Sorption-Supported Air-Conditioning. The Ecological Alternative.

The sorption-supported DEC-technology by robatherm is an environmental-friendly and economical alternative to conventional cooling technology.

robatherm
the air handling company

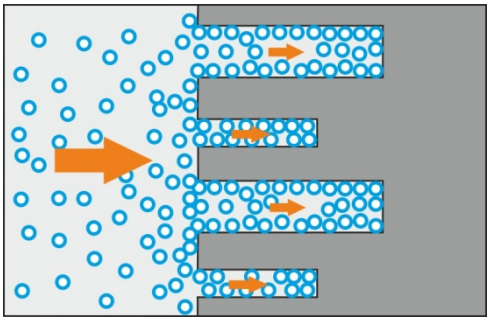
Sorption-Supported Air-Conditioning

Sorption is the collective name for those processes leading to an enrichment of a matter within a phase (absorption) or on a bounding surface between two phases (adsorption).
In air-conditioning, this technology called “sorption-supported air conditioning” is excellently suited for the dehumidification and drying of air, and offers numerous possibilities of application.

Comparison of Adsorption and Absorption

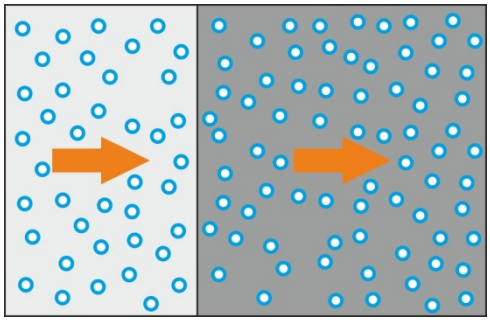
In sorption technology, a difference is made between two types of dehumidification: adsorption and absorption.

Adsorption (physisorption)



Adsorption (Latin “adsorbere” = to adsorb sth.) characterizes the enrichment of matter through gases or liquids on the surface of a solid state body (bounding surface between two phases) based on the capillary action of a widely ramified pore system.

Absorption (chemisorption)



Absorption (Latin “absorbere” = to absorb sth.) characterizes the process of taking in or the release of an atom, molecule or ion in another phase. In this case, it is not an accumulation on the surface, but instead a take-in to the free volume of the absorbing phase.

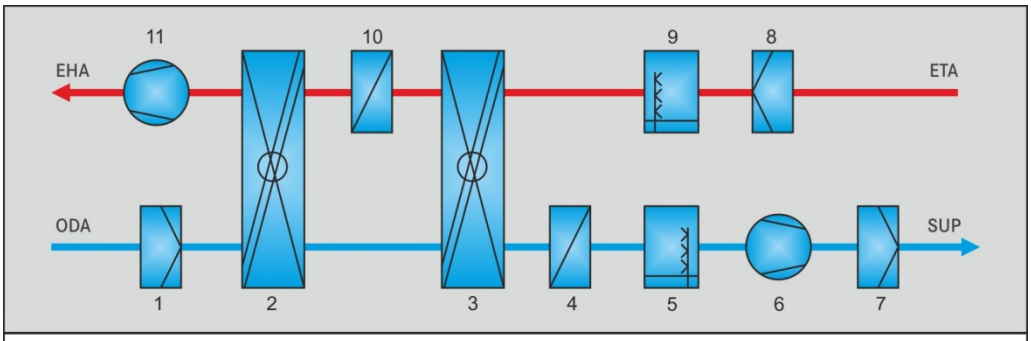
Desiccative and Evaporative Cooling (DEC)

Within the context of sorption-supported air conditioning, the so-called DEC-Technology represents a special process for air cooling. In this process, the sorption (air drying) is combined with evaporative cooling, from which the name is derived: Desiccative and Evaporative Cooling.

In comparison to conventional cold production, water substitutes previous CFC (chlorofluorocarbon) cooling agents and those containing FC (fluorocarbon), making the DEC-Technology an environmental-friendly alternative process. As the energy prices increase on the market, DEC-Technology's economic attractiveness is becoming increasingly attractive.

Function Principle (Summer Mode)

During the first step, the DEC-Technology dries the outdoor air that has been taken in.
This measure is becomes necessary because, during hot and humid summer weather, the outdoor air is saturated with moisture. If solely dependent on the evaporation of water, air containing high relative humidity would not achieve a sufficient cooling effect.



Komponenten			Names for Types of Air
1 Outdoor Air Filter	5 Humidifier	9 Regeneration Air Humidifier	ODA=Outdoor Air
2 Desiccant Rotor	6 Supply Air Fan	10 Regeneration Air Reheater	SUP=Supply Air
3 Rotary Heat Exchanger	7 Supply Air Filter	11 Regeneration Air Fan	ETA=Extract Air
4 Reheater	8 Regeneration Air Filter		EHA=Exhaust Air

Supply Air
During DEC-Technology, the outdoor air taken in and filtered initially flows through a desiccant rotor (sorption generator). The continuous dehumidification (sorption) taking place in the rotor can withdraw up to approximately 8 grams of water per kilogram of air.

The regeneration heat released during the dehumidification (evaporation enthalpy) triggers an increase of temperature. The following heat recovery system transfers that heat from the outdoor air to the regeneration air.

The further cooling of the outdoor air down to supply air level subsequently follows in an adiabatic evaporation humidifier. The evaporative cooling achieves a temperature drop of ca. 12 K. This value is dependent upon the respective outdoor air condition and is true for normal climate conditions within Central Europe.

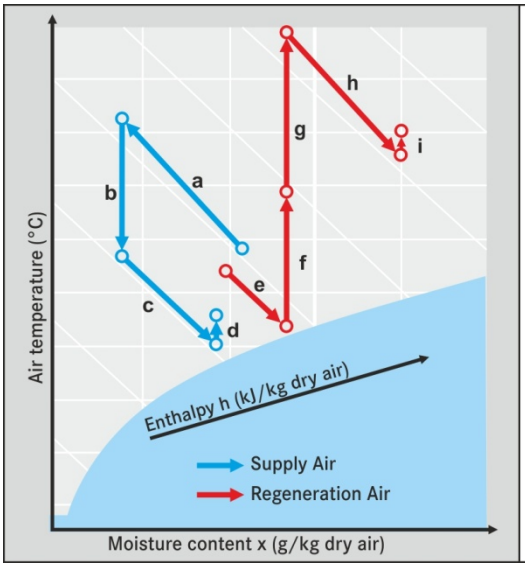
Regeneration Air

For the regeneration airflow leading to the supply air, exhaust air is usually used as a counterflow. In special cases of a high thermal volume load, e.g. in printing shops or laundry, outdoor air is used.

This exhaust or outdoor air is initially moistened up to saturation in a second evaporation humidifier. This results in maximum cooling. The air supply's heat is taken up within the heat recovery system and thus, cools the supply air.

The exhaust or outdoor air is then heated to approx. 60° C up to 100°C and regenerates (desorbs) the desiccant rotor.

DEC-Technology within the h,x-Diagram



Supply Air

a Drying of the outdoor air by means of a desiccant rotor ②
b Pre-cooling of the outdoor air by means of heat recovery (HR) ③
c Cooling of the air to the desired supply air temperature by means of an adjustable evaporation humidifier ⑤
d Heating via the engine waste heat of the supply air fan ⑥

Regeneration Air

e Cooling of the regeneration air by means of an adjustable evaporation humidifier ⑨
f Pre-heating of the regeneration air by means of HR by pre-cooling the outdoor air (Step b) ③
g Reheating of the regeneration air ⑩
h Desorption of the moisture contained in the desiccant rotor (Step a) through regeneration air flow ②
i Heating via the engine waste heat of the regeneration air fan ⑪

The small digits stand for the respective components found within the function chart on page 4.

System Components

Desiccant Rotor

Silica Gel-Rotor
• Sorbent: SiO_2 Silica Gel • Carrier Matrix: Glass Fiber (inorganic) • Type of Dehumidification: Adsorption • Dehumidification Capacity: < 8 g/kg • Regeneration Temperature 70° up to 100 °C • Volume Load: 3,000 up to 75,000 m³/h • Purification: with compressed air • Standstill Mode: Interval switching and regeneration (at a minimum of 50°C daily once a week for 1-2 hours) • Physiologically fully harmless

Regeneration Air Heater

For the heating of regeneration air, the following primary heat sources are possible:

- Hot water (pumped hot water, district heating, waste heat, cogeneration, trigeneration, solar energy)
- Steam
- Electrical energy

Possibilities are also directly fired systems that, however, are not an integral element of the DDC-Software “Smart Control” developed by robatherm:

- Gas-directly fired without a heat exchanger (gas surface burners)
- Oil or gas-fired with a heat exchanger (combustion chamber)

Heat Recovery

To achieve optimal process parameters, heat recovery systems without transmission of humidity with heat recovery efficiency of up to 80% are implemented. Regenerators as well as recuperators connected in series. The higher the heat recovery efficiency, the further the incoming air can be cooled down.

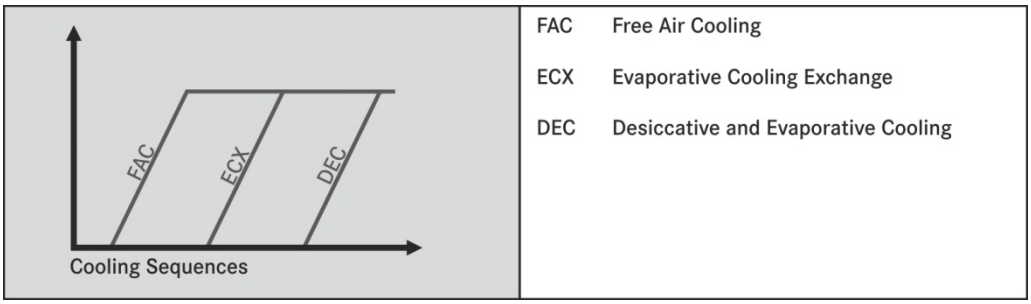
Rotary Heat Exchanger	Plate Heat Exchanger
	
• Regenerative heat recovery • Adjustable via rotational speed • Integrated purge sector for self-purification • Short installation length	• Recuperative heat recovery • Adjustable via an integrated bypass • Long installation length and higher air resistances • For air flows up to ca. 40,000 m³/h

Humidifier

Nozzle humidifier (air washer)	High-pressure humidifier
	
• Nozzle pressure ca 2.5 bar • Degree of humidity up to 90 % • Smooth interior stainless steel surface V2A or V4A. • Circulation water operation • HYGIENECONTROL provides for correct hygienic conditions PLC-controlled draining, purification and drying of the washer trough • Cost-effective due to infinitely frequency-controlled pumps	• Nozzle pressure ca 120 bar • Degree of humidity up to 95 % • Smooth interior stainless steel surface V2A or V4A. • Fresh water operation • Fresh water treatment (reverse osmosis is imperative) • Cost-effective due to infinitely frequency-controlled pumps

Process Measuring and Control Technology

Through appropriate control strategies, the sequential arrangement of the control sequences can be adjusted dependent of the system or plant installation. This, for example, allows the energy carrier to implement electricity and heat according to availability and in line with demand.



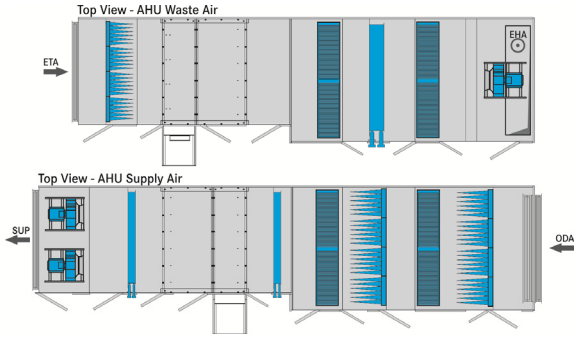
In a robatherm DEC-device, all required process measuring and control components are available upon request and where necessary, hydraulic control groups including pipe installations can be fully and space-savingly integrated. The devices leave our factory in a “plug-in” state. Commissioning and proper orientation is conducted onsite by a robatherm service technician.

Cooling Sequences (Summer)	Heating Sequences (Winter)
• Heat Recovery • Regeneration Air Humidifier • Supply Air Humidifier • Desiccant Rotor incl. Regeneration Air Heater • Cooler	• Desiccant Rotor • Supply Air Heater

Examples of Use

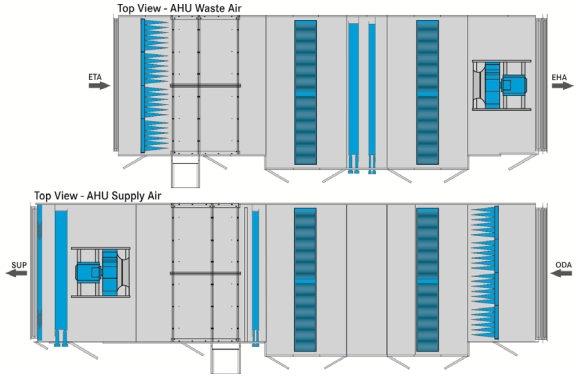
Parliament Brandenburg, Potsdam

On approximately 19,000 m², the new Parliament Brandenburg accommodates, amongst other things, 400 offices and conference rooms, a Chamber, library, restaurant as well as an underground parking garage.
10 AHUs with integrated IC-Technology are installed; a majority of them boast an energy efficiency class of A+ and antimicrobial powder-coating.



Cour des Comptes, Luxembourg

During the reconstruction of the General Accounting Office in Luxembourg, the builder bet on DEC-Technology. 10 AHUs, partially with integrated IC-Technology, now ensure that the office building is efficiently air conditioned.



Examples of Conceptual Design

Of course, the flexibility found in the RM- and RL-Lines also applies for DEC-devices. The incomparable numbers of device possibilities available guarantee individual adaption to customer needs.

Exemplary designed DEC-devices

Volume Load [m³/h]	Device Type	Dimensions H/D/L [mm]	Weight [kg]	Cooling Capacity [kW]	Electr. Capacity [kW]	Regeneration Air Heating Capacity [kW]
3,000	RM-Line 09/12	2,116 / 1,304 / 8,925	3,558	16	7.2	31.4
4,500	RM-Line 09/12	2,116 / 1,304 / 8,925	3,554	24	8.8	47.1
7,900	RM-Line 09/15	2,728 / 1,610 / 9,078	4,860	42	14	81.9
11,900	RM-Line 09/18	2,728 / 1,916 / 9,078	5,675	63	17.4	123.3
16,600	RL-Line 12/21	2,708 / 2,282 / 9,384	6,963	89	26.8	172
27,500	RL-Line 15/27	3,320 / 2,894 / 10,608	9,940	147	40	285
34,500	RL-Line 15/30	3,320 / 3,200 / 10,914	11,233	184	51	357
57,600	RL-Line 21/39	4,544 / 4,118 / 13,362	18,527	307	86.5	597

Design Bases:

Fan
External Pressure 500 Pa

Supply Air Heater
t_{inflow}: 10°C
$t_{outflow}$: 35°C

Regeneration Air Heater
t_{inflow}: 39°C
$t_{outflow}$: 70°C

Summer Operation
Outdoor Air 32 °C / 40 % r.H.
Supply Air: 19 °C / 80 % r.H.
Exhaust Air: 28 °C / 40 % r.H.

Winter Operation
Supply Air: 22 °C / 80 % r.H.
Exhaust Air: 25 °C / 40 % r.H.

DEC-Technology with Solar Energy (DEC + S)

Fundamentals

DEC-Technology represents one of the most promising thermal-driven air conditioning technologies for the integration of thermal solar energy.
The highest solar radiation occurs almost simultaneously with the highest load requirements.
Regeneration at maximum load requirement is possible without additional primary energy input.

Systems for the solar sorption-supported air conditioning	
Solar Independent Systems	**Solar-Supported Systems**
The regeneration energy is completely supplied by the sun.	A part of the regeneration energy is supplied by the sun.
Over the entire year, desired ambient conditions will be partially exceeded.	A back-up system is required for thermal feeding.

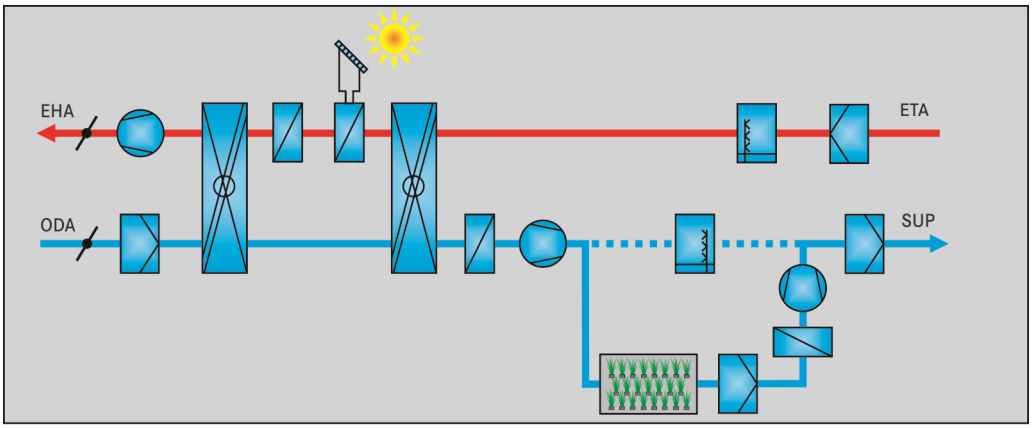
Types of Collectors and Switching Variants

Another possibility of differentiation results from the type of thermal solar collectors as well as the switching variants.

Thermal Solar Collector					
Solar Air Collectors		Solar Fluid Collectors			
Outdoor Air Intake	System-integrated	Flat Plate Collectors		Vacuum tube collectors	
		directly integrated	hydraulically decoupled	directly integrated	hydraulically decoupled

Example of use - Office Building ENERGYbase in Vienna, Austria

With its project ENERGYbase, the Vienna Business Agency has set new standards in the development of energy optimized office buildings. Besides the DEC-Technology, this pilot project includes around 500 plants that serve the controlled humidification of the supply air.

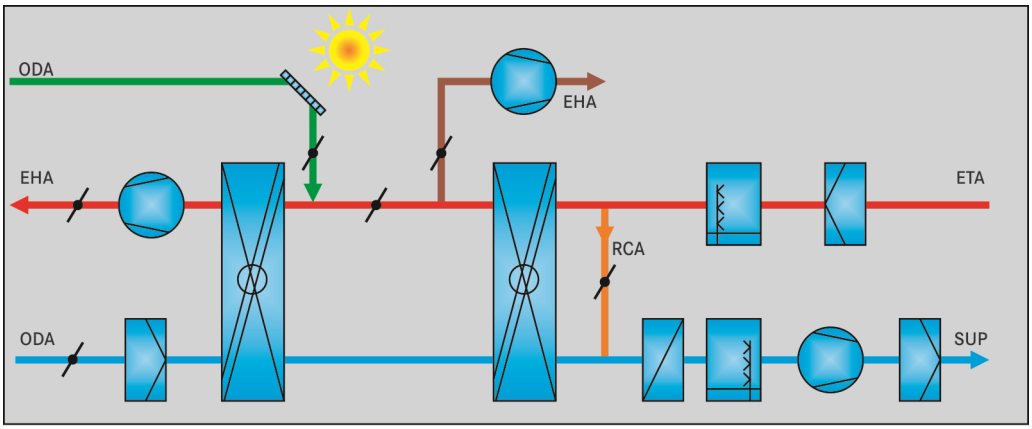


Names for Types of Air: ODA=Outdoor Air, SUP=Supply Air, ETA=Extract Air, EHA=Exhaust Air

At a Glance:

- Total Air Volume 40,800 m³/h
- 6 AHUs

Example of use – Office Building in Freiburg, Germany

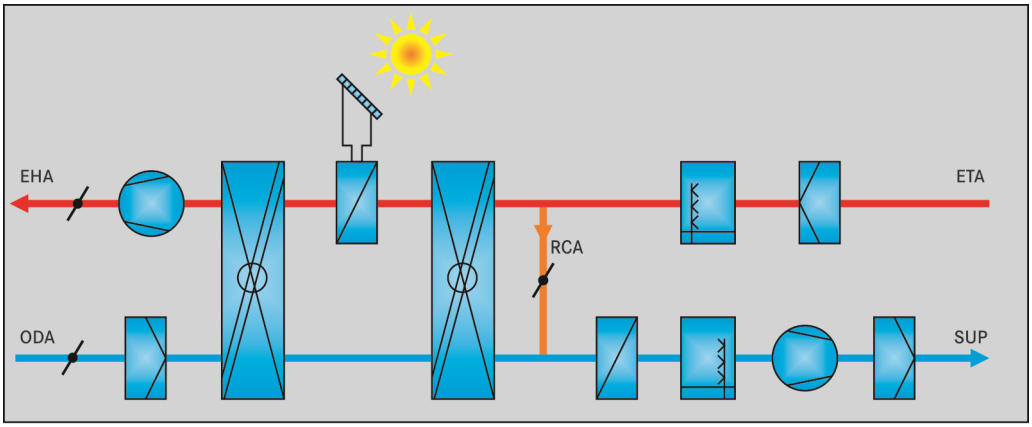


Names for Types of Air: ODA=Outdoor Air, SUP=Supply Air, ETA=Extract Air, EHA=Exhaust Air, RCA=Recirculation air

At a Glance:

- Total Air Volume 10,200 m³/h
- Solar Air Collectors including a 100 m² collector surface und outdoor air intake

Example of use – Office Building in Sintra, Portugal



Names for Types of Air: ODA=Outdoor Air, SUP=Supply Air, ETA=Extract Air, EHA=Exhaust Air, RCA=Recirculation air

At a Glance:

- CPC-Solar Flat Collectors including a 72 m³ collector surface
- Total Air Volume 9,600 m³/h
- Cooling Capacity 75 kW

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