Heizung - Lüftung - Klimatechnik
Heating - Ventilation - Air Conditioning

Your Profit Zone

Energy Saving:

Heat Recovery
Cold Recovery
Humidity Recovery
Night Cooling
Multifunctional Utilization

WOLF
GEISENFELD

Energy Recovery for a clean Environment

With growing environmental awareness and increasing requirements of authorities, the energy-saving developments of air-conditioning technology are getting more and more important.

Lower energy consumption means less pollutant emissions, better protection of the environment and lower operational costs.

Heat Recovery System (HRS)

In winter (heating period), a part of its energy is taken from the warm exhaust air leaving the building and is added to the cold outside air flow.

Heat from Refrigeration Processes

Even small refrigerating plants produce so much waste heat that using this waste heat will pay off quickly. This effect is even accelerated by growing energy costs.

Heat from Dehumidification

When liquefying water steam, heat is being released which can be used by recovery.

Cold Recovery

In summer, when outside temperatures are high (cooling period), the colder exhaust air is pre-cooling the outside air.

By recovering coldness from the exhaust air, a lot of energy is being saved for the refrigerating machine.

Almost all heat recovery systems can also be used for recovering coldness in process reversal.

Coldness from Dehumidification

Moreover, the exhaust air can be humidified adiabatically and thus cooled - instead of machine cooling or additionally.
The coldness recovered can be transferred to the warm outside air. This process saves a lot of energy for cold production.

Humidity Recovery

Air inlet humidification by recovering the humidity from the warm exhaust air reduces the energy consumption of RLT-plants with room air humidity regulation in winter.

Plants with humidity recovery are in total much more energy-efficient than plants without humidity recovery.

In RLT-plants with cooling, the humidit transfer reduces the necessary refrigeration capacity.

The air-conditioning may be rated smaller, since it has to provide up to 20 % less capacity, thus saving investment and operating costs.

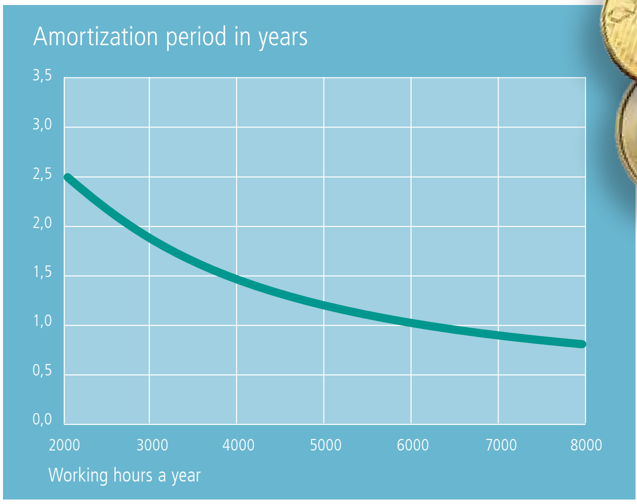
You can save up to 30 % of your energy costs by HRS-systems!

... and economical Operation

Heat recovery is always economical

The essential efficiency factors are:

- Location of the building
- Type and utilization of the building
- Type of the heat recovery system (HRS)
- Kind of operation of the technical plant for room air (TPRA)



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Check List for Planning

Careful planning is the optimal saving effect.

The following items should definitely be clarified when planning heat recovery plants.

- **Record data precisely and practically**
  Above all, determine air capacities, temperatures and humidity load at the exchanger entrance.
  Caution! If rating data are selected too optimistically, the forecast values often cannot be reached in practice.
- **Determine location and air guidance**
  Here, installation costs can be saved from the beginning. Often, also the exchanger system is defined here.
- **Determine necessary air quality**
  Which demands are raised to tightness (contamination of outside air)?
  Is air cleaning required?
- **Humidity Transfer**
  Shall humidity be transferred?
  Is humidity transfer required only in winter or also in summer?
- **Regulation**
  Is capacity regulation required?
  Is the integration into existing building management sytems required?
- **Kondensate Production**
  Is condensate being produced? If so, which measures are required?
- **Is there a danger of corrosion?**
- **Is there a danger of contamination?**
- **Temperature Range**
  Are special designs regarding temperature required?
- **Determine heat exchanger system**
  Select suitable system and optimize it regarding efficiency.
- **Optimization of the Plant**
  May the heat/cold/humidity production and distribution be dimensioned smaller by the heat/cold/humidity recovery?
- **Specification**
  Specify exactly the design and make sure that the specificatios are also installed.
- **Acceptance**
  Effect commissioning with acceptance test.

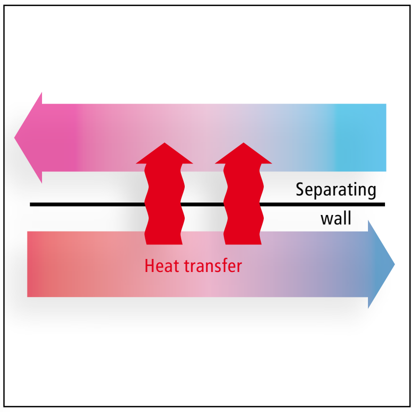
Guidance for HRS-Systems

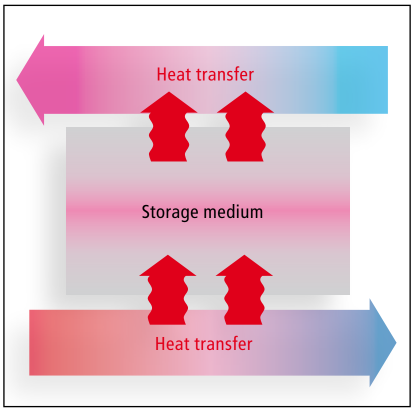
HRS-Systems

Basically, there are two different systems of heat recoveries for RLT-plants:

- **Recuperators**
- **Regenerators**

Systems with separating surfaces, consisting of regenerative and recuperative function units, like for example cycle compound systems, belong to regenerative systems, since the transfer the temperature by an intermediate medium.





Tips for Selection

- Return heat number and pressure loss depend on the operating data; therefore always calculate both with extreme values (summer, winter) **and** with average values.
- If outside and outlet air units are placed separated from each other, only the cycle compound system can be used.
- For exhaust air containing pollutants, heat recoveries without separating surfaces (for example rotors) are not suitable.
- For low air capacities (approx. 1.000 to 20.000 m³/h), plate heat exchangers are the most economical solution.
- In process engineering, the heat tube is often a good solution for very high temperatures (up to 200 °C).
- For high air capacities (approx. 15.000 to 100.000 m³/h), the rotation heat exchanger is the most economical solution, unless other reasons tell against it.
- Regarding efficiency and protection of the environment, the return heat number should be at least 50 %, better 60 %.
- For saving energy, the pressure loss should be kept as low as possible.

These recommendations are based on long years of practical experience and are therefore generalized.
Of course, different decisions can be taken in concrete applications.

Recuperative Systems

**By recuperative heat recovery, the heat is directly transferred from the exhaust to the air inlet flow by a fixed separating wall made of metal, plastic or glass.
Material transfer is not possible.**

Depending on their shape, they are called

- **Plate Heat Exchangers** or
- **Tube Heat Exchangers.**

A further distinctive feature of recuperative systems is the kind of both air flows, running either in

- **cross-flow** or in
- **counter-flow** (also called cross counter-flow).

By the way, with otherwise equal prerequisites, the k-values of metal and glass differ by only approx. 5 %.

Plate distance and profiling are important criteria for this kind of heat exchangers. Small distances (few millimeters) enable the installation of much more transfer area with the same cross-section and also more capacity than with larger distances; however, also the pressure loss is rising.

Regenerative Systems

In regenerative heat recovery systems, the heat is transferred indirectly (by a storage mass or an intermediate medium) from the exhaust to the inlet air. Material transfer is possible.

Regenerative heat recovery systems are available in very different designs.
The VDI 2071 distinguishes between rotating and static storage masses. Other divisions distinguish between systems with and without separating surfaces.

- **Rotation Heat Exchangers** with rotating storage mass in corrugated foil structure made of metal for recovering heat and humidity are the best-known system. The rotating storage mass of the rotor is transferring the heat and - depending on the filling material - also humidity from one air flow to the other.

- **Accu-block Heat Exchangers** consist of two or more static stores which are alternately „loaded" by the warm exhaust air and „unloaded" to the passing cold outside air. Installation dimensions are flexible, the return heat number is especially high. Storage blocks are also available extensible in order to fulfill the requirements of the VDI 6022.

- **Cycle Compound Systems** are working with a water/glycol mixture as intermediate medium in a closed tube cycle between radiator and heater.

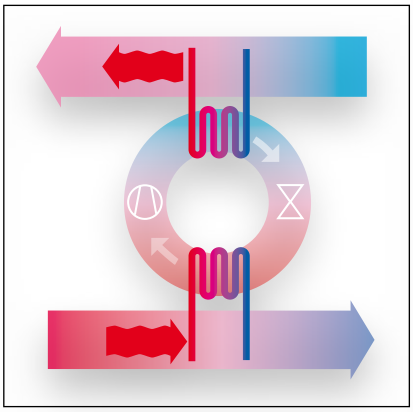
The heat taken from the exhaust air by the air radiator is transferred by the medium to the air heater (pre-heater) in the outside air flow, so that both air flows needn’t be joined.
By the tube system and sufficient insulation, even longer distances can be bridged. Therefore, also a locally separated installation of heater and radiator is possible.

▶ **High-performance Cycle Compound Systems** reach substantially higher heating capacities, with equal functional principle.

▶ The warm outlet air flow passing the **heat tube** makes the refrigerant (intermediate medium) in the closed tube system evaporate. The steam is condensating in the range of the cold outside air flow and circulating back by its gravity.

A horizontal installation requires a certain descent of the internal pipes, following the warm air flow. In summer operation, a tilting regulation can be used here.

With vertical installation, the outlet air must pass below and the outside air above.



Heat Pump

Also heat pumps can be used for heat recovery. The temperature of the outlet air is increased by the heat pump and given to the entering outside air.

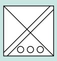
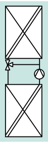
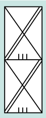
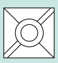
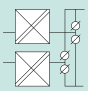
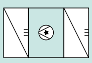
Colour Legend

For the layouts in this brochure, the colours are defined acc. to the air temperature:

- AU = outside air (cold)
- ZU = inlet air (warmed up)
- AB = exhaust air (warm)
- FO = outlet air (cool)

Market Shares

Rotation Heat Exchangers approx. 35 %
Plate Heat Exchangers approx. 30 %
Cycle Compound Systems approx. 20 %
Heat Tubes approx. 5 %

VDI 2071	Denomination	Symbol	Air Flows	Humidity Exchange
I.1	Plate Heat Exchanger		joined	no
I.2	Tube Heat Exchanger		joined	no
II.1.1	Cycle Compound Heat Exchanger		separated	no
II.2	Heat Tube		joined	no
III.1	Rotation Heat Exchanger		joined	possible
III.3	Switch-over Heat Exchanger (Accumulator)		joined	possible
IV	Heat Pump		separated	no

Heat Recovery Systems

Plate Heat Exchangers

Plate Heat Exchangers for Heat Recovery

Function

In plate heat exchangers, both air flows are separated from each other, so that the transfer of humidity, but also of pollutants, is not possible.

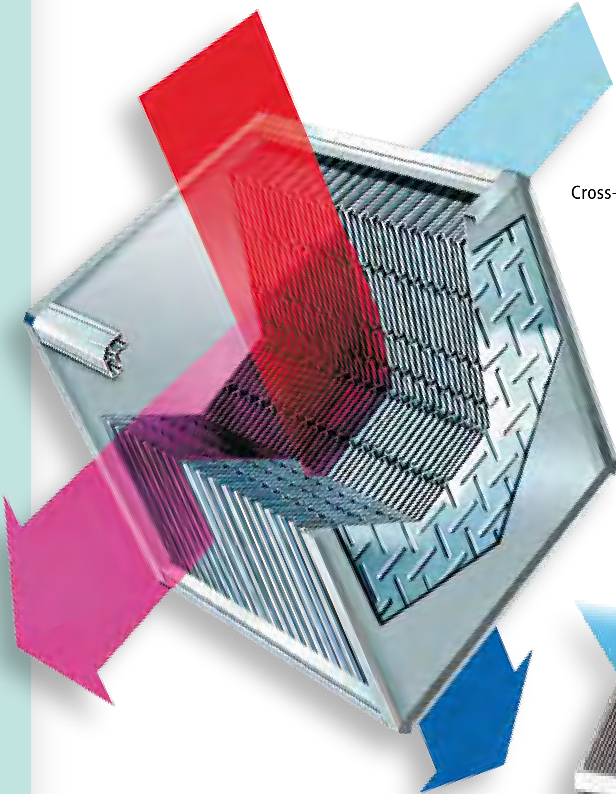
By a pure heat pipe (recuperative), the temperatures of both air flows are adapted to each other.

Cross-flow Heat Exchanger

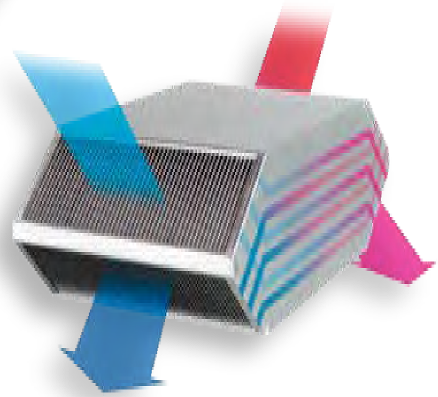
The return heat number is approx. 50 % to 60 %. The pressure loss is between 150 and 250 Pa. Plate heat exchangers are also available with adiabatic cooling.

Counterflow-Heat Exchanger

By the same functional principle, counterflow heat exchangers (also called cross-counterflow heat exchangers) return heat numbers up to approx. 90 %.



Cross-flow Heat Exchanger



Cross-counterflow Heat Exchanger

Application

Plate heat exchangers are preferred if

- no humidity is to be transferred,
- the outside air must not be contaminated,
- high operation security is required,
- for smaller air capacities (approx. 1.000 to 20.000 m³/h) low costs are required.
- The heat recovery can be regulated by bypass.

Quotation Text

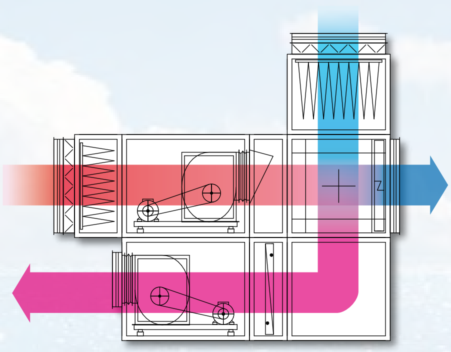
Plate heat exchangers in cross or diagonal design for two air flows crossing each other, plate heat exchangers with opposed air flows.

The plates are conjugated to each other by a fold which is additionally sealed with synthetic resin. A bypass flap can be installed in the outside air flow in order to assure that the heat recovery is not working in summer.

By respective flap control, the bypass can serve as freezing protection of the heat recovery. If requested, an integrated recirculating air flap is possible.

Complete exchanger package with condensate collection tub made of corrosion-proff material, installed in the unit housing. Condensate discharge connection led out sidewards.

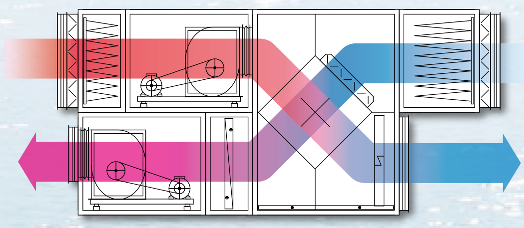
Combination Possibilities



Air Guidance vertical - horizontal

Sideview

The air flows are crossing each other in the heat exchanger.



Air Guidance diagonal

Sideview

The air flows are crossing each other in the heat exchanger.

Rotation Heat Exchanger

Rotation heat exchanger for heat recovery

Function

By turning movement, the exhaust air and the outside air are alternately flowing through the rotor mass, while the rotor mass is nearing the air flow temperature, i.e. it is alternately being heated and cooled, thus transferring energy between both air flows.

The return heat number is usually 70 % to 75 %. The pressure loss is between 70 Pa and 150 Pa.

It is a regenerative system without separating surfaces, i.e. also substances like for example humidity can be transferred. Inlet and exhaust air must be joined.

By planning rinsing areas, an undesired contamination of the inlet air with exhaust air is minimized.

Application

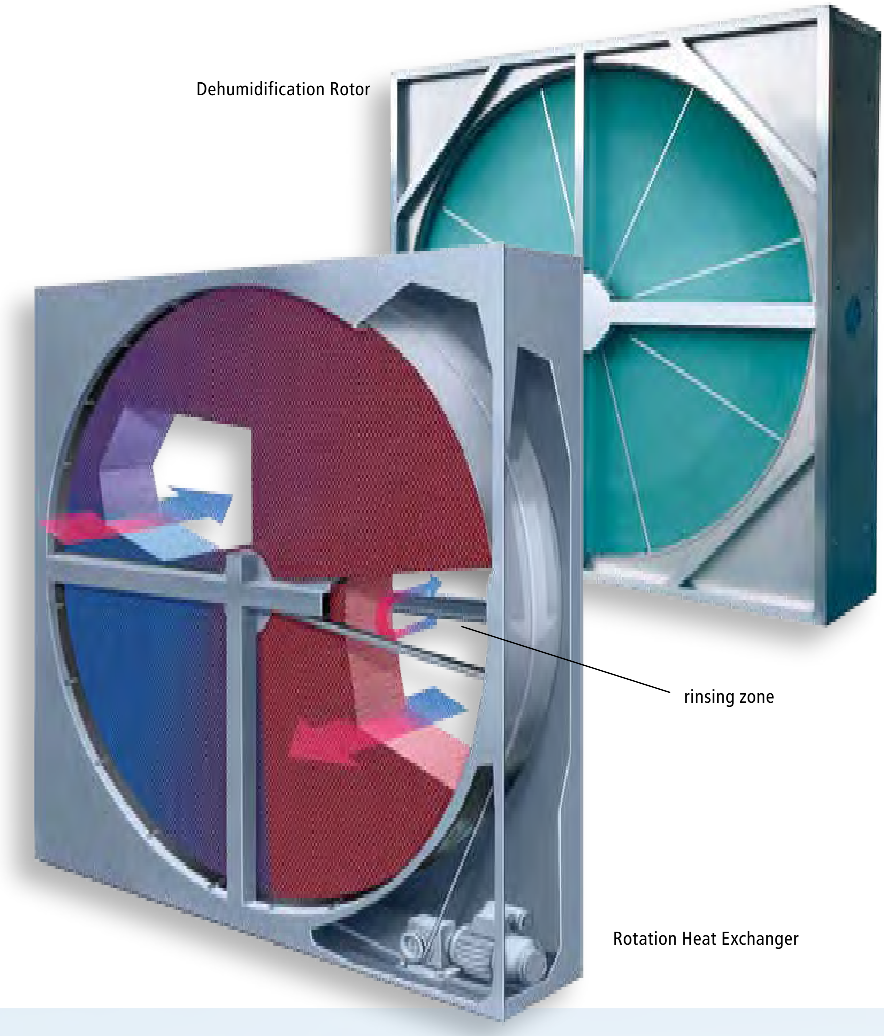
Rotation heat exchangers are preferred if

- a high return heat number is required,
- beside heat also humidity is to be transferred,
- high air capacities (approx. 15.000 to 100.000 m3/h) are required,
- with high air capacities low costs are required.
- Stepless regulation by number of turns possible
- Bypass possible

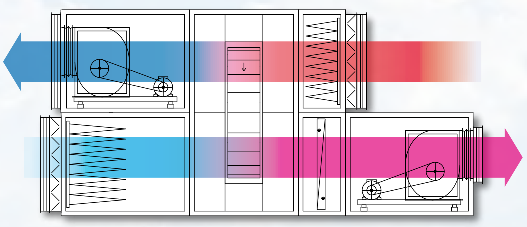
Quotation Text

Heat recovery with rotating heat exchanger, with a storage mass made of alternately smooth and corrugated aluminium foil for laminar air flow. Rotor sealing by sealing strips made of felt, rubber or brushes, held by clamp springs.

Drive by motor with step-down gear and V-belt all around the rotor circumference. Rotational speed of motor infinitely adjustable.



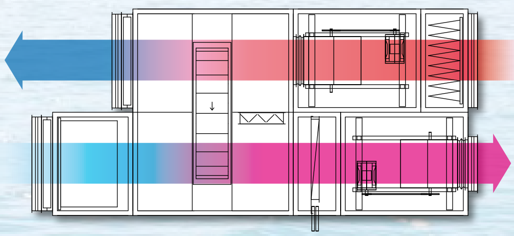
Combination Possibilities



Air Guidance on top of each other
Sideview

The air flows are led on top of each other through the unit.

The outlet air flow can be above or below.



Airguidance beside each other
Top View

The air flows can be led through the unit as you like.

Heat Recovery Systems

Cycle compound system

Cycle compound system for heat recovery

Function

A cooling register in the outlet air and a heating register in the outside air are connected by advance and return, the piping system is filled with water/freezing preventive. A pump is circulating the water.

The cooling register in the exhaust air is absorbing water and transferring it onto the water cycle, which is transporting the heat to the heating register in the outside air. The outside air is emitting the heat again.

The return heat number is usually 35 - 45%. The pressure loss should be in between 150 and 250 Pa in order to guarantee efficiency.

Application

Cycle compound systems are preferred when

- exhaust air and outside air are separated from each other,
- exhaust air and outside air must absolutely be separated from each other (for example hygiene / hospital),
- for large air capacities, small unit sizes are required.
- The heat recovery can be regulated by the mixing valve.

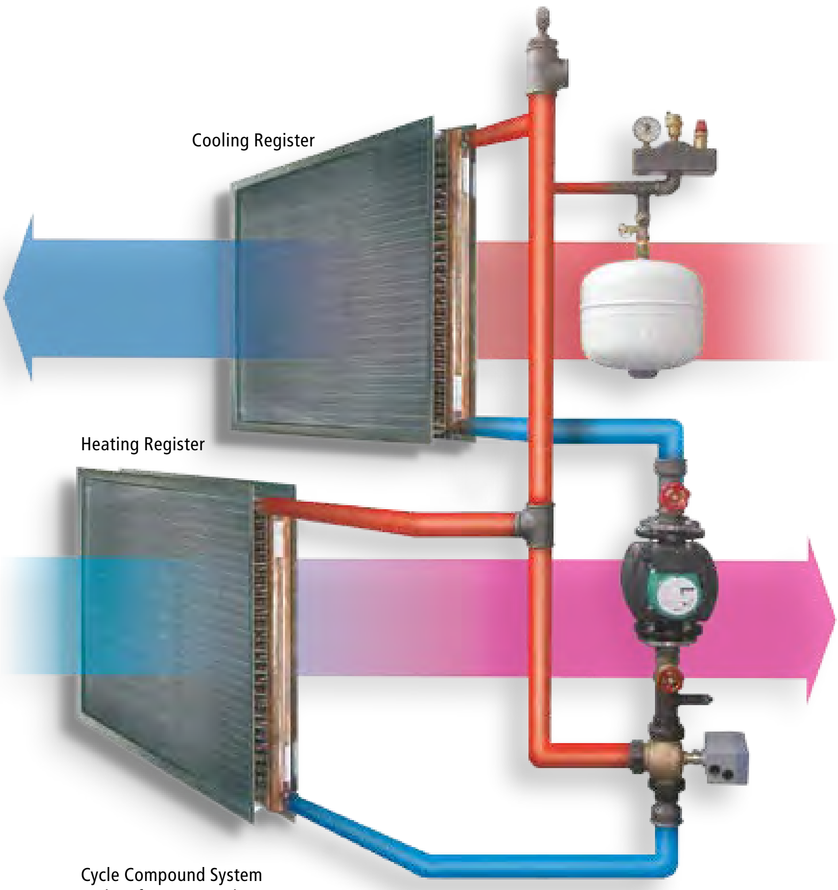
It is a regenerative system with separating surfaces. Materials cannot be transferred. Inlet and exhaust air can be locally separated.

Quotation Text

In the inlet air flow as air heater made of Cu/Al or Stv for transferring sensitive heating energy.

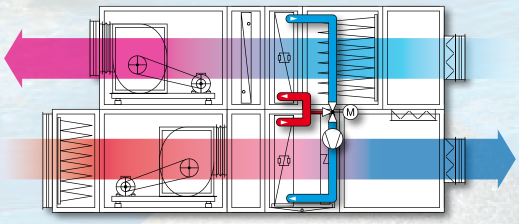
Frame made of galvanized steel. The collector pipes for advance and return made of steel are equipped with and external thread. Design of connections optionally squared off for internal piping of both exchangers or led outside. The passages are sealed by rubber rosettes.

Installed in the return air flow as radiator with tandem-arranged drop separator made of PPTV and condensate collecting tub made of corrosion-proof material. The requested frost resistance is adjusted by the mixing proportion of the freezing preventive with water.



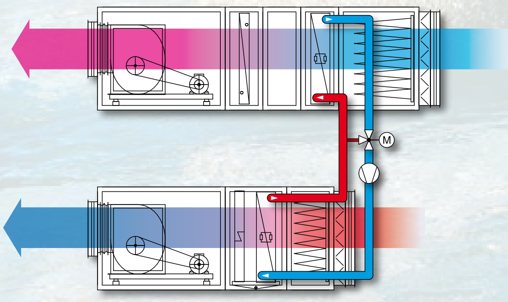
Cycle Compound System with Refrigerant Cycle

Combination Possibilities



Compact Construction
Sideview

Radiator and heater of the KV-system can be installed in one unit.



Split Construction
Sideview

Radiator and heater of the KV-system can also be installed separated from each other. Pay attention to a sufficient insulation of the pipes.

High-performance KV-System

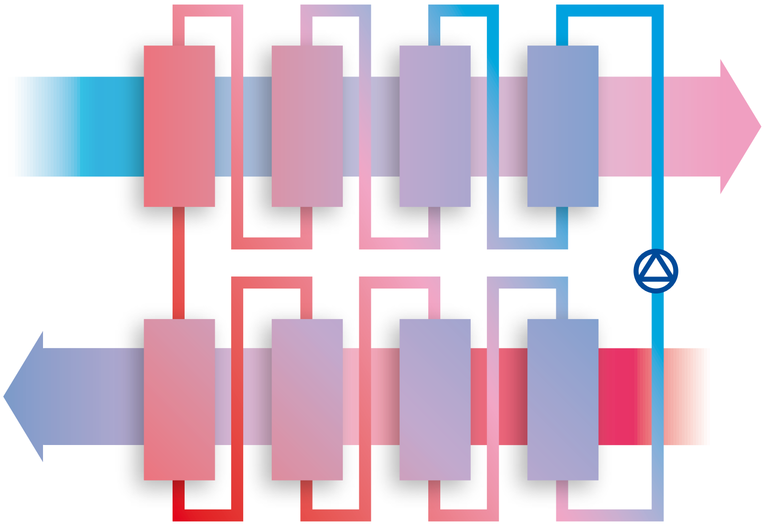
High-performance heat recovery, based on cycle compound system with an efficiency of up to 90 %

Function

The HKV-system reach an efficiency of up to 90 %, gas and medium conditions being optimal.

Application

Like the KV-system however also suitable for multifunctional use. For example combined with indirect adiabatic cooling, integrated subsequent heating/cooling, integrated free cooling, integrated recooling of cooling machines, waste water pre-heating with cold potential use, solar and waste heat exploitation.



High-performance system by tandem connection of several heating-/cooling registers

High-performance Register in n-fold Connection

Quotation Text

High-performance cycle compound system acc. to DIN EN 308 in concentration of transfer performance acc. to VDI 2071, fulfilling the hygiene requirements of VDI 6022.

Consisting of registers in n-fold circuit with exclusive cross counterflow switching ways. Tube lamellae system with optimized tube geometry in staggered arrangement (tube diameter at least D 16,5 with aluminium suppor tube design, integrated in frame). Frame made of steel (hot-dip galvanized of high-grade steel 1.4301) with at least 2,0 mm sheet thickness (installation version), collector in copper / high-grade steel.

Lamellae thickness is at least 0,2 mm for Al/Cu/AlMg, 0,15 mm for high-grade steel and 0,34 mm for steel and full bath galvanization. The tube lamellae system can be ventilated and empties to 100 %, approval acc. to DGRL PED 97/23 EG Module A.
Max. admissible operational overpressure 6 bar, test pressure 9 bar.

Series connection of registers (n-fold connection)

Only with maximal counterflow share of the single transfer units, very high transfer degrees are possible.
In order to reach the required values, heat-transfer agents with a thermodynamic counterflow content of 98 to 99 % are used.

Beside the special flow guidance, high-performance systems require lamellae heat-transfer agents in construction depths of approx. 900 to 1200 mm. These are composed of single (horizontal or vertical) registers.

Variants

For realizing the increased efficiencies, various systems are on the market.
The high performance of HKV-systems is reached in all designs basically by a tandem connection of several registers

Heat Recovery Systems

Heat Tube Exchanger

Heat Tube Exchanger for Heat Recovery

Function

The heat tube is a regenerative system with separating surfaces. Materials cannot be transferred; inlet and exhaust air must be joined.

The warm outlet air is flowing through the lower part of the heat tube and thus warming the refrigerant. It is evaporating and rising up into the cold outside air flow. There, it is condensating and thus transferring the evaporating heat from the outlet air to the outside air. For return heat number and pressure loss, there are two categories:

- Standard plants: The efficiency is approx. 25 % to 35 %, the pressure loss is between 200 Pa and 400 Pa.
- High-performance plants: The efficiency is between 50 % and 75 %, the pressure loss between 100 Pa and 250 Pa.

Application

Heat tubes are used, when

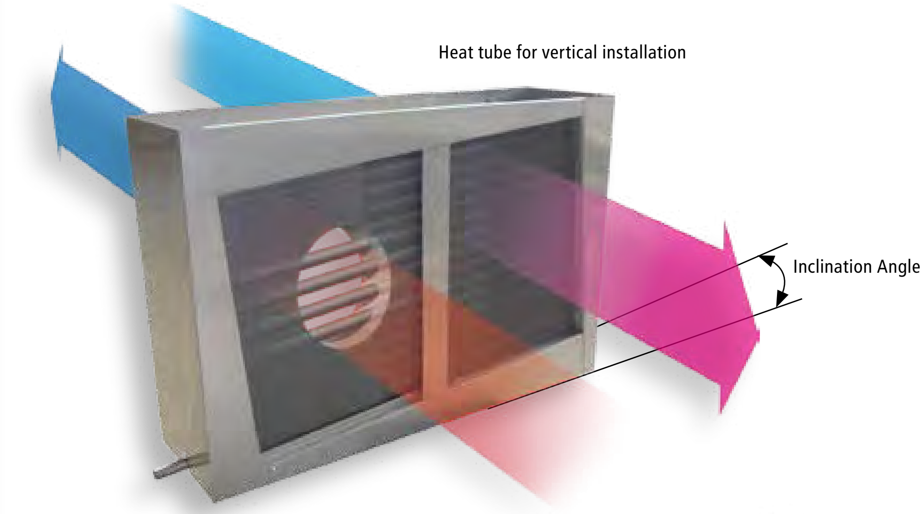
- no humidity is to be transferred,
- no cold is to be transferred,
- the outside air must not be contaminated, for example hygiene in hospitals,
- for large air capacities small unit sizes are required,
- for very high temperatures.
- The heat recovery can be regulated by tilting regulation (with horizontal tubes) or by bypass.

Quotation Text

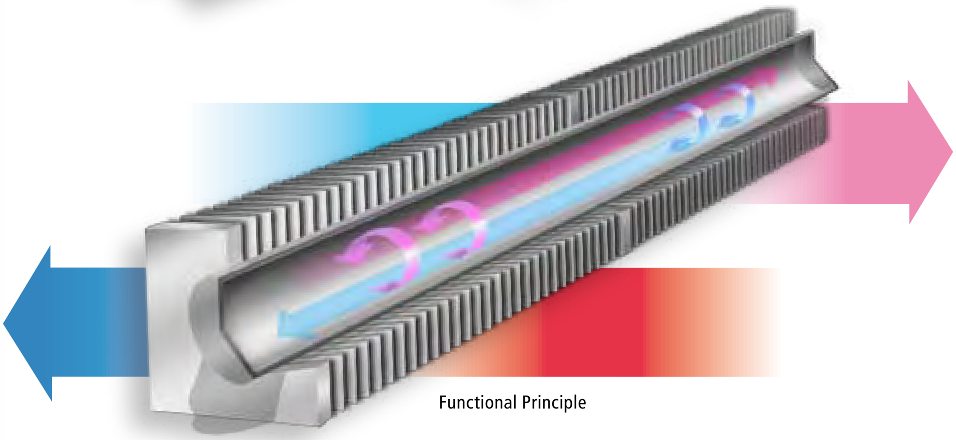
Heat recovery by heat tube exchanger, consisting of single, completey closed tubes with lamellae pressed on. Inlet and exhaust air flows are hermetically separated by a bulkhead wall. Bypass for summer use.

Complete exchanger with galvanized steel sheet frames as integral element installed in the unit housing.

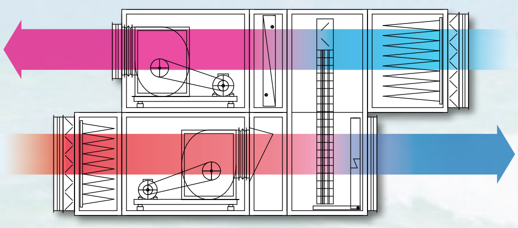
Optionally in horizontal or vertical installation. In exhaust air flow condensate tube made of corrosion-proof material with lateral discharge connection piece and drop separator made of PPTV.



Heat tube for vertical installation


Functional Principle

Combination Possibilities

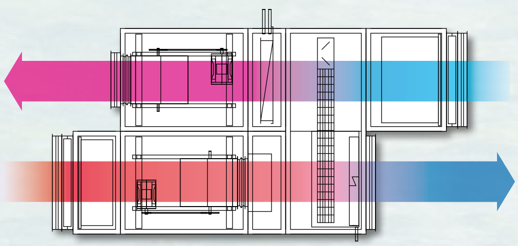


Air Guidance on top of each other

Sideview

The air flows are running on top of each other through the unit.

The outlet air flow is to be planned below.



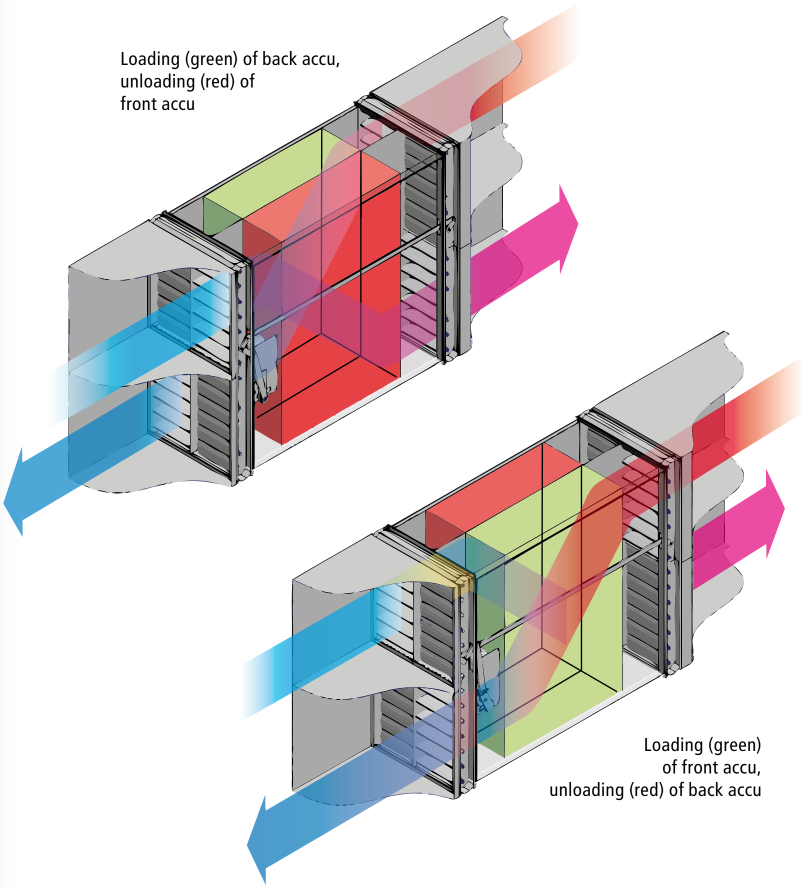
Air Guidance beside each other

Top View

The air flows can be led through the unit on one level.

Heat Accumulator

Heat exchanger for heat recovery with static heat storage



Function

The HRS-accu is a switch-over heat exchanger with two or more static, not moved storages for installation into a ventilation unit or intermediate installation into ventilation ducts.

By a flap system connected in series, alternately one storage block is loaded, each (flow-through with warm exhaust air), while at the same time the other one is unloaded (flow-through with cold outside air). For this, the flaps are switched over depending on the load.

Application

The HRS-accu is used

- when especially high return heat numbers are to be reached,
- when hygiene is required: Acc. to VDI 6022, the system can be equipped with storages on ball bearings easy to remove,
- for heat extraction in winter,
- for cold absorption in summer,
- for saving humidifier capacity (high return heat number - in winter and transition periods high return humidity number).
- no after-heater necessary.

Quotation Text

Regenerative heat exchanger for installation into ventilating units.
The storage masses are made of aluminium, different lamellae distances are possible.
The capacity is regulated by the cycle time loading/unloading of the storages.
The accu block is adjusted to the unit cross-section.
To be used also for plants acc. to DIN 1946 part.4, by using respective flaps.
The blocks can easily be removed for cleaning. A condensate tub is not required, the condensate is remaining on the storage mass and evaporating again into the inlet air.
Incl. regulation

HRS-Module Accu Block

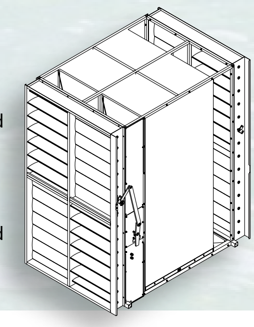
HRS-Accu Module with Flap Control System

Flap System

Sideview

The louver flaps are alternately opened right-hand or left-hand above and in flow direction below for exhaust air, so that both accus are loaded one after the other.

The already loaded accu, each, is at the same time unloaded by the outside air flowing in counter-direction.



Save Energy Avoid Losses

Recirculating Air

Theoretically, a pure recirculating air connection provides 100 % utilization of exhaust air heat.

Practically, however, the utilization of recirculating air has got its limits, when fresh air supply is required or when there are hygienic doubts regarding re-utilization of the exhaust air.

Bypass

By a so-called bypass, the outside air flow is led past the heat recovery.
Thus, in summer evenings, the cool outside air flow can enter directly the building and „pre-cool" the room for the next day.
A regulation is providing the required air guidance, each.

In connection with a speed-regulated driving system, energy costs can further be optimized.

Adiabatic Cooling with Bypass

Adiabatic Cooling

In summer, the heat recovery turns into refrigerator.

The cooling potential is produced by humidifying the warm exhaust air by a spraying system. The heat recovery is using the produced evaporation cold for cooling the entering outside air, the humidity is leaving with the outlet air.

Together with the heat recovery tempering the inlet air in winter, a primary energy saving air-conditioning is thus possible during the whole year.

Night Cold Utilization

We distinguish between active and passive night cooling. Active night cooling is transporting cold by fans or pumps, passive night cooling by thermals, draught or transverse ventilation.

Passive night cooling is depending on the weather and not very comfortable due to the draught, therefore it is suitable for buildings being empty at night (offices, storage halls etc.).

Active night cooling is more comfortable. Air-conditioning is ventilated with 100 % outside air at night.

In order to avoid energy-expensive air transport, the cold can be transferred to a liquid and used for direct component cooling (also cooling ceilings etc.). Cold water can additionally be stored in buffer storages and unloaded again when cooling is needed, only.

Multifunctional Utilization

The aim of multifunctional utilization is to cover as many technical functions as possible by the used components. Systems of this kind are very compact and efficient.
As base unit, two high-performance heat exchangers are joined by a cycle compound system (HKV-system) to a heat recovery.

To this base unit, further functions can be added for multifunctional utilization:

- Integrated adiabatic Cooling
  By the base system, the cold potential from humidification of the outlet air is transferred onto the air inlet flow to be cooled, often saving a mechanical cold production.
- Integrated subsequent heating / cooling by the KV-system saves the heating or cooling register.
- Integrated free Cooling
- Integrated return cooling of refrigerating machines saves cooling capacitiy and thus energy.
- Waste Water Pre-Heating with Cold Potential Utilization
- Integrated solar and waste heat utilization by the KV-system is exploiting heat from already 20 °C for heating purposes.
- Integrated Air and Heat Exchanger Connection for Night Cold Utilization
- Utilization of natural Cold Potentials like Well Water, Earth Cold etc.

Block Heating Power Station (BHPS)

BHPSs are compact power-heat-coupling plants producing both electric power and heat. For their operation, either fossil (oil or gas) or renewable combustibles (biogas, biodiesel) are used.
The waste heat produced by power, production can for example be used for heating buildings. By double energy exploitation (power and heat), the efficiency (combustible exploitation) is increased up to approx. 85 %.

Due to highly efficient energy utilization, BHPSs are considered as very progressive, taking into account ecological and economic aspects.

Regulation Concepts

By programmes for operational / failure supervision, time circuit and energy optimization, a direct digital regulation (DDR) can realize considerable energy savings in addition to recovery effects.
Room regulation acc. to requirement, sliding switching on and cyclic switching of RLT-plants, consumption supervision, energy-optimized control system of heat and cold production are only a few of the possible applications.

In large buildings, complex building technologies are used today in order to control centrally all technical functions like lighting and sun protection, time circuit plans etc.

Modern regulating systems for RLT-plants can be integrated into existing building technologies.

Modern regulations are easy to handle.

Cooling economically

Making cold economical

Conventional air-conditioning units are usually operated by compression refrigerating machines. These plants have a high power consumption.

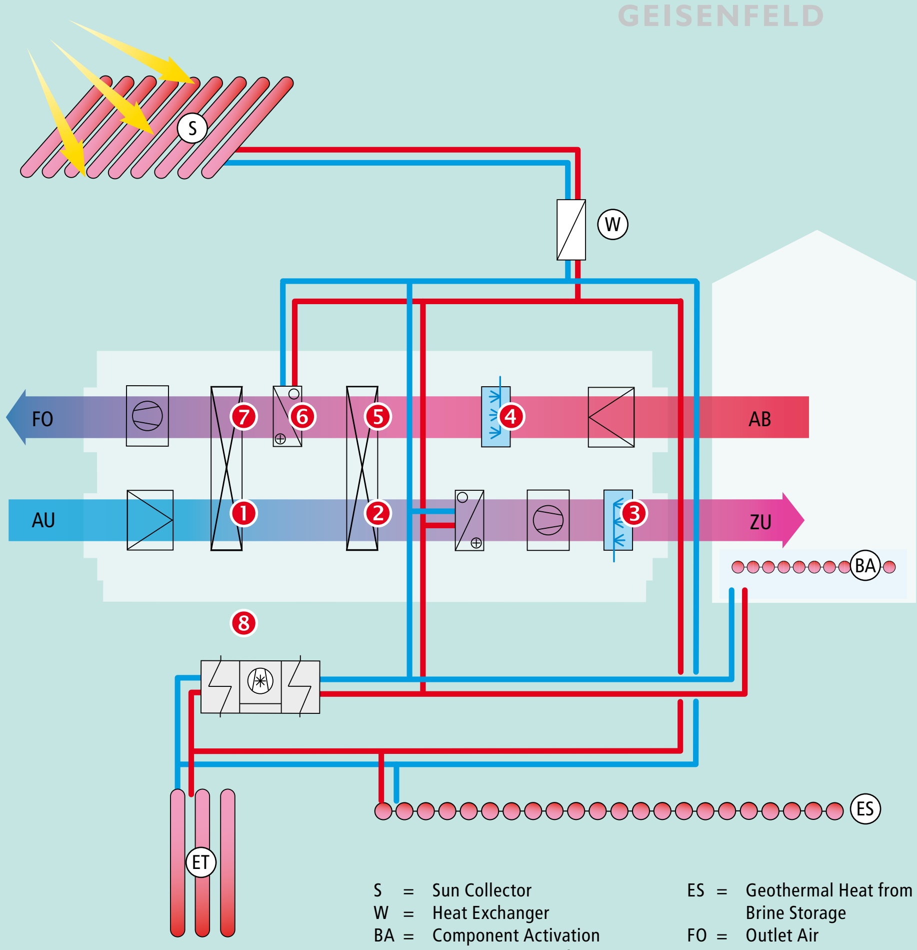
If enough low temperature waste heat, for example from industrial processes, a block heating power station, district heat, air or solar collectors is available, **sorption refrigerating machines** are an interesting alternative.

Absorption refrigerators are producing cold by means of a material couple, separating itself by heat supply and uniting itself by heat loss. For operating this plant type, (waste) heat with a temperature of at least 85 °C is required.

Also **adsorptions refrigerating machines** and **DEC-plants** (Dessicative and Evaporative Cooling) are plant types using physical effects. They are operated with low temperature heat from 55 °C resp. 40 °C on, so that they can also be used in connection with solar thermals.

The mentioned plants usually have higher investment costs than compression refrigerating machines. Since they are using waste heat and their construction is more wear-resistant and needs less maintenance, however, their operation is much cheaper.

Apart from waste heat temperature, the selection of the plant type depends on the cold transfer system and the outside air conditions.



S = Sun Collector
W = Heat Exchanger
BA = Component Activation
ET = Geothermal Heat from Depth Probes
ES = Geothermal Heat from Brine Storage
FO = Outlet Air
AB = Exhaust Air
AU = Outside Air
ZU = Inlet Air

Functional Principle of a DEC-Plant

1 The outside air is entering the sorptions wheel which is absorbing a part of the contained humidity. During this sorption process, the temperature of the de-humidified air is increasing.

2 In the subsequent heat recovery (regenerative rotation heat exchanger), the air is being cooled again.

3 By the subsequent humidification (high-pressure humidifier, regulated by frequency converter), the temperature is decreasing. The air - conditioned to nominal value - is supplied to the room to be air-conditioned.

4 The exhaust air warmed in the room is flowing through the high-pressure humidifier, regulated by frequency converter. The exhaust air is being humidified adiabatically, approaching the humid ball temperature (max. temperature difference / cooling) and thus being cooled.

5 Then this adiabatically humidified and cooled air is entering the heat recovery, acting as cooling air and absorbing the heat.

6 In the subsequent heater, which is warmed by a storage medium by sun collectors, the air is being warmed to the required temperature.

7 Then it is fed to the sorption wheel as regeneration air.
By the exhaust air fan, the air is leaving the plant.

The refrigerating capacity (pump cold water) is produced by process reversal of the existing heat pump 8 as refrigerating machine.

Mini Dictionary of Technical Terms

Adiabatic

An adiabatic condition change is a thermo-dynamic process transferring a system from one condition into another without exchanging heat energy with its environment (Greek. α [a] = not, διαβαίνειν [diabaínein] = to pass).

Adiabatic Cooling resp. Humidifying

Warm air is able to absorb large quantities of water steam. When water is evaporating, heat is taken from the air which is necessary for evaporating water. The air is getting cooler and more humid, keeping its heat content.
The adiabatic evaporation cooling has already been known in ancient times as porous clay pots containing liquid (for example water or wine).

Adsorption and Absorption

In contrast to adsorption, absorption means storing an atom or molecule in a solid or a liquid
(Latin.: absorbere = to absorb, to suck)

Adsorption means that atoms or molecules from a gas or a liquid are sticking to the surface of the so-called adsorbent.

Absorption practically presupposed the adsorption of a particle on the surface. The opposite (release) is called **desorption**.

Absorption Refrigerating machines

In the absorption refrigerating machine, a liquid working material couple consisting of a refrigerant and a solvent is circulating. Various material couples are used: For cold water temperatures of more than 0 °C water/lithium bromide with water as refrigerant, for air-conditioning and for cold water temperatures of less than 0 °C ammonia/water with ammonia as refrigerant.
The refrigerant is absorbed in the absorber by the solvent, while heat ist being released; then it is separated again from the solvent in the taper drift, while heat is being supplied.

In the capacitor, the refrigerant is being liquefied and in the evaporator evaporated again, absorbing heat from the system to be cooled.

Adsorption Refrigerating machines

For adsorbing the liquid refrigerant (for example water), the adsorption refrigerating machine is using a solid material (zeolite or silicagel). Only the refrigerant is circulating.

Due to negative pressure in the plant, the refrigerant is already evaporating at low temperatures.
This refrigerant vapour is stored chemically or physically at a surface (chamber filled with adsorbent, for example silicagel = collector). The heat being released during adsorption is led off by the cooling water.

At the same time, the refrigerant is being driven off the adsorbent by heat (for example from the solar plant) in the other adsorbent chamber (taper drift).

The water vapour produced is liquefied again in the capacitor and then led to the evaporator.
After this cycle, collector and taper drift are exchanging their functions.

Air

The air sucked outside is called „outside air" (AU), the air fed into the room „inlet air" (ZU), the air extracted from inside „exhaust air" (AB) and the air led outside as „outlet air" (FO).

Building Energy Certificate

The building energy certificate shows the energetic quality of buildings. In connection with modernization recommendations, it also advises low-cost improvements of the energetic building features.

DDC-Regulation

The task of the regulation is to control air-conditioning units with a minimum of energy costs and handling and to reach an optimal extent of operational safety, economy and convenience.

A „Direct Digital Control", abbr.: DDC, is an electronic group of components used for control and regulation tasks in building automation, mainly regulation.

The DDC is, independent of the respective control task, internally firmly wired. Depending on programming, the software is fixing the requested process. Many modern DDC's are small computers (microcontrollers) with base software. Software for communication and programming facilitates its handling.

DEC-System

The abbreviation DEC means „Dessicant and Evaporative Cooling" and enables in summer a de-humidification and cooling of the air without cold water set with recooling.

In winter, the sorption rotor can be used as additional heat recovery with humidity transfer.

DEC-Plants

The classic DEC-process with two rotors is drying the outside air in the first rotor and cooling back the heated and dried air by the adiabatic exhaust air humidification and the second rotor (heat recovery), producing conditioned inlet air.

The warm room exhaust air is first being cooled adiabatically and then serves as cooling air in the heat exchanger.

The heated exhaust air is then being heated to regeneration temperature. This hot air is taking the stored humidity from the sorption wheel into the outlet air, while it is cooling down.

EnEV

The decree for energy-saving heat protection and energy-saving plant technology in buildings.

On 27.06.2007, the new energy saving decree was passed, replacing the EnEV 2004 which was valid since 08.12.2004 and including also ventilation technology. By the decree, the energy certificate is introduced as obligatory for existing buildings to be rented or sold from 2008-2009 on.

Efficiency

The efficiency describes the relation between the energy delivered by a plant for energy transformation and that given to it.

Frequency Converters (FU)

Frequency converters are used for electronic speed control of drives. They are controlling the fan speed infinitely, as required, and are thus saving electric power.

Heat Pump

Heat pumps enable the technical exploitation of low temperature heat from air, water, ground of solar thermals. Also process heat

from waste water and exhaust air can be exploited.

The heat pump has got an electrically driven compressor for the refrigerant which is taking heat from the environment when evaporating, so-called anergy. The used electric energy and the anergy result in exploitable heating energy. The lower the temperature rise, the more efficiently heat pumps are working.

Leakage Air Rate

Acc. to VDI, a leakage air rate or a recirculating air content is allowed for all heat recovery systems.

Only a cycle compound system can be executed absolutely tight.
The higher the pressure difference between inlet and exhaust air flow, the higher are the leakage rates.
For heat exchangers with storage mass, the recirculating air content is mostly the highest.

Modulating Operation

In modulating operation, the heating capacity emitted by heating cauldrons, heat pumps or small block heating power stations is adjusted to the current requirement without switching off or on the heating device. In contrast to one- or two-stage operation, the efficiency is increased, while pollutant emission and wear are reduced.

Power-Heat-Coupling

Thermodynamic process using heat which is inevitably produced when generating power (or electric power) for heating purposes, and causing a better utilization or primary energy than with separated energy production in a power plant and heat production in a heating cauldron.

Primary Energy Demand

By primary energy demand, the expenditure of energy needed for covering the final energy demand is meant. Also the quantity of energy produced by anticipated processes outside the system „building" by gaining, transforming and distributing the used combustibles must be added.

The expenditure of primary energy also serves for calculating the CO_2-emission.

Regenerative Heat Recovery

Heat transfer by means of an intermediate medium. The heating energy is stored temporarily in a medium and emitted to the other air flow later on. Systems transferring the stored heat by a separating wall are regarded as a unit and belong to regeneratives.

The VDI 2071 distinguishes movable (rotation heat exchangers) from static storage masses (heat accumulators).

Recuperative Heat Recovery

Installations transferring heat by a separating wall. The systems are either constructed in counterflow or in cross-flow principle.

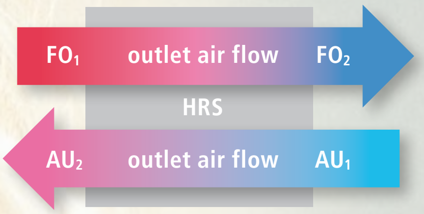
Return Heat Number Φ

The return heat number is the temperature difference betwenn entrance and exit (into / out of the heat recovery) of one of the air flows, divided by the temperature difference between both air entrances.
It indicates the temperature recovery rate of the heat exchanger.

The return heat number for the outside air flow (Φ_A) is the more important value. The return heat number for the outset air flow = Φ_F.

$$\Phi_A = \frac{t_{Au2} - t_{Au1}}{t_{Fo1} - t_{Au1}} \qquad \Phi_F = \frac{t_{Fo1} - t_{Fo2}}{t_{Fo1} - t_{Au1}}$$

t = temperature



Return Humidity Number Ψ

The humidity modification degree, also called return humidity number, determines the humidity recovery and is defined by analogy with the temperature modification degree (absolute humidity of the air flows).

$$\Psi_A = \frac{x_{Au2} - x_{Au1}}{x_{Fo1} - x_{Au1}} \qquad \Psi_F = \frac{x_{Fo1} - x_{Fo2}}{x_{Fo1} - x_{Au1}}$$

x = absolute humidity

Solar Cooling

Solar cooling is using solar energy for a refrigerating machine. In summer, with high cooling demand, a thermal solar plant, delivers maximal output, since the daily profiles of the cooling load are mostly the same.

Refrigerating machines suitable for solar cooling are working with **sorption technology**. **Absorption and adsorption refrigerating machines** as well as **DEC-plants** rank among them. Depending on the selected type, these machines require heat with a temperature of between 60 °C and 80 °C for drive.

Absorption and adsorption plants are usually planned as cold water sets and the DEC-plants as air systems.

Sorption Technology

The sorption process is practically to be understood as de-humidification. In reversal to evaporation where cold is being produced, liquefaction of water steam is releasing heat.

During sorption, molecules from the liquid stage are bound, releasing their energy (combination heat). Moreover, the sorbate is being liquified, releasing evaporation heat. Evaporation and combination heat result in sorption heat.

▶ Cf. also page 13 DEC-plant.

VDI 2071

The guideline VDI 2071 defines terms and definitions of „Heat Recovery in Technical Equipment for Room Air" and describes devices and processes as well as operating features.

Furthermore, criteria for selecting the heat recovery system are shown, enabling statements for suitability and economy of the different systems.

Volume Stream Regulation

By choosing variable volume streams, costs for cooling in summer and heating in winter can be reduced substantially. Also the electric power consumption of the fans is adjusted to the respective air requirement.

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