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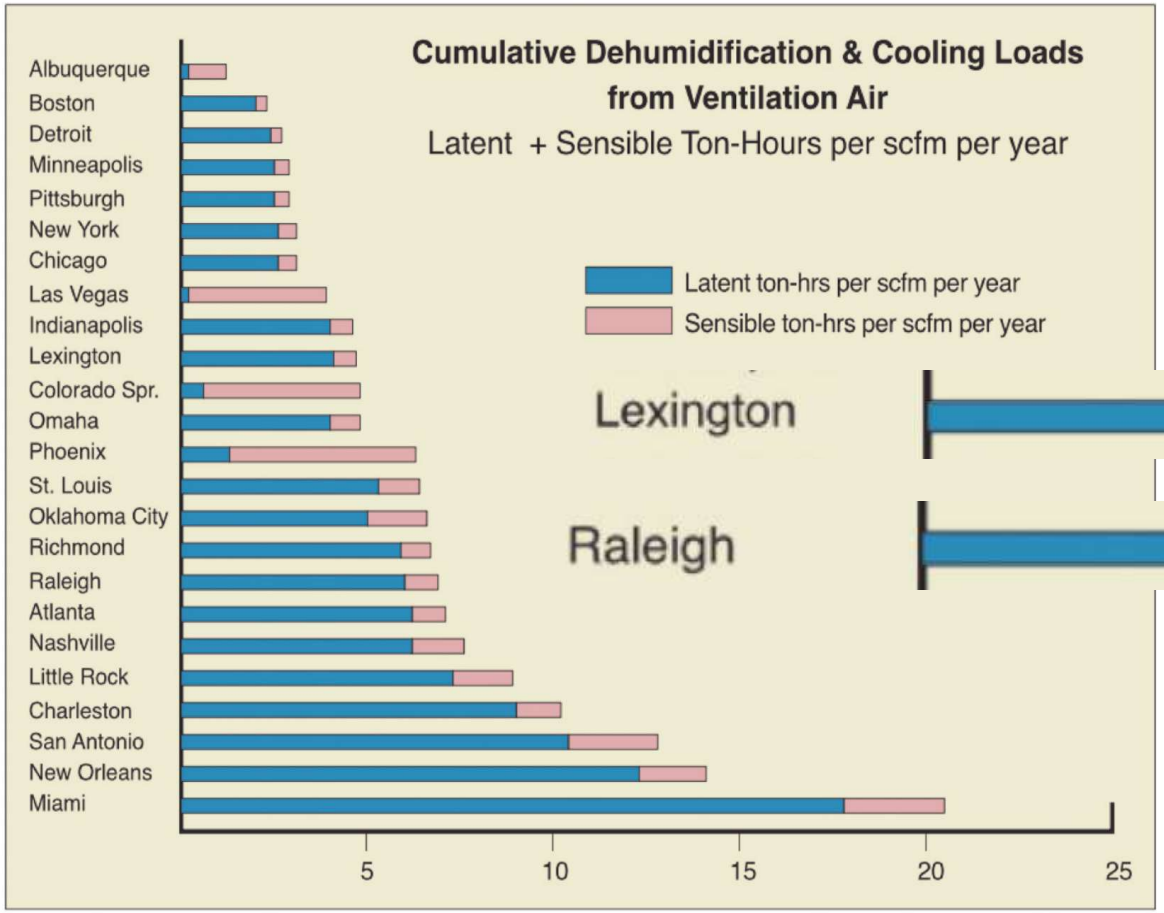
ASHRAE Design Guide for DOAS

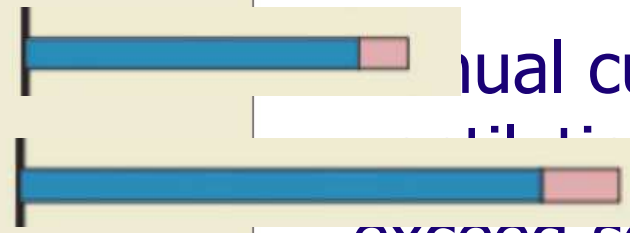
- Reasons for using DOAS & Applications
- OA Requirements and Design (Standards)
- DOAS Equipment Configurations
- Operation and Maintenance

Reasons for using DOAS & Applications

- There are many reasons to use DOAS. Some of the most common drivers are:
- (1) Improving humidity control
- (2) Reducing energy use
- (3) The desire to simplify ventilation design and control
- (4) The desire to use heating and cooling equipment that does not provide ventilation and/or dehumidification (e.g., radiant panels or passive chilled beams)
- (5) Reducing installation cost

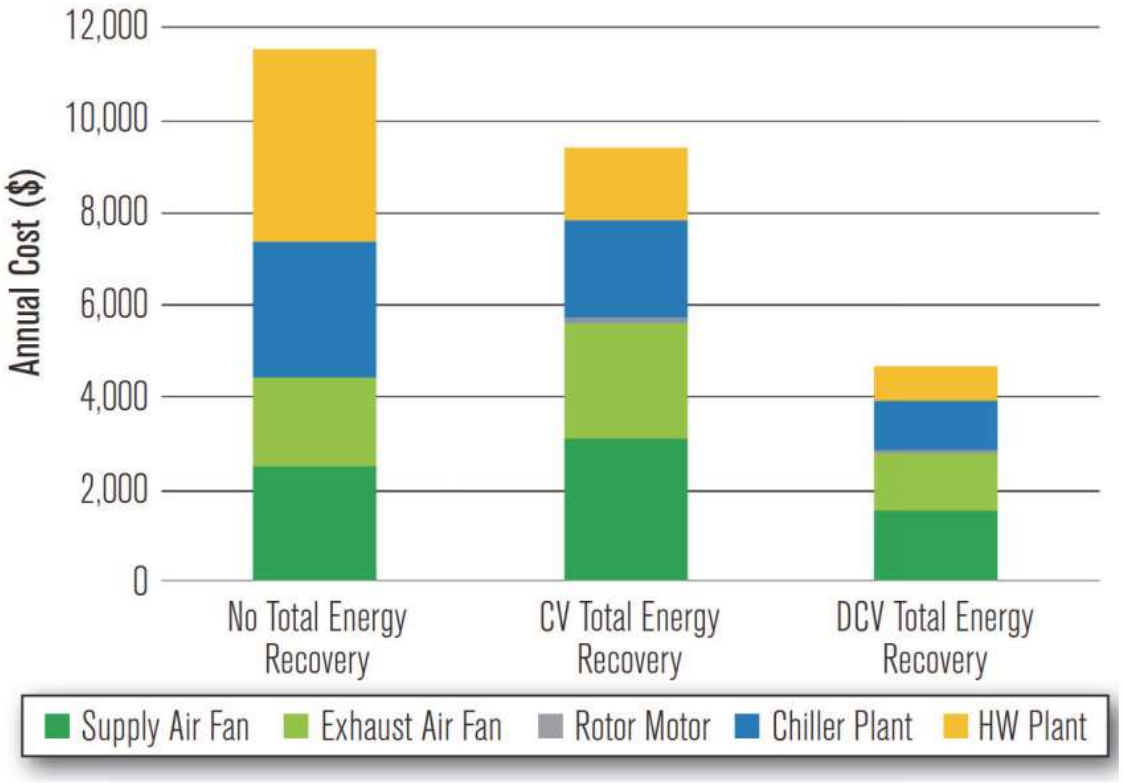
Humidity Control





- With the introduction of outdoor air often comes an increase in dehumidification loads.
- ...ual cumulative latent ... loads typically exceed sensible ventilation cooling loads by 3:1 to 5:1

Energy Impacts



- Remove humidity from the outdoor air, which allows the remaining cooling components to operate based solely on dry-bulb temperature.
- DOAS is often the easiest way to provide the air-to-air energy recovery required for large airstreams.
- Control (reduce) OA required.

Ventilation Control

- Because DOAS airflow is independent of building heating and cooling loads, it is relatively simple to control and operate, particularly if the DOAS is a constant-volume system.
- DOAS is also effective at meeting outdoor air requirements under all conditions.

Use of HVAC Equipment Without OA

- Lower sensible-cooling demands than were previously required has resulted in the development of less traditional HVAC equipment.
- This kind of equipment typically has very limited dehumidification capacity and must rely on a separate DOAS to provide dry air ventilation for the building.

First Cost Reduction

- By addressing outdoor air loads, however, DOAS can reduce the heating and cooling loads that must be met by other components of the HVAC system.
- Using a DOAS that handles the entire (external and internal) latent load with an enthalpy exchanger and a cooling coil might allow for:
  - Downsizing the tonnage of in-space units
  - Reducing the central heating and cooling equipment capacities
  - Reduce the piping, ductwork, and electrical installation

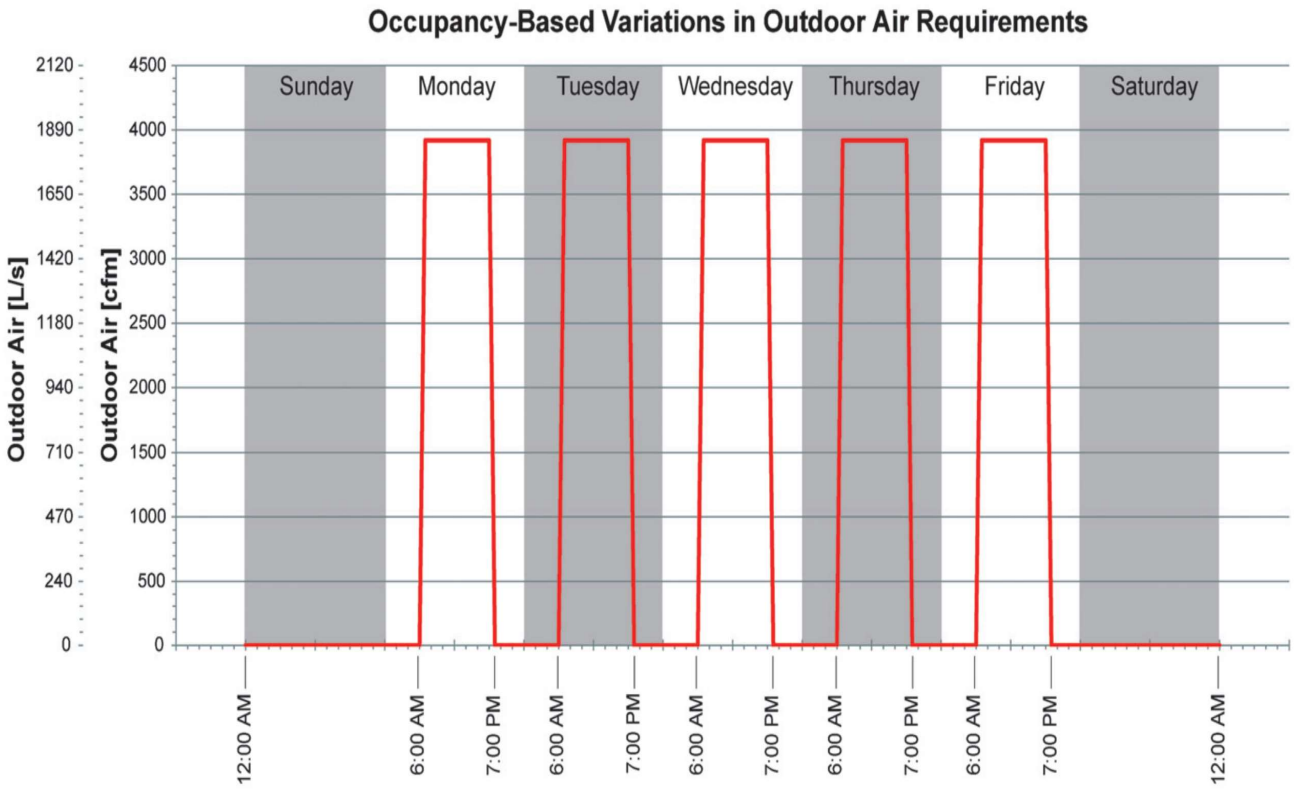
Outdoor Air Requirements

- ASHRAE Standard 62.1 is often incorporated into local building codes.
- The minimum amount of outdoor air needed by a space is determined by one of three factors: codes and standards, exhaust, or loads.
- ASHRAE Standard 62.1 contains three procedures that can be used to design a ventilation system: the "Ventilation Rate Procedure" (Section 6.2), the "Indoor Air Quality (IAQ) Procedure" (Section 6.3), and the "Natural Ventilation Procedure" (Section 6.4)

Outdoor Air Requirements

- In some cases, there may be benefits to supplying more outdoor air than the minimum required.
- **LEED** - can achieve one point for supplying 30% more outdoor air to each breathing zone than the minimum required by ASHRAE Standard 62.1.
- **WELL** – requiring optimal indoor air quality to support the health well-being of building occupants by increasing ASHRAE 62.1 requirements by 30%
- Some studies have also shown correlations between increased ventilation, enhanced productivity, and reductions in employee sick days.

Outdoor Air Requirements

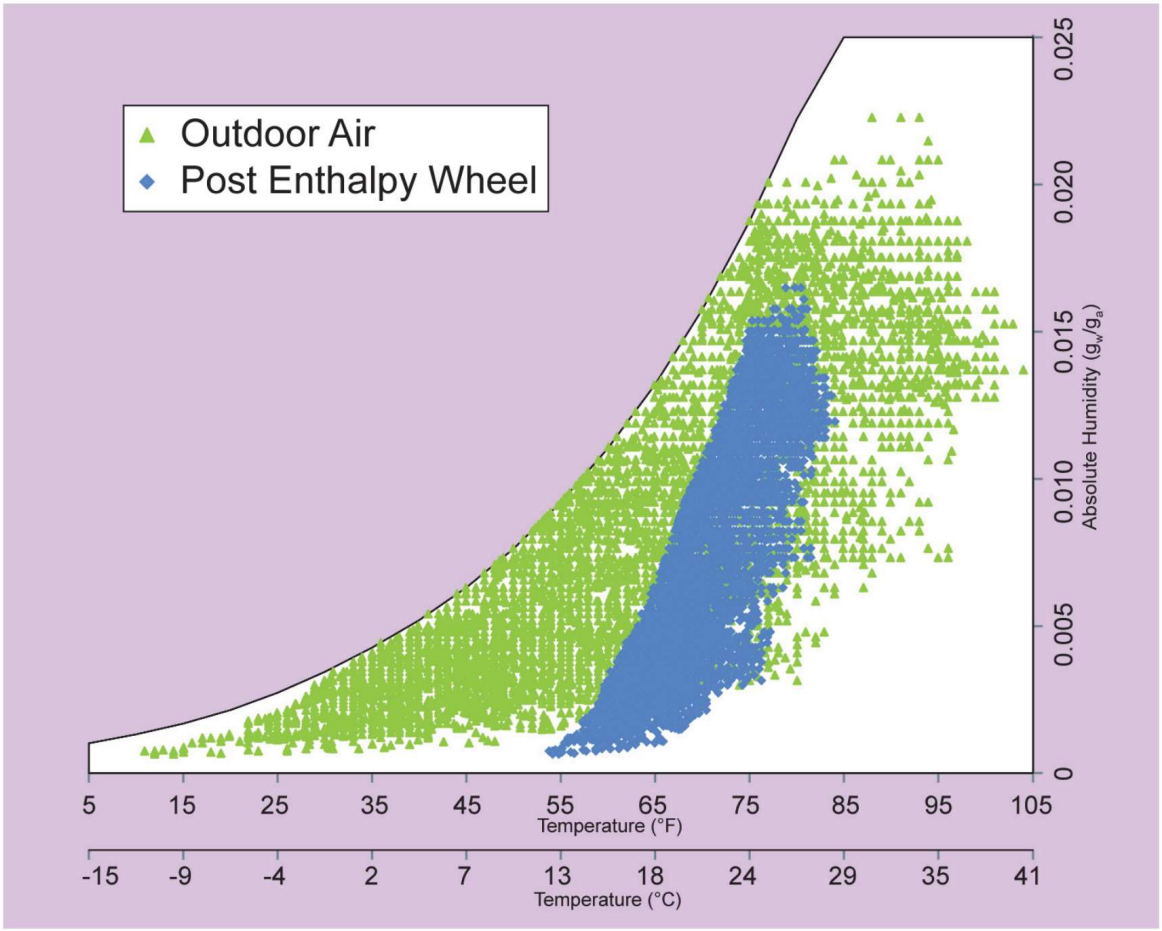


- For spaces that exhibit high variability in occupancy density (e.g., conference rooms, auditoriums, and cafeterias) technologies such as occupancy sensors and CO2 sensors can be used to curtail outdoor airflow when it is not needed.

DOAS Design

- It is useful to remember that most ASHRAE design values are **averages based on 25 years of weather data**. This means that during less typical years the number of hours with outdoor air conditions above and/or below ASHRAE design values will be increased.
- For most commercial and institutional applications, if the temperature or humidity is slightly higher or lower than usual for a few hours per year, **there will likely be no significant problems.**
- Outdoor air loads have the potential to switch from heating to cooling and from humidification to dehumidification multiple times a day. The design of a system and its controls must be able to **respond to weather-related changes in addition to changes in ventilation** and exhaust air requirements.

DOAS Design – Energy Recovery



- One significant benefit of exhaust air energy recovery is that it can narrow the wide range of outdoor air conditions encountered over the year into a much tighter range of conditions.

DOAS Design - Humidity

- Major dehumidification load considerations include outdoor design conditions, target indoor dew point, occupant number and activity level, ventilation and makeup air loads, infiltration loads, and door openings.
- In some cases, cooled, dehumidified air from a DOAS unit may cause some zones to become too cool.

Abridged humidification distance with the aid of multiple steam distribution system Condair Optisorp

System Design

There are four common DOAS air distribution configurations

- **Conditioned Outdoor Air Supplied Directly to Each Zone**
- Pro: to ensure that the required outdoor airflow reaches each zone
- Con: the installation of additional ductwork and separate diffusers
- **Conditioned Outdoor Air Supplied to Intake of Local Units**
- Pro: no space required to install additional ductwork and separate diffusers
- Con: fan on local unit is used to deliver outdoor air to the zone, it must operate continuously whenever outdoor air is needed during occupancy
- **Conditioned Outdoor Air Delivered to Supply Side of Local Units**
- Pro: opportunity to downsize the local units if OA is delivered cold
- Con: measurement and balancing are more difficult
- **Conditioned Outdoor Air Supplied to Plenum near Local Units**
- Pro: no additional ductwork, separate diffusers, or mixing plenums on the local units.
- Con: hard to ensure required amount of outdoor air reaches each zone, because it is not ducted directly

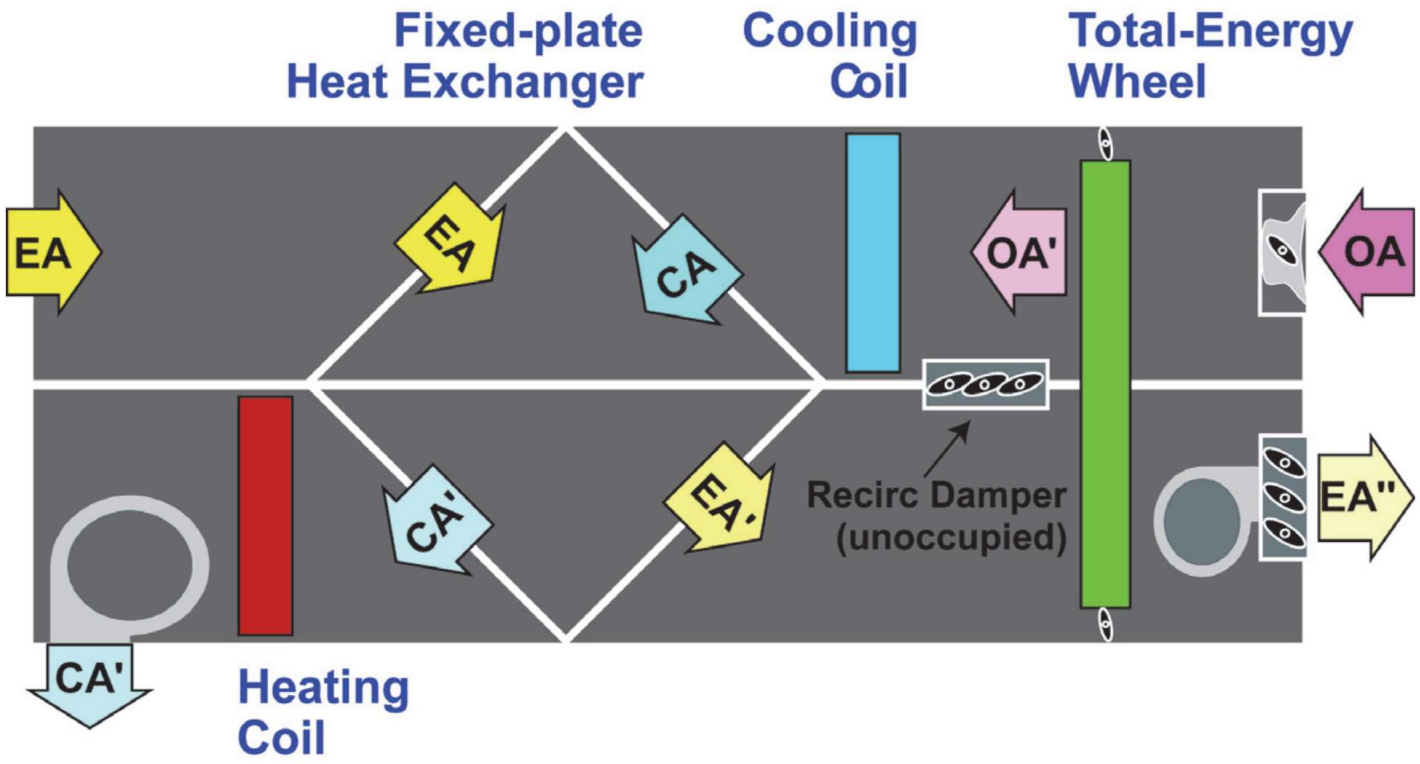
DOAS Unit Configurations

- **Typical options include:**

- **Variable capacity compressors** (10-100% capacity & dehumidification)
- **Energy recovery wheels** (reclaim exhaust air energy to pre-cool, pre-heat, dehumidify, and humidify the ventilation outside air)
- **Modulating gas heating** (tight control of the supply air during the heating season)
- **High capacity coils** (handle variable airflows of DOAS units and provide more dehumidification)
- **Modulating hot gas reheat** (precise humidity control for consistent occupant comfort without temperature swings common to on/off reheat systems)

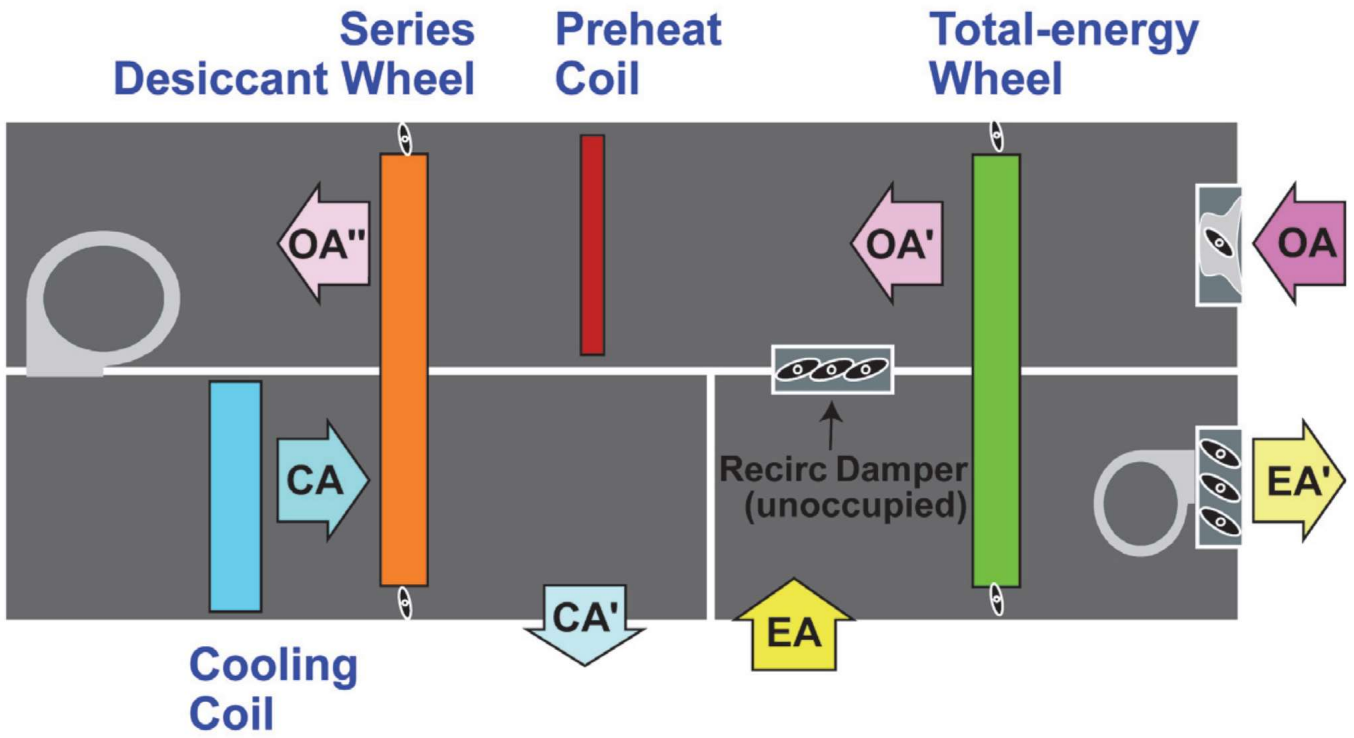
DOAS Unit Configurations

- **Exhaust Air Energy Recovery with Sensible Reheat**



DOAS Unit Configurations

- **Exhaust Air Energy Recovery with Desiccant Wheel**



Additional Design Considerations

- **Fan Energy –** pay careful attention to fan selection to ensure that the system will operate efficiently and cost effectively.
- **Cooling/Dehumidifying Capacity Modulation and Staging** – number and type of compressors (stages)
- **Variable Frequency Drives** – Allow for fan power consumption to be reduced during some operating conditions and soft-start extends motor life.
- **Filtration/Air Cleaning -** In urban locations where air pollution is a persistent problem, higher levels of filtration or other types of air cleaning may be needed; also when trying to achieve LEED or WELL

DOAS Retrofit

- In retrofit cases, local units can satisfy space heating and cooling needs, and outdoor air can be provided by a central DOAS unit via distribution ducts.
- The duct size required for outdoor air delivery only is much smaller than what would be needed for a central AHU. Consider routing outdoor air ducts along corridors and hallways.
- Conditioned outdoor air is then delivered to each space using one of the configurations shown previously.

DOAS Controls

- Detailed sequences with schematic diagrams are particularly helpful tools for contractors and future operators.
- Local HVAC equipment is responsible only for maintaining dry-bulb temperature in the space through a thermostat.
- The most common way to activate a DOAS unit is based on the building occupancy schedule through the BMS.
- There are four general modes of operation for the DOAS unit that are based on outdoor air conditions: dehumidification and cooling, sensible cooling, heating, and ventilation only.

DOAS Control Modes

Control Mode	Outdoor Conditions
Dehumidification and Cooling	Outdoor air dew point > dehumidification set point
Sensible Cooling	Outdoor air dew point ≤ dehumidification set point Outdoor air dry-bulb temperature > cooling set point
Ventilation Only	Outdoor air dew point ≤ dehumidification set point Heating set point ≤ outdoor air dry-bulb temperature ≤ cooling set point
Heating	Outdoor air dew point ≤ dehumidification set point Outdoor air dry-bulb temperature < heating set point

DOAS Controls

- When using DCV, as outdoor air is varied by fan VFD, the exhaust air may also have to be modulated to avoid negative building pressures.
- A slightly positive or neutral average building pressure can be achieved using

one of two distinct approaches.

- Measure the building pressure and control outdoor (intake) and/or exhaust airflows to achieve the desired average building pressure.
- Measure (or estimate) outdoor and exhaust airflows, and maintain a set difference between them to create the desired building pressure.
- Sensors should be checked and recalibrated after a certain amount of time.

DOAS Controls

- Does the DOAS unit have factory-mounted or field-supplied controllers (or both)?
- Are all BAS-required control points available from the DOAS controller?
- Are there duct smoke detectors on supply and/or return connections?
- Are motorized dampers provided with the DOAS unit, and will they operate
- via signals from the BAS?
- If a factory controller is provided with the DOAS unit, confirm that control points in the BAS submittal match those in the DOAS submittal.
- Verify that during unoccupied mode, the DOAS will either stop operation or will recirculate and dry the indoor air rather than bringing in humid or cold outdoor air.

DOAS Operation & Maintenance

- Should be included with equipment:

- Run test report, wiring diagrams, startup form
- Color-coded wiring diagrams (allow fast connection identification and analysis and thus a reduction in down time and cost).
- Access doors with hinges and quarter turn, lockable handles (provide improved reliability over single point hinges and make the unit easily serviceable).
- Compressors and unit controls are contained within a compartment isolated from the air stream for ease of service and increased sound dampening.
- Require start-up by factory authorized technician

DOAS Operation & Maintenance

- Provide the Owner with the following documentation:
- Operation and Maintenance Manual
- Systems Manual
- As-Built Documents
- Training Pan for New and Future Facilities Personnel
- Warranties

DOAS Operation & Maintenance

- Operational performance checks should be carried out on a regular basis, such as during the change of seasons when other preventative maintenance items are reviewed.
- To ensure the DOAS continues to deliver clean outdoor air to the building, the following items should be reviewed monthly:
  - Filters
  - Cooling Coils
  - Drain Pans
  - ERWs
  - Fans/ Bearings
  - Air Flow Stations/ Sensors

- See checklists in ASHRAE Design Manual

DOAS Design Summary

- When choosing to incorporate DOAS, the designer must:
- First identify the loads that the system will be required to meet and note that, in contrast to other loads, outdoor air loads are highly variable.
- Determine how the DOAS will interact with other systems.
- Which components the DOAS unit should include, and how to control those components.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