Strategy – Examples
- Pilot Testing Measures
- CO_2 emission calculation
- LCA calculation

Financial Aspects

- Life cycle costs of LTDH projects
- Economic efficiency and funding gaps
- Contracting and payment models
- Business models and innovative funding structures

Technical Aspects

- Pipe Systems
- Combined heat and power (CHP)
- Large Scale Solar Thermal
- Waste & Surplus Heat
- Large Scale Heat Pumps
- Power-2-Heat and Power-2-X
- Thermal, Solar Ice and PCM Storages
- Heat Pump Systems
- LT and Floor heating
- Tap water production
- Ventilation Systems

Best Practice

- Best Practice I
- Best Practice II

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1. Technical Introduction

General function

Different heat recovery systems

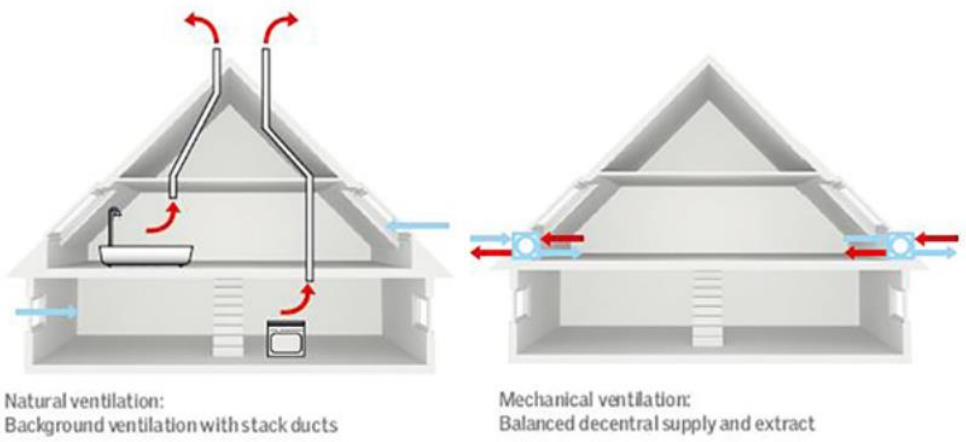
Technical Introduction

Ventilation systems instead of window ventilation

- Provision of fresh air → increased quality of indoor air → increased occupant's well-being
- Centralized / decentralized ventilation systems → management / monitoring of air exchange
- Possibility of heat recovery → significant energy saving potentials

Technical Introduction

Common natural and mechanical ventilation systems



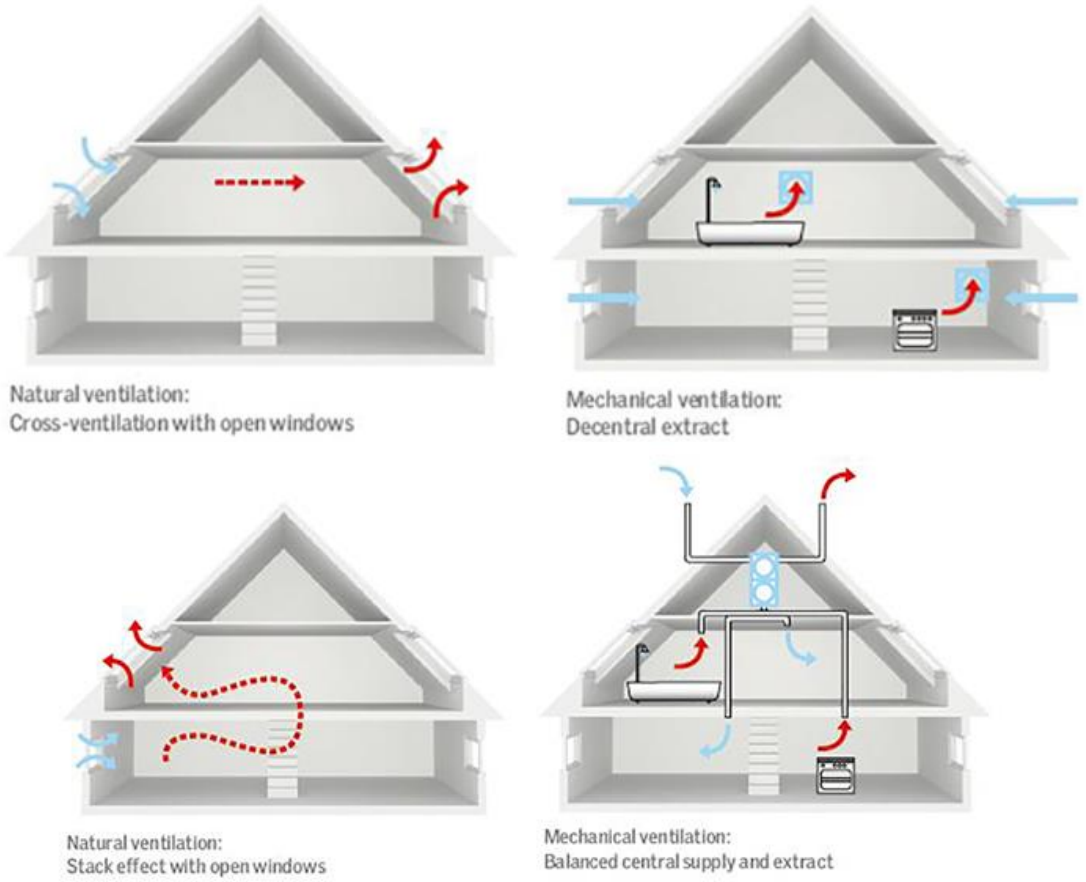


Figure 1: Ventilation systems. Source: Velux Group [1]

Centralised and decentralised ventilation systems

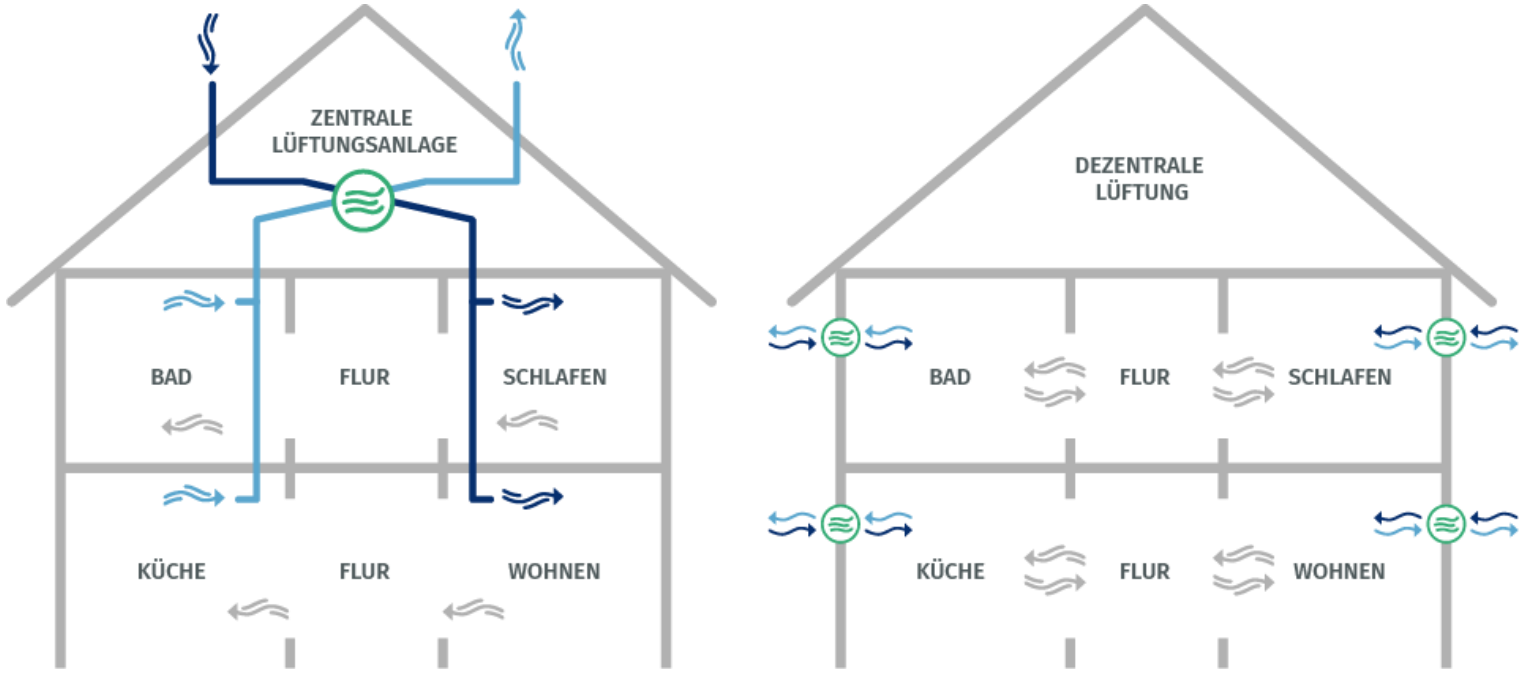


Figure 2: Centralised and decentralised ventilation systems. Source: Dierker Luft und Klima GmbH [2]

Technical Introduction

General function of heat recovery

- Winter

  cold outside air is preheated by the warm extracted indoor air and filtered

- Summer nights

  cool outside air is directed indoors via a bypass

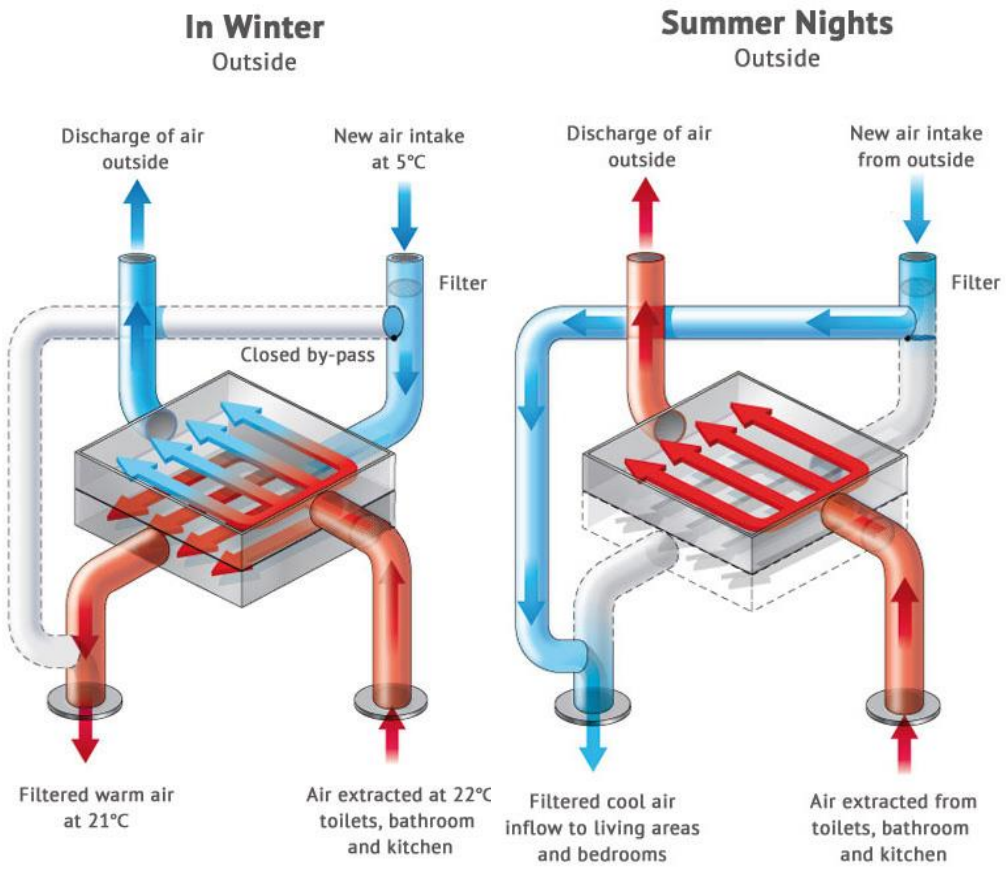


Figure 3: Seasonal situations of heat recovery systems. Source: Atlantics Australasia [3]

Technical Introduction

Main components of ventilation systems with heat recovery

- Fresh air intake & exhaust air outlet
  protected by screen
- Heat exchange core
  different systems available
- Fresh air outlet & stale air intake
  supported by circulation fans
- Filters at air intakes:
  pollen and dust can be filtered
- Drain for condensate
- Control unit

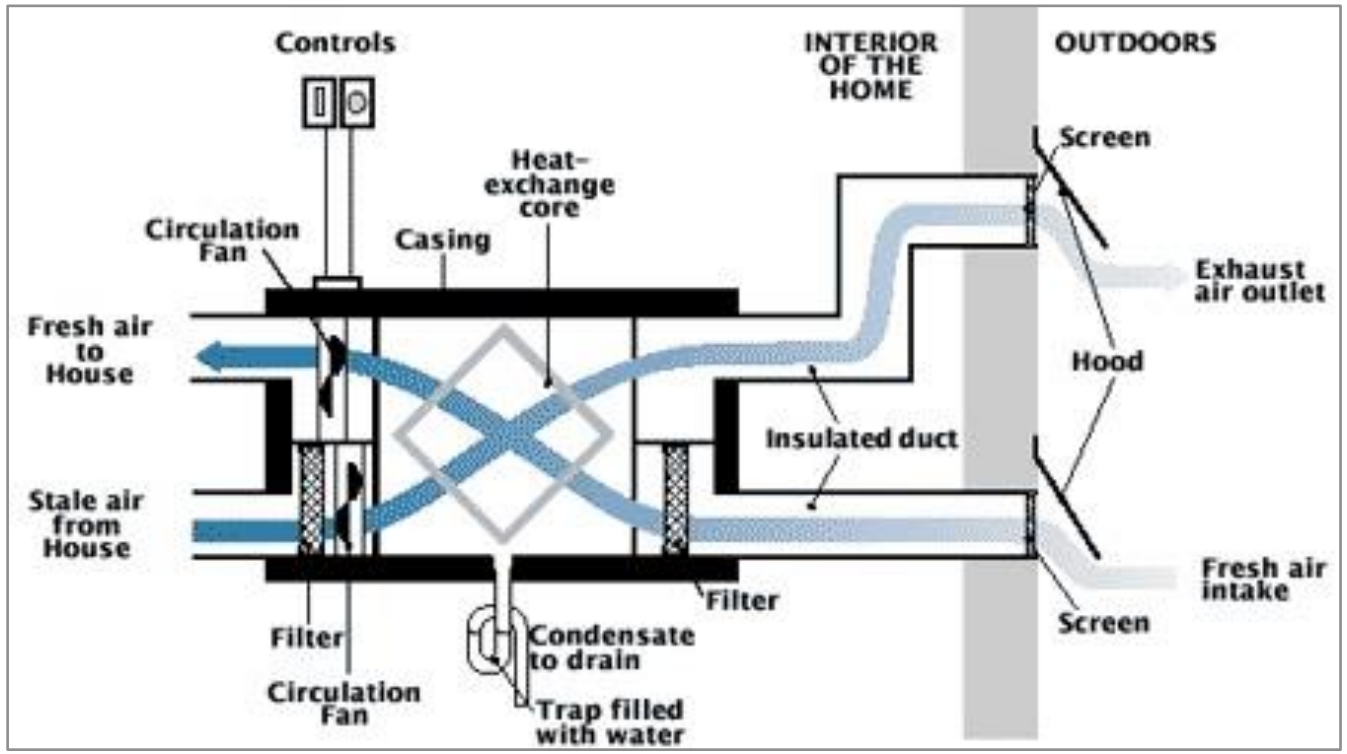


Figure 4: Components of a heat recovery ventilator. Source: One House Green [4]

Technical Introduction

Recuperative heat recovery

- Heat is directly transferred from one airstream to another via a metal sheet
- No connection between the two airstreams → no contamination

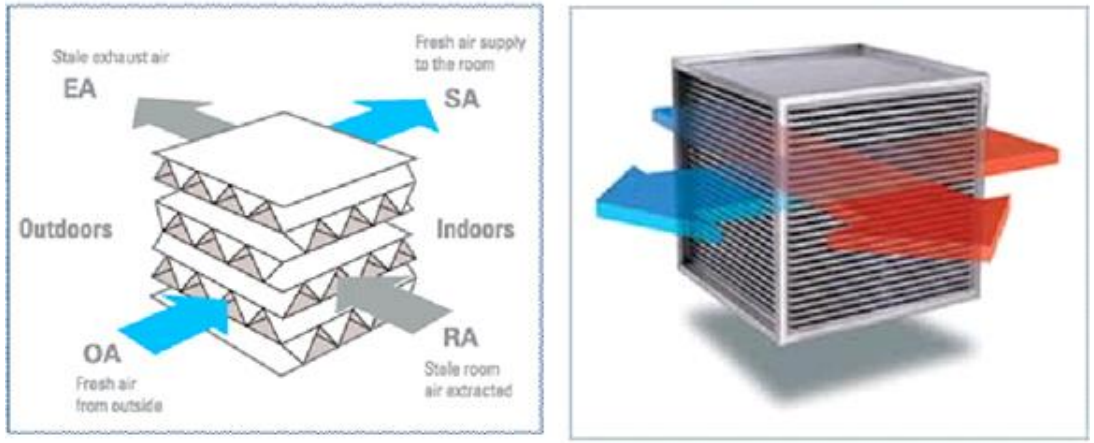


Figure 5: Plate heat exchanger. Source: NFAN [5]

Plate heat exchanger

- Package of thin metal/plastic sheets with small spacing between them
- Warm and cold airstream are alternately directed through these spaces
- Heat is transferred from one airstream to the other
- High efficiency rates

Technical Introduction

Regenerative heat recovery

- Heat is transferred to a solid or liquid intermediate medium
- Medium transfers the heat to the cold outdoor air

→ Heat is buffered and then later released

Examples

- Rotary thermal wheels
- Heat pipes
- Circuit connected system

Technical Introduction

Rotary thermal wheels

- Wheel turns 5-20 times per minute
- Consists of metal sheets
  → thermal storage mass
- Heat is tranferred from extract air to the wheel and then the outside air
  → preheating the supply air

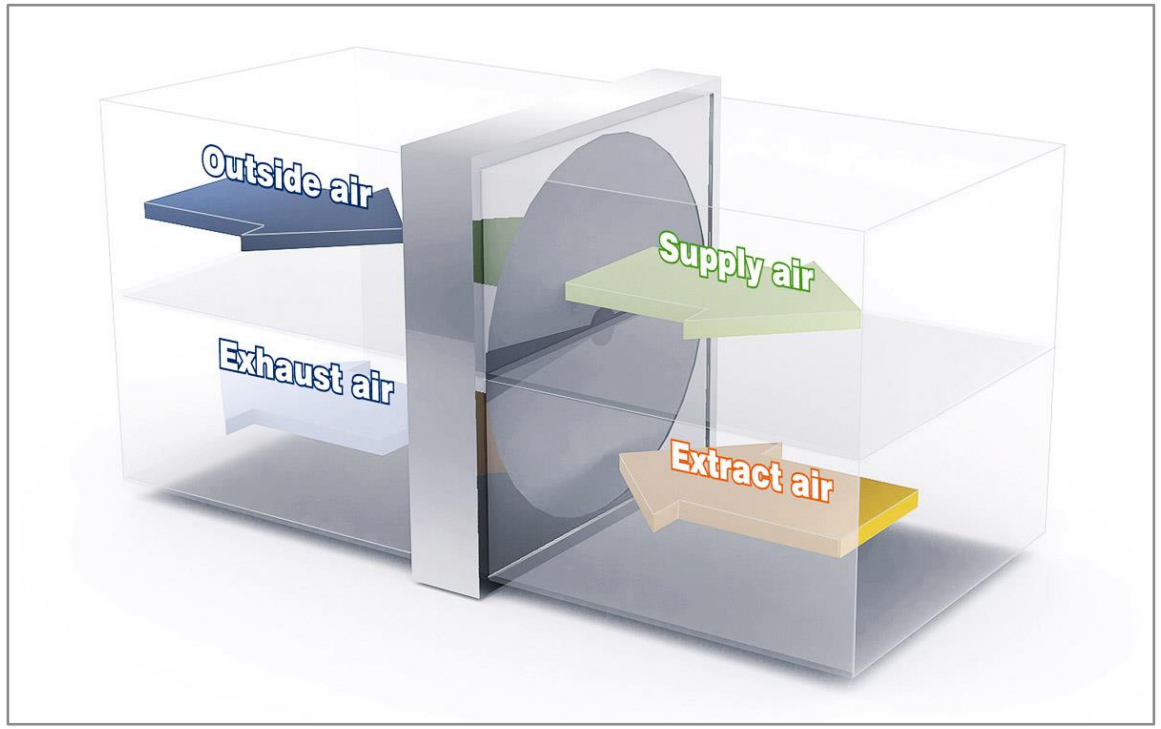


Figure 6: Rotary thermal wheel. Source: Klingenburg USA [6]

Technical Introduction

Heat pipes

- Heat pipes are filled with a refrigerant liquid
- Warm extract air functions as the heat source
  → heat leads to evaporation of refrigerant liquid
- Vapour rises to the other end of the heat pipe
- Cold outdoor air passes this end of the heat pipe
  → vapour liquifies and releases the heat
- Supply air is preheated and refrigerant liquified
  → cycle starts again

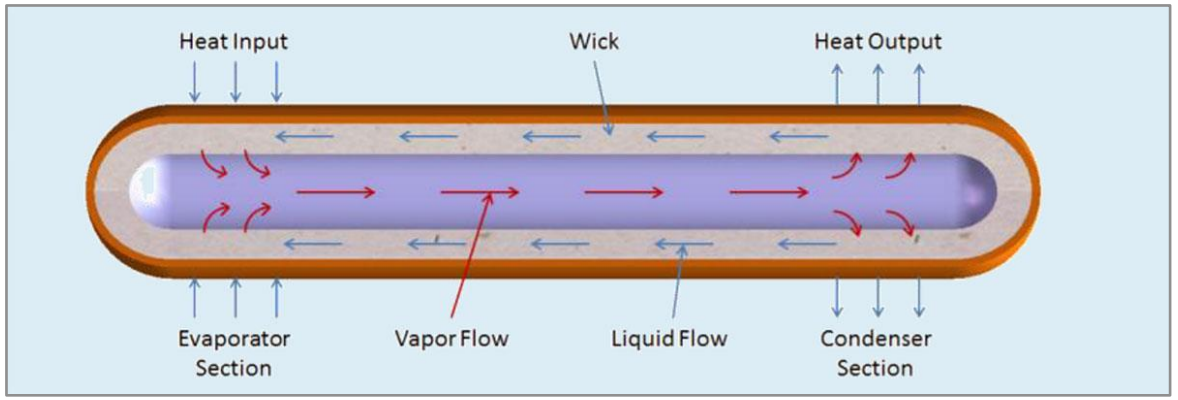


Figure 7: Principle of heat pipes. Source: Cooliance [7]

Technical Introduction

Circuit connected system

- Airstreams are separated and can be installed separately
- Heat transfer medium is circulating in a pipe system

→ heat is transferred from the warm exhaust air to the medium and then to the cold outside air

→ the same mechanism works for cool summer nights precooling the supply air

Advantages and disadvantages of different heat recovery systems

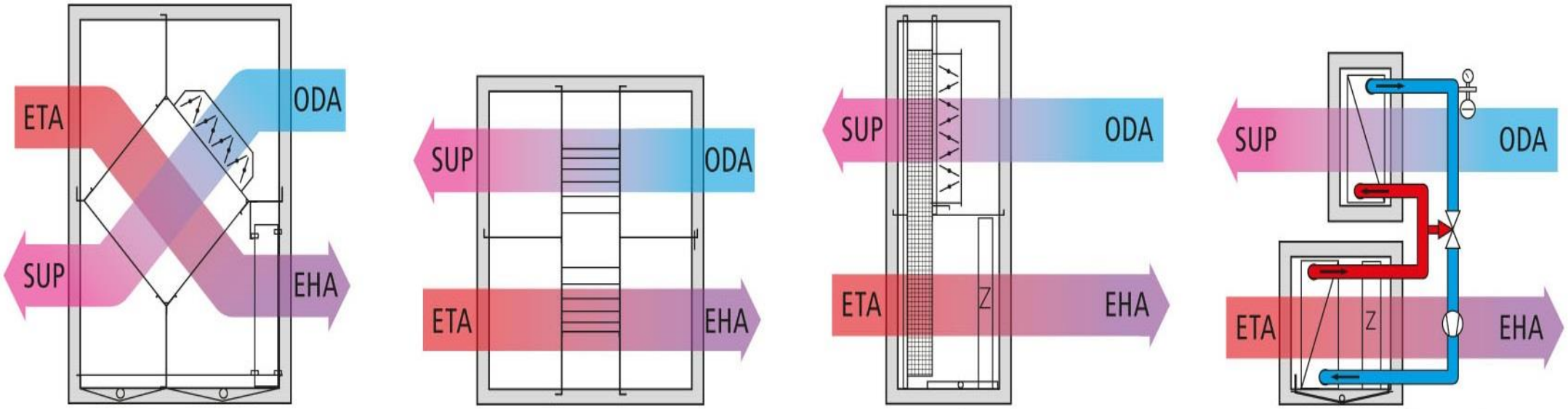


Plate heat exchanger *Rotary thermal wheel* *Heat pipes* *Circuit connected system*

Figure 8: Heat recovery systems. Source: KLAISS GmbH Apuso Lüftungstechnik [8]

Technical Introduction

HEAT RECOVERY SYSTEM	ADVANTAGES	DISADVANTAGES
Plate heat exchanger	◦ No contamination ◦ Fixed parts, high reliability ◦ High heat transfer coefficient	◦ Limited to two airstreams ◦ Condensation
Rotary thermal wheel	◦ Compact design ◦ High efficiency	◦ Energy input required ◦ Cross contamination of airstreams
Heat pipes	◦ Heat recovery in two directions possible ◦ Compact design ◦ Fixed parts, high reliability	◦ Requires close localization of air streams ◦ Moving parts, maintenance necessary
Circuit connected system	◦ Airstreams can be separate ◦ No contamination	◦ Pumps are required to move the liquid ◦ Rather low efficiency ◦ Difficult to integrate

Technical Introduction

Ventilation system with an earth heat exchanger

- Earth to air:
  outside air is directed in a pipe 1,5m-2m beneath the ground

  → air is preheated/precooled due to constant ground temperature

- Earth to medium to air:
  heat exchange medium is directed in pipes 2m beneath the ground

  → medium is preheated/precooled due to constant ground temperature

  → heat is transferred from medium to cold outdoor air

  → the same mechanism works for cool summer nights (precooling)

Technical Introduction

Heat recovery and heat pumps

- Hot water heat pump:
  heat pump extracts warm air from building

  → heats up drinking water

  → connected water storage system has to be available

- Air heating and heat pump:
  heat pump extracts warm air from building

  → heats up supply air

  → heat pump can heat up the air so no additional heating is required

Technical Introduction

Exhaust air heat pump

A: warm room air is drawn into the duct system

B: warm room air is led to F 730

C: After passing F730, the room air is discharged to the outside, which lowers the air temperature

D: F730 supplies the building with service water and heating heat

E: Outside air is fed into the building and heated as required

F: Air is led from rooms with outdoor valves into rooms with exhaust air valves

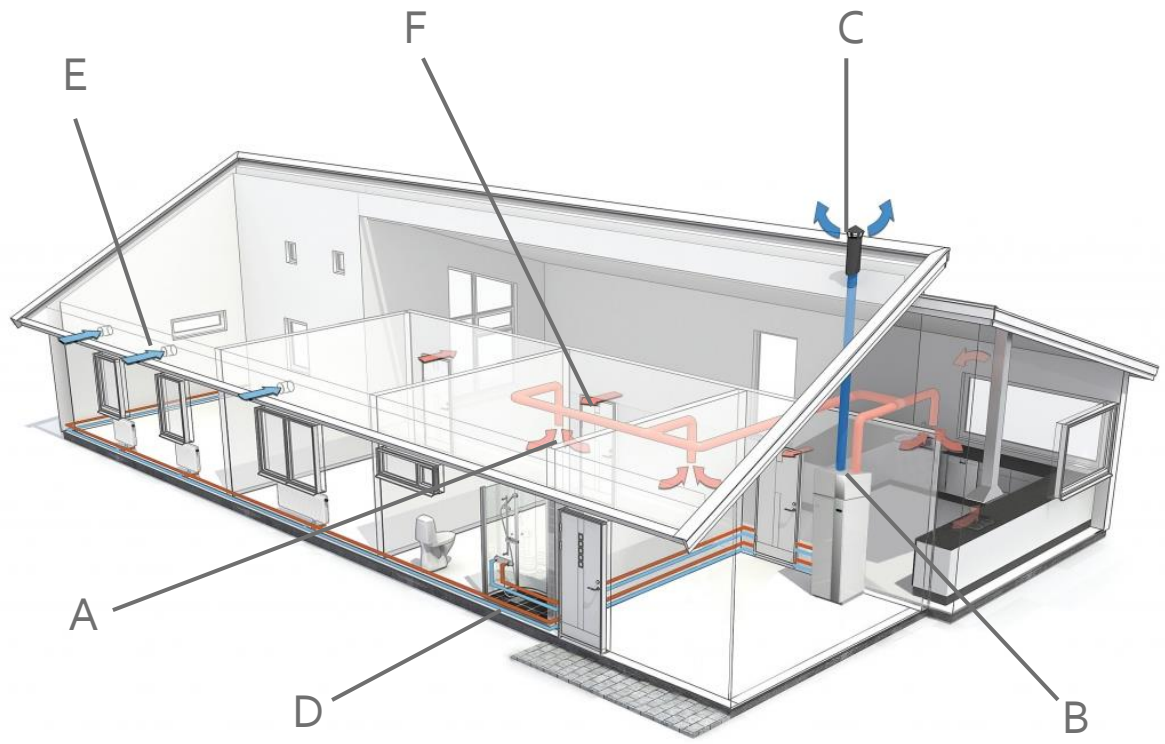


Figure 9: Functional principle of exhaust air heat pump. Source: NIBE Systemtechnik GmbH [9]

Example Plant (NIBE 730/NIBE 750)

- Specially developed for modern houses with low heating requirements
- Basic units combine heating, domestic hot water and controlled domestic ventilation and heat recovery
- Used in single-family houses and apartment buildings with a living area between 75 and 200 m²
- Basic unit does not require more space than a household appliance

Figure 10: NIBE 730/NIBE 750. Source: NIBE Systemtechnik GmbH [10]

2. Implementation

Planning and design

Examples decentralised ventilation units/systems

Implementation

Planning and design - Unit size and distribution box

- The unit size is based on air flow volume and design
- Operation planned at 75% of max. -> system resistance
- Distribution box made out of metal sheets
- Mounted on the walls, under the ceiling, in ceiling or on the floor

Implementation

Planning and design - Supply and exhaust air pipe system

- Installation in the concrete ceiling (1)
- Laying in the shaft (2)
- Installation on the floor (3)
- Installation under the ceiling (4)
  in frame construction

(1)

(3)

(2)

(4)

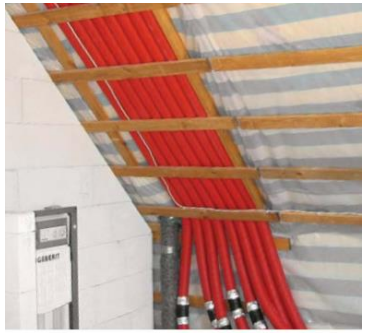


Figure 11: Planning and design. Source: Vallox GmbH [11]

Implementation

Planning and design - Silencers

- Ventilation generates noise, that is transferred via the ductwork
- To prevent noise pollution silencers are installed in the pipe system
- German DIN standard requires <30 dB in recreation rooms
- Dense residential development can call for additional silencers

Implementation

Planning and design - Diffusers

- The air outlets are to be installed in an accessible way for cleaning, maintenance
- Can be installed in walls or ceilings, designed to allow good air flow through the room
- Supply Air:
  - Not behind curtains, cupboards or other furniture, not directly above living area (bed, sofa)
- Exhaust air:
  - As high as possible under the ceiling, not directly above radiators
  - In close proximity to odour and moisture sources (toilet, shower)
  - Kitchen fumes are extracted with filters to prevent grease pollution

Decentralised fan (Inventer) with heat recovery

- Two airflows pass through a copper heat exchanger located inside the working module
- Two airways are separated from each other, both inside the working module and the „input-output"
- Installation of filters is possible

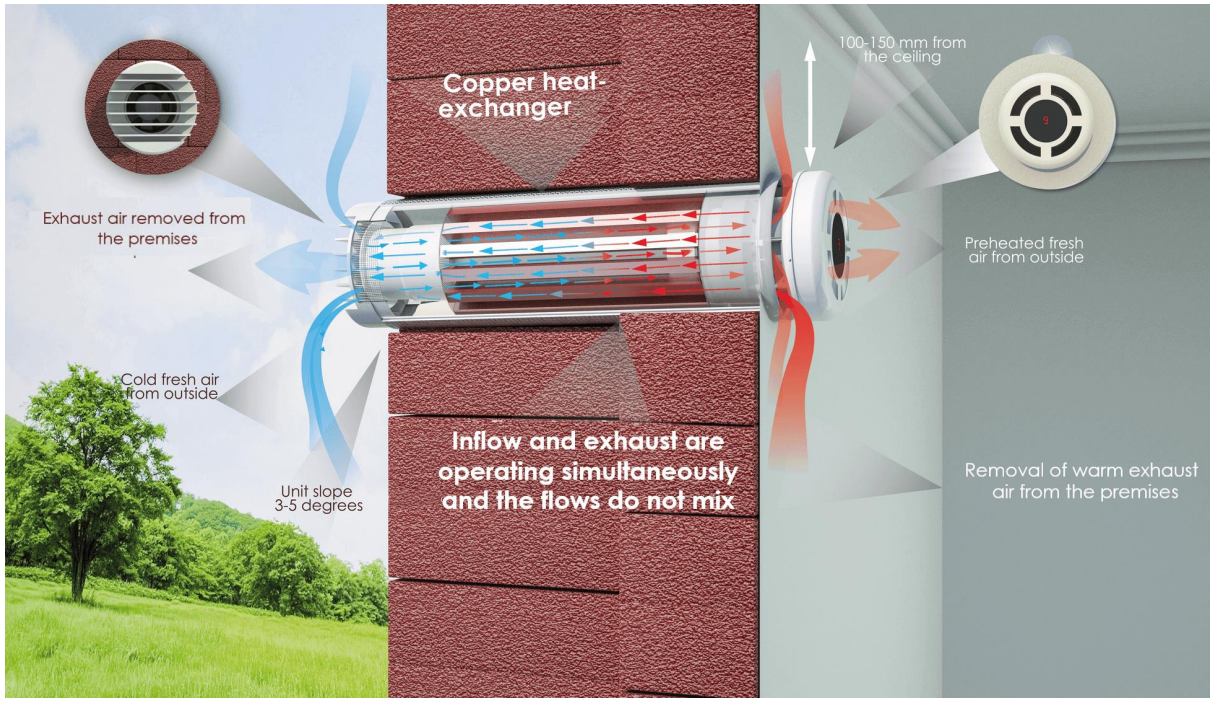


Figure 12: Prana ventilation system with heat recovery. Source: Ecostream [12]

Technical Introduction

Decentralised ventilation unit with heat recovery

- Components:
  ceramic heat acumulator, reversing fan
  double air deflectors for straightening the air flow,
  filters for all hygenic requirements,
  lockable inner panel, powder coated,
  driving rain-proof weather protection hood
- Inner ceramic core stores the heat
- Direction change after 70 seconds of rotation
- Ventilation system is operated by appropriate controllers

Figure 13: Prana ventilation system with heat recovery, source: inVENTer GmbH [13]

Implementation

Decentralised ventilation systems for window reveals

- Polish company EWTG developed a thermal ventilation system for window frames
- Decentralised ventilation, can be added to existing buildings
- Allows the supply air to mingle with the inside air
  -> preheated air
- Has a patented valve that allows constand air flow regardless of athmospheric conditions

Implementation

Decentralised ventilation systems for window reveals

- Is particularly suitable for installation on exterior walls with insulation, e. g. as part of a building renovation
- The wall opening must be in the immediate vicinity of a window, as the air inlet and outlet is through a ventilation grille in the window reveal
- The flat duct is laid inside the insulation towards the window reveal

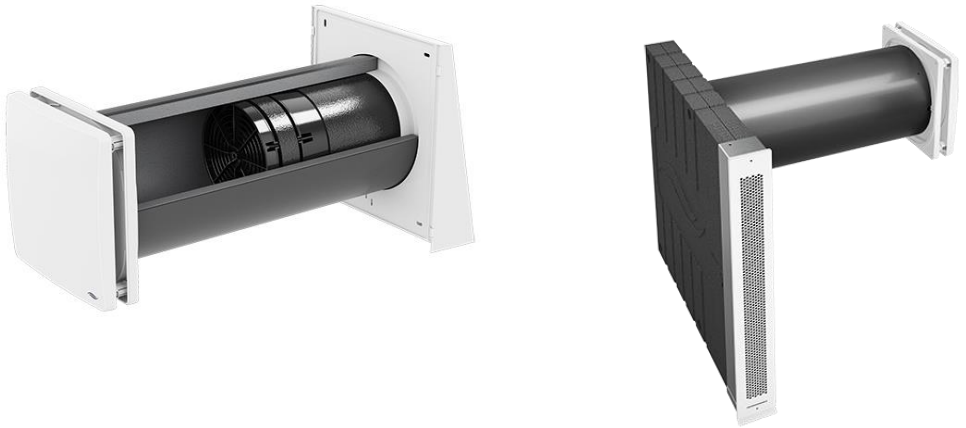


Figure 14: Decentralised ventilation system for window reveals. Source: inVENTer GmbH [14]

Implementation

Decentralised ventilation systems for window reveals

- Aesthetic integration of the external and exhaust air ducting on the house facade
- Excellent sound insulation values
  - Reduces the intrusion of external noise and expands the planning possibilities
- Perfectly suited for inner-city living areas

Figure 15: Decentralised ventilation system for window reveals. Source: Zehnder Group Deutschland GmbH [15]

Conclusion

- Ventilation systems enable the controlling and monitoring of the air exchange of a building. This way the air can also be filtered.
- Integrated heat recovery uses the energy of the exhaust air to preheat or precool the fresh supply air. This can result in significant energy saving potentials and economical benefits.
- The choice of the appropriate system depends on the situation and must be carefully chosen to ensure an ideal utilization.

References

- [1] Velux Group. Ventilation and ventilation systems. https://www.velux.com/what-we-do/research-and-knowledge/deic-basic-book/ventilation/ventilation-and-ventilation-systems
- [2] Dierker Luft und Klima GmbH. https://www.dierker.de/faq/
- [3] Atlantics Australasia. https://atlantics.com.au/optimocosy-ventilation/
- [4] One House Green. http://onehousegreen.com/heat-recovery-ventilator/
- [5] Northern Fan Supplies (NFAN). https://www.nfan.co.uk/what_are_heat_recovery_systems
- [6] Klingenburg USA. Rotary Heat Exchangers. http://www.klingenburg-usa.com/knowledge/rotary-heat-exchangers/
- [7] Cooliance. http://www.cooliance.com/NA/Technologies/Heat-Pipes/index.php
- [8] KLAISS GmbH Apuso Lüftungstechnik. https://www.apuso.de/lueftungstechnik/waermerueckgewinnung/

Last reviewed on: 13.04.2021

References

- [9] NIBE Systemtechnik GmbH. https://www.nibe.cz/grafika
- [10] NIBE Systemtechnik GmbH. Produktflyer NIBE F730/F750. https://www.nibe.eu/assets/documents/20730/639703-1.pdf
- [11] Vallox GmbH. Planungshandbuch „Lüftungsspezialisten". https://vallox.de/Service/Downloads/Unterlagen?selection=handbuch
- [12] Ecostream. The working principle of "Prana" recuperator. https://ecostream.org.uk/decentralised-mechanical-ventilation-with-heat-recovery-dmvhr/
- [13] inVENTer GmbH. https://www.inventer.de/produkte/lueftungsgeraete/inventer-iv14r/
- [14] inVENTer GmbH. https://www.inventer.de/produkte/lueftungsgeraete/inventer-iv14r-corner/
- [15] Zehnder Group Deutschland GmbH. https://www.zehnder-systems.de/csy-neuheit-erweiterungen-dezentral

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