Air Handling Systems for Educational Facilities

robatherm
the air handling company
Increase Educational Quality and Comfort.

Air quality has a decisive impact on the attentiveness and learning ability of pupils and students.

**Education** is our most valuable commodity. Our children’s development and education are the capital of the future. Optimal educational opportunities are not only a question of curricula. Successful learning is impossible in air with excessive carbon dioxide concentration (CO₂).

Many educational facilities such as kindergartens, schools or universities are in great need of renovation. Building fabric and the general conditions students and teachers are exposed to, have long been out of date. Moreover, the high energy demand of non-renovated buildings cost municipalities more and more money.

Renovating or even reconstructing is the answer. In accordance with legal requirements, this will result in a particularly airtight building envelope. Air quality will be even poorer than in the old building if renovation and reconstruction measures cut down on air handling investments.

Without controlled outdoor air supply, chemical and biological substances turn into hygiene problems. Simple window ventilation, inviting noise and fine dust into classrooms, often adds to the adverse effects – especially in congested areas. As a consequence of insufficient ventilation, mood disorders of both, students and teachers are increasing.

Air handling systems are indispensable for minimizing the negative effects of contaminants, humidity, and CO₂. Combined with efficient heat recovery, these systems afford hygienically impeccable indoor air and high comfort at low energy cost. Improving comfort conditions and energy efficiency at the same time is not only possible, but is even supported financially by the government. A financial aid of up to 25 percent of the capital cost currently makes it particularly attractive to retrofit or replace air handling systems in educational facilities in Germany (as of 2010).
Air Handling Systems Improve Learning Climate.

Among other things, the readiness to learn is the result of air quality and a comfortable room climate. Air handling systems must satisfy both requirements.

**Learning**, teaching, and living: those are the activities in modern educational facilities. Indoor air quality always plays an important part in these complex living spaces. As a general rule, people stay indoors during about 90 percent of wintertime. Children, adolescents and students unfortunately spend most of this time in often overcrowded rooms with poor-quality air, high CO₂ concentration leading to fatigue, headaches, and a lack of performance. Teachers, too, complain. Exciting and instructive lessons are thus hardly possible.

**Controlled air change**
Controlled supply of outdoor air with high oxygen content and the removal of vitiated air are the main tasks of ventilation. The direct impact of increased outdoor air rates on students’ performance was investigated and confirmed in various studies some time ago already.

**Internal loads**
Aside from the thermal loads, material loads are a particular problem due to the high occupancy during classes. Principal loads include carbon dioxide and humidity. Likewise odors emitted by occupants (bioeffluents) or volatile organic compounds (VOCs) emanating from furnishings increase CO₂ concentrations and are thus more intensively perceived. Only controlled replacement of contaminated air ensures proper indoor quality and comfort.

**Heat recovery**
Whereas heat losses are high with natural (window) ventilation, air handling units equipped with efficient heat recovery (HR) allow ecological operation in an economical way. Thanks to a demand-controlled airflow rate, the operating costs of the entire facility remain manageable. The heating system, too, can be smaller as less reheating energy is required as opposed to simple window ventilation.

**Sound attenuation**
Minor sound emissions are a basic requirement for educational facilities. Therefore, future impacts of AHUs towards occupants and environment has to be carefully considered from the early design-stage. Emissions to the outside environment and its reflections have to be taken into account as much as the sound emittance to the classrooms.
Demand-based control

Enormous short-term peak loads are typical in classrooms and comparable rooms, hence demand-controlled load management is particularly effective here. Mixed-gas sensors or CO₂ sensors in the room or extract air duct are the ideal setpoint devices for this purpose. Overshooting is prevented by supplying the maximum outdoor air rate already before reaching the upper threshold limit value (approx. 1,000 ppm CO₂). The lower switch point is specified as a compromise between indoor air quality (mind. IDA value) and operating costs. Time-controlled preconditioning is regularly a convenient solution for utilized rooms.

Important standards and guidelines pertaining to educational buildings

<table>
<thead>
<tr>
<th>Requirements regarding buildings</th>
<th>Requirements regarding air handling systems</th>
<th>Requirements regarding AHUs</th>
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<tr>
<td>Energy Savings Act (EnEG)</td>
<td>DIN EN 13779 Ventilation for non-residential buildings</td>
<td>DIN EN 13053 Rating and performance for units, components and sections</td>
</tr>
<tr>
<td>Renewable Energies Heat Act (EEWärmeG)</td>
<td>DIN EN 15251 Indoor environmental input parameters</td>
<td>DIN EN 1886 Air handling units – Mechanical performance and measurement methods</td>
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<tr>
<td>Energy Savings Ordinance (EnEV)</td>
<td>DIN 18032-1 and DIN 18032-3 Halls and rooms for sports and multi-purpose use</td>
<td>VDI 3803 Air-conditioning systems – Structural and technical principles</td>
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<tr>
<td>DIN V 18599 Energetic evaluation of buildings</td>
<td>LüAR Guideline for fire protection in ventilation systems</td>
<td>VDI 6022 Hygienic requirements for ventilation and air-conditioning systems</td>
</tr>
<tr>
<td>SchulbauV School building ordinance including additional administrative provisions of the Länder</td>
<td>TA-Lärm Technical Instructions on Noise Abatement</td>
<td>AHU Guideline 01 General requirements regarding AHUs</td>
</tr>
</tbody>
</table>

¹¹ http://www.umweltbundesamt.de/uba-infomedien/search-public.php
¹² http://www.fz-juelich.de/ptj/klimaschutztechnologien
¹³ http://www.rlt-geraete.de
Design Approaches Are Pillars of Efficiency.

Harmless indoor air and its efficient preparation and supply is determined by decisions made in the early design stage.

The energy demand of a building is determined by the building itself, its technical equipment and the users’ behavior. Only if all factors are considered and coordinated, the available energy saving potential can be developed. Users will be ready to accept the building services as long as they have the opportunity to influence it. Thermostates and hygrostats in each room allow adjustments to individual perceptions. Its easy handling facilitates acceptance of the entire air handling system.

The various renovation measures also greatly differ in efficiency. An investigation conducted on 19 schools in the scope of an EU-wide project compared the final-energy savings and the required capital expenditures. The very small amount of 3 percent invested in the ventilation systems of the participating schools catches the eye. The reason: HR systems were retrofitted for the most part, while new systems were installed in some cases only. However, a very remarkable energy saving of about 15 percent per year is achieved, with the room users’ comfort increased at the same time.

The improvement of room climate conditions through controlled ventilation of the rooms increases the students’ and teachers’ performance and well-being. The options of how to supply outdoor air to the rooms are multifarious.

System selection
Whether to opt for a central or decentralized ventilation concept depends on the building structure and the desired comfort conditions. Façade-mounted units (decentralized) are critical in terms of maintenance effort and maintenance frequency. In most cases, hygiene problems and dissatisfied users will ensue during practical operation later on. Central air handling systems have an advantage here, as well as in part load operation despite the necessary duct work, including fire dampers.

Air supply
In demand-based ventilation-systems, air grills and diffusers are of prime importance since these devices have to work properly with very different air-volumes. To ensure a draft-free room ventilation at all times, special attention is to be paid to the characteristic of air-grills and diffusers.
Preconditioning
Conditioning of the classrooms before classes begin fills the rooms with fresh outdoor air and brings room walls to a moderate temperature. This method effectively delays exceeding room temperatures and overshooting conditions are perceived later. Odors released from furnishings and cleaning agents are removed before the rooms are used.

Plant management
Operating costs are considerably reduced by implementing a plant or energy management system. For instance, the status of the system can be checked by means of telediagnosis, and maintenance messages can be evaluated. Periodic and early filter change allow considerable reductions of the system’s energy demand. The additional adaption of the control parameters to the prevailing conditions effect more savings.

Indoor air humidity
In educational buildings, humidity loads by humans are substantial. Window ventilation alone cannot manage the humidity. On the other hand, mechanical ventilation systems often remove excessive amounts of humidity in winter. This can be avoided by implementing a heat recovery system with humidity transfer. In winter, part of the humidity released is then transferred to the dry outdoor air.

Dedicated room sensors
Demand-based control is the most efficient type of control in educational buildings. Supply losses are minimized and varying room influences are taken into account. Users can influence the control via room sensors with setpoint device. Combined with CO₂ or mixed-gas sensors, this makes the room control efficiently in terms of operating costs. With a slightly reduced efficiency, pressure detectors can be used as a low cost alternative.
Planning. Cornerstone of Success.

Solution orientated purposeful job realization.

Planning guidance

**General**

- Demand-based control reduces operating costs.
- Preconditioning of room enclosure surfaces allows postponing the occurrence of maximum room temperatures to times outside the period of use.
- Observe the vertical temperature gradient (max. 3 K from head to toe).
- Max. volume flow to be supplied before CO₂ threshold is reached (1,000 ppm) (corresponds to 20% dissatisfied users).
- Early shading of west and east façades reduces simultaneity of internal and external loads.
- Maintenance management for reducing energy costs (filter pressure losses) to be planned and agreed with the user.
- Analysis of utilization requirements together with the builder-owner and/or user (comfort conditions, design data, occupancy, further internal loads, times of use, etc.).
- Recording of requirements and assumptions on which planning is based (obligation to document).
- Reconciliation of user requirement and specified process- or workplace-related requirements (mind spec. heat and humidity loads!) Possibly clarification with customer.
- Compilation of a list of current standards.
- Planning and manufacturing of the system in accordance with current standards.
- Updating of the standards list upon finalization of the planning stage.

**Air handling system**

- Assess intake conditions with regard to
  - main wind direction
  - snow height
  - foliage
  - noise
  - other emission sources, and
  - position of the exhaust air outlet.
- Provide ports for drainage and cleaning in outdoor air duct.
- For roof intakes: distance from intake to roof surface at least 1.5 times the snow height.
- With volume flow rates > 25 m³/(h · pers.), there is a risk of the relative humidity level lying permanently below 30% r.h.; Provide HR systems with humidity transfer.
- In case of reduced volume flow rates, function-check the supply air terminals.
- Provide dedicated room sensors with setpoint device.
- Consider operation and maintenance of the individual components as early as the planning stage.
- Conduct a structural analysis and check the mounting apertures at an early stage.
- Extract local emissions at source (copiers, printers, etc.).
- Use high-quality pocket filters with high retention capacity (class F7 or better).
- Comply with hygiene standard as per VDI 6022.
- Criteria for financial aid fulfilled as per “Information on climate protection technologies in electricity use”?

### Regulatory framework to be defined at preplanning stage.

### Experience and recognized codes of practice facilitate the design.
### Design parameters

<table>
<thead>
<tr>
<th>Outdoor</th>
<th>Indoor-air temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature</strong></td>
<td><strong>Winter:</strong></td>
</tr>
<tr>
<td>Winter:</td>
<td>17.5 °C to 22.5 °C</td>
</tr>
<tr>
<td>Summer:</td>
<td>20 °C to 24 °C</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Auditorium:</td>
</tr>
<tr>
<td>Summer:</td>
<td>20 °C to 24 °C</td>
</tr>
<tr>
<td><strong>Sound pressure level (TA-Lärm)</strong></td>
<td><strong>Summer:</strong></td>
</tr>
<tr>
<td><strong>Daytime (6–22 h):</strong></td>
<td>Kindergarten:</td>
</tr>
<tr>
<td>Solely residential zones:</td>
<td>21.5 °C to 25.5 °C</td>
</tr>
<tr>
<td>50 dB (A)</td>
<td>Classroom:</td>
</tr>
<tr>
<td>General residential zones:</td>
<td>23 °C to 26 °C</td>
</tr>
<tr>
<td>55 dB (A)</td>
<td>Auditorium:</td>
</tr>
<tr>
<td>Mixed-use zones:</td>
<td>23 °C to 26 °C</td>
</tr>
<tr>
<td>60 dB (A)</td>
<td>Cafeteria:</td>
</tr>
<tr>
<td><strong>Night-time (22–6 h):</strong></td>
<td>23 °C to 26 °C</td>
</tr>
<tr>
<td>Solely residential zones:</td>
<td><strong>Indoor-air humidity</strong></td>
</tr>
<tr>
<td>35 dB (A)</td>
<td>Classrooms:</td>
</tr>
<tr>
<td>General residential zones:</td>
<td>no requirements</td>
</tr>
<tr>
<td>40 dB (A)</td>
<td>recommended,</td>
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<tr>
<td>Mixed-use zones:</td>
<td>however:</td>
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<tr>
<td>45 dB (A)</td>
<td>≥ 25 % r.h.</td>
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<tr>
<td><strong>CO₂ background concentration</strong></td>
<td>Summer:</td>
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<tr>
<td>Rural areas:</td>
<td>≤ 60 % r.h.</td>
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<tr>
<td>approx. 350 ppm</td>
<td>or</td>
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<tr>
<td>Urban areas:</td>
<td>max. 12 g/kg</td>
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<tr>
<td>approx. 375 ppm</td>
<td><strong>Sound pressure level</strong></td>
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<tr>
<td>Densely populated areas:</td>
<td>(line 1: Standard design value; line 2: Typical range)</td>
</tr>
<tr>
<td>approx. 400 ppm</td>
<td>Day-care centers:</td>
</tr>
<tr>
<td><strong>Minimum outdoor air rate</strong></td>
<td>40 dB(A)</td>
</tr>
<tr>
<td><strong>1, 3</strong></td>
<td>30 to 45 dB(A)</td>
</tr>
<tr>
<td>Considering the outdoor air concentration</td>
<td>Classrooms:</td>
</tr>
<tr>
<td>and the students’ age:</td>
<td>35 dB(A)</td>
</tr>
<tr>
<td>1 to 3 years</td>
<td>30 to 40 dB(A)</td>
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<tr>
<td>15.4 m³/(h · pers.)</td>
<td>Gymns:</td>
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<tr>
<td>4 to 6 years</td>
<td>40 dB(A)</td>
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<tr>
<td>15.4 m³/(h · pers.)</td>
<td>35 to 45 dB(A)</td>
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<tr>
<td>7 to 9 years</td>
<td>Halls:</td>
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<tr>
<td>22.7 m³/(h · pers.)</td>
<td>40 dB(A)</td>
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<tr>
<td>10 to 14 years</td>
<td>35 to 50 dB(A)</td>
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<tr>
<td>31.7 m³/(h · pers.)</td>
<td>Staff rooms:</td>
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<tr>
<td>above 14 years</td>
<td>35 dB(A)</td>
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<tr>
<td>34.4 m³/(h · pers.)</td>
<td>30 to 40 dB(A)</td>
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<tr>
<td>or, according to room categories as per</td>
<td>Auditoriums:</td>
</tr>
<tr>
<td>DIN EN 15251:</td>
<td>33 dB(A)</td>
</tr>
<tr>
<td>II (max. 500 ppm above ODA): 30 m³/(h · pers.)</td>
<td>30 to 35 dB(A)</td>
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<tr>
<td>III (max. 800 ppm above ODA): 18 m³/(h · pers.)</td>
<td>Restrooms:</td>
</tr>
<tr>
<td><strong>1</strong> For further information, also on the</td>
<td>45 dB(A)</td>
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<tr>
<td>design of buildings and the use of air</td>
<td>40 to 50 dB(A)</td>
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<tr>
<td>handling systems, see DIN EN 13779.</td>
<td><strong>2</strong> Calculated taking into account CO₂</td>
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<tr>
<td></td>
<td>outdoor air concentration</td>
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<td>(e.g. 370 ppm), max. permissible indoor</td>
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<td></td>
<td>air concentration (e.g. 1,000 ppm), and</td>
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<td>age-related CO₂ emissions by students</td>
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<td>with age-appropriate activity level</td>
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<td>(activity level II: 1-3 years; activity</td>
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<td>level I: all other age groups).</td>
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<td></td>
<td>For deviating parameters, other</td>
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<td>minimum outdoor air volume flow</td>
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<td>rates ensue.</td>
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<td><strong>3</strong> As per DIN EN 15251, room category II</td>
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<td></td>
<td>(corresponds to an expected 20 %</td>
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<td>dissatisfied users).</td>
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<td><strong>4</strong> Values correspond to the operative</td>
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<td>temperatures. Temperatures near the</td>
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<td>lower limit increase comfort and</td>
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</tbody>
</table>
| | learning success.
Solutions Made by robatherm. Flexible and Efficient.

Air handling units specifically customized on the basis of optimized AHU concepts.

**Flexibility** has always been one of the hallmarks of robatherm’s air handling units. Thanks to modular design and maximum freedom of configuration, the specific needs of any educational facility can be met ideally.

**Adaptive AHU concepts**
Adaptive, preconfigured AHU concepts are also optimized in terms of operating costs. A maximum of reliability is achieved in these defined concepts. In project planning, quick and reliable access to the complete AHU data is ensured. Highest versatility is achieved by means of adaptations to limited mounting dimensions or to particular installation conditions.

**Excellent hygiene**
The Berlin Institute for Air Hygiene (ILH) has tested and certified the hygiene characteristics. All components of robatherm AHUs are accessible; the surfaces are most easily cleaned – for constant hygiene and sustainably reduced energy demand.

**Thermal breaks**
Outstanding thermal bridge factors (TB classes) are reached even with the standard design. This means that the casing’s tendency of condensation is minimal. An important criterion for service life and hygiene – condensate is only very rarely found on the surface and occurs only in extreme conditions.

**Low heat losses**
The robatherm casing design ensures excellent thermal insulation and high airtightness. The energy input remains usable to the maximum extent.

**Highest efficiency classes**
Clever dimensioning and the use of optimized built-in parts are the key to reach the highest efficiency classes. AHUs by robatherm are certified in accordance with the energy efficiency classes of the German AHU manufacturers’ association, and the guideline of the European certification body EUROVENT.
Proven mechanical stability
The rugged and proven construction of the casing relies on galvanized sheet metal as standard corrosion protection. Using additional powder coating or stainless steel, it becomes the all-purpose solution.

Ease of assembly
Owing to the modular design, a minimum of components need to be assembled, which saves on-site assembly time. Sturdy casing connections facilitate assembly even further.

Intelligent control
Upon request, robatherm AHUs are delivered with integrated control. Readily wired for hook-up, they are ideal for the renovation of schools.

The physical characteristics
of the AHU casing as specified in DIN EN 1886:

- Thermal transmittance: Class T2
- Thermal bridges: Class TB1/TB2
- Casing leakage: Class L1 (M), L2 (R)
- Filter bypass leakage: Class F9
- Casing deflection: Class D1/D2
Higher Efficiency Thanks to Plant Management.

Plant visualization and interconnecting all AHUs allows savings potentials to be identified and tapped.

Analyzing operating states, interconnecting several air handling systems, and their simple on-line operation – these are the first steps toward plant management. These steps open up all the options for sustainable efficient operation of the air handling systems. Anomalies, such as the mutual interference of control circuits, can thus be detected. Data logging is an excellent tool for revealing savings potentials even for extended periods of time. Plant parameters can be monitored, evaluated and adjusted from practically anywhere.

Smart Control Web Server
robatherm has developed the Smart Control Web Server for more efficient plant management of air handling systems. The “Basic” and “Professional” versions of the web server provide access to all air handling systems of the facility via the modern communication paths of internet and intranet. Communication, diagnosis, operation and telediagnosis of all air handling systems are easily and effectively performed from any network access point. The “Professional” web server offers a particularly comfortable solution: Information from all air handling units is accessed through just one central login.

Saving opportunities by comparison of actual value/desired value.

Plant management via internet and intranet.

Failure reports by text message or e-mail.
Operation
Measured values, control signals, and messages regarding system status, failures and maintenance are clearly displayed in the mimic diagram of the relevant system. Target values including time programs and the holidays calendar are edited in the password-protected area.

Measured-value recording
The “Professional” web server allows recording of measured data, control signals, operating states, and maintenance messages. Subsequent analysis can thus be carried out using various output formats.

Fault management
Alert and inspection messages are relayed to the users by e-mail or, in the Professional version, also by text message or fax. Tele-diagnosis, fault correction, or emergency operation are initiated via internet.

Communication
The Basic version relies on open communication protocols for communicating with higher-level building automation systems. The well-known and wide-spread protocols BACnet or Modbus are used to this end.

Abbreviations for types of air (as specified in DIN EN 13779): ODA = outdoor air, SUP = supply air, ETA = extract air, EHA = exhaust air, RCA = recirculation air.

Benefit from our know-how, also in the educational facility sector.

We offer AHU concepts specifically optimized for educational buildings and in compliance with the current standards and guidelines. The AHU concepts provide you with quick, specific, and competent information concerning the design of a unit and its performance data – optimized in terms of performance, function and value for money. All this is tailored to your individual requirements. You require further details or the documented “TrueBlue”-evidence of efficiency? We look forward to providing competent advice!

Equipment features

- AHU designed for outdoor installation (weatherproof)
- Rotor heat recovery
- Cross-flow plate heat exchanger
- Heat recovery loop
- Plug fan
- High-efficiency electric motor IE 2/IE 3
- Controls integrated into AHU
- Direct refrigeration integrated into AHU
- Reversible heat pump integrated into AHU
- Hydraulic set integrated into AHU
- Steam humidifier integrated into AHU
- Silencer integrated into AHU

Optimization features

- Low investment cost
- Reduced operating cost
- High energy efficiency
- Compact design
- Easy-to-install
- Easy-to-maintain
Design: Indoor installation  
Filters: Supply air: F7 biostatic pocket filter  
Extract air: F5  
HR: Rotary heat exchanger incl. rotor controller with impeller monitor  
Dampers: ODA: steel galv., tightness class 2  
ETA: steel galv., tightness class 2  
Adapters: All unit connections with flexible adapters  
Heater: optional  
\[ T_e = 11 \, ^\circ C, \ T_a = 22 \, ^\circ C \]  
Accessories: Inclined tube manometer  
Frequency converter incl. repair switch  
Options:  
- antimicrobial powder coating  
- desiccant rotor  
- heater module  
- controls and cooling  
- different unit connections  
- silencers  
- etc.  

Low capital expenditures and compact dimensions for use in even the most confined spaces. Suited for high-occupancy rooms such as classrooms or auditoriums.  
Desiccant rotors (optional) protect from excessively dry indoor air in winter, particularly in case of high specific volume flow rates.  
Efficient heat recovery thanks to low pressure losses combined with high heat recovery coefficients allows cost-effective operation.  
Small number of components for ease of installation. Upon request, also bolted together at the factory. Access for maintenance afforded by removable filters and large doors.  
Direct-drive fans allow trouble-free operation. Motor control unit ready installed, wired, and parameterized.  
Sound attenuation in the ducts to be adjusted by customer to the permissible or agreed values (see Design parameters).
Proven AHU concepts

### Equipment features

- **Navigator**
  - Indoor installation
- **Filters**
  - Supply air: F7 biostatic pocket filter
  - Extract air: F5
- **HR**
  - Cross flow plate heat exchanger
  - (heat recovery coefficient, dry ≥ 80%)
- **Dampers**
  - ODA: steel galv., tightness class 2
  - ETA: steel galv., tightness class 2
- **Adapters**
  - All unit connections with flexible adapters

### Optimization features

- **Heater**
  - Optional
  - \( T_1 = 12 \, ^\circ C \) \( T_a = 22 \, ^\circ C \)
  - \(^1\) only where ice protection is required
- **Accessories**
  - Inclined tube manometer
  - Frequency converter incl. repair switch
- **Options**
  - Antimicrobial powder coating
  - Heater module
  - Controls and cooling
  - Different unit connections
  - Silencers
  - Etc.

### AHU description

- **Design**
  - Indoor installation
- **Heater**
  - Optional
  - \( T_1 = 12 \, ^\circ C \), \( T_a = 22 \, ^\circ C \)
- **Accessories**
  - Inclined tube manometer
  - Frequency converter incl. repair switch
- **Options**
  - Antimicrobial powder coating
  - Heater module
  - Controls and cooling
  - Different unit connections
  - Silencers
  - Etc.

- Low operating costs and most easy access for maintenance despite compact design. Suited for odorous areas such as gyms, locker rooms, or cafeterias.
- Separation of airflows in the HR system.
- No transmission of substances (e.g. odor, humidity) from extract air to supply air (recuperative HR).
- Heat recovery with high heat recovery coefficient requires only minimal reheating energy while pressure losses are moderate.

### Abbreviations for types of air (as specified in DIN EN 13779):
- ODA = outdoor air, SUP = supply air, ETA = extract air, EHA = exhaust air, RCA = recirculation air

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<td>Silencers</td>
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<tr>
<td></td>
<td>Etc.</td>
</tr>
</tbody>
</table>

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- Ease of installation thanks to small number of components, also bolted together at the factory. Plate heat exchanger ensures high indoor air quality combined with minimal maintenance effort.
- Direct-drive fans allow trouble-free operation.
- Motor control unit ready installed, wired, and parameterized.
- Sound attenuation in the ducts to be adjusted by customer to the permissible or agreed values (see Design parameters).
Proven AHU concepts

**AHU description**

Low capital expenditures and high energy efficiency at the same time. Suited for high-airflow and/or highly odorous areas such as large auditoriums, gyms, cafeterias, canteens.

Separation of airflows in the HR system. No transmission of substances (e.g. odor, humidity) from extract air to supply air (recuperative HR).

Heat recovery with moderate pressure losses ensures short payback periods and trouble-free operation.

**AHU equipment**

<table>
<thead>
<tr>
<th>Design:</th>
<th>Indoor installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filters:</td>
<td>Supply air: F7 biostatic pocket filter</td>
</tr>
<tr>
<td></td>
<td>Extract air: F5</td>
</tr>
<tr>
<td>HR:</td>
<td>Cross flow plate heat exchanger (heat recovery coefficient, dry ~60%)</td>
</tr>
<tr>
<td>Heater:</td>
<td>( t_{\text{r}} \approx 8 \degree \text{C}, t_{\text{a}} = 22 \degree \text{C} )</td>
</tr>
<tr>
<td></td>
<td>Fluid: PHW 70/50 \degree \text{C}</td>
</tr>
<tr>
<td>Cooler:</td>
<td>( t_{\text{r}} = 32 \degree \text{C}, \varphi_{\text{r}} = 40 % \text{r.h.} )</td>
</tr>
<tr>
<td></td>
<td>( h_{\text{r}} = 62.8 \text{kJ/kg} )</td>
</tr>
<tr>
<td></td>
<td>( t_{\text{a}} = 18 \degree \text{C}, \varphi_{\text{a}} \approx 85 % \text{r.h.} )</td>
</tr>
<tr>
<td></td>
<td>Fluid: PCW 7/13 \degree \text{C}</td>
</tr>
<tr>
<td>Dampers:</td>
<td>ODA: steel galv., tightness class 2</td>
</tr>
<tr>
<td></td>
<td>ETA: steel galv., tightness class 2</td>
</tr>
<tr>
<td>Options:</td>
<td>- antimicrobial powder coating</td>
</tr>
<tr>
<td></td>
<td>- controls and cooling</td>
</tr>
<tr>
<td></td>
<td>- other unit connections</td>
</tr>
<tr>
<td></td>
<td>- silencers</td>
</tr>
<tr>
<td></td>
<td>- grease filters and enclosed motor</td>
</tr>
<tr>
<td></td>
<td>- etc.</td>
</tr>
</tbody>
</table>

**AHU schematic**

- ODA
- ETA
- EHA
- SUP

**Plant flow diagram**

- ODA
- ETA
- EHA
- SUP

**Abbreviations for types of air (as specified in DIN EN 13779):**

- ODA = outdoor air
- SUP = supply air
- ETA = extract air
- EHA = exhaust air
- RCA = recirculation air
**Equipment features**

- Indoor installation
- Filters: Supply air: F5 biostatic pocket filter, F7 pocket filter
- Extract air: F5 pocket filter
- HR: Rotary heat exchanger incl. rotor controller with impeller monitor, summer mode taken into account in the cooler design
- Heater: $t_e \approx 9 \, ^\circ C, \, t_a = 22 \, ^\circ C$, Fluid: PHW 70/50 °C
- Cooler: $t_e = 28.5 \, ^\circ C, \, \varphi_a = 50 \% \, r.h.$
- $h_e = 59.8 \, kJ/kg$
- $t_a = 18 \, ^\circ C, \, \varphi_a = 85 \% \, r.h.$
- Dampers: ODA: steel galv., tightness class 2
- EHA: steel galv., tightness class 2
- Accessories: Inclined tube manometer
- Frequency converter incl. repair switch
- Options: - antimicrobial powder coating
- desiccant rotor
- integrated controls and cooling

**Optimization features**

- Low operating costs even in case of higher airflow rates thanks to moderate component design. Suited for high-occupancy rooms such as classrooms or auditoriums.
- Desiccant rotors (optional) protect from excessively dry indoor air in winter, particularly in case of high specific volume flow rates.
- Efficient heat recovery thanks to low pressure losses combined with high heat recovery coefficients allows cost-effective operation.

**AHU description**

Integrated chilling systems allow easy, centralized maintenance; no external chillers, no distribution losses, no piping effort. Chilling system pre-piped.

High versatility in throughput ranges, equipment, and installation. Ease of maintenance afforded by large doors. Reduced installation effort on site.

For the heat-up mode (winter), the energy demand can be further reduced by means of the integrated air recirculation function.

NOTE: Mind odor transmission!

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**Abbreviations for types of air (as specified in DIN EN 13779):**
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