Récupération d'énergie air-air pour des environnements intérieurs supérieurs dans un contexte de la COVID-19

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Master
AIR CONDITIONING | REFRIGERATION
VENTILATION | HEATING

Paul Pieper, ing.
Directeur de projets spéciaux ventes

Abstrait

Nous examinerons la position de l'ASHRAE sur les aérosols infectieux et les meilleurs moyens d'atténuer la transmission du SRAS-CoV-2 (COVID-19) pour les environnements intérieurs ainsi que les directives spécifiques de l'ASHRAE concernant les VRE dans ce contexte. Enfin, nous examinerons les technologies commerciales disponibles et les meilleurs moyens de les intégrer pratiquement dans les systèmes de ventilation courants.

Agenda

- Context
- General Recommendations
- HVAC Systems with Air-to-Air Energy Recovery (AAERV)
- ASHRAE Standard 62.1-2013
- Exhaust Air Transfer Ratio (EATR)
- System Design Considerations
- AAERV On-site Inspections
- Remediation
- Conclusions
- Useful References

Context: ASHRAE Board of Directors

- On April 14, 2020, the ASHRAE Board of Directors stated (in the ASHRAE Position Document on Infectious Aerosols):
  - *Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection.* ***In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.***

Context: ASHRAE TC5.5

Question: Given the need to control airborne exposure to SARS-CoV-2, what does a building operator need to know about Energy Recovery Ventilation (ERV) systems in their building?

Answer: TC5.5 produced the Practical Guidance for Epidemic Operation of Energy Recovery Ventilation Systems or recommendations **for existing buildings**

General Recommendations

AAERV in the context of combatting airborne transmission of infectious diseases

- Ventilation for reducing the risk of exposure;
- Effective filtration efficiencies to capture respirable particles;
- The efficacy, safety and implementation of different air disinfection technologies and operating strategies within the enterprise or in public facilities;
- The effect of air distribution, directionality and objects within spaces on exposure risk; and
- Reduced occupancy, and space allocation and room set-up as risk mitigation strategies.

ASHRAE, June 9, 2020, TC5.5 Practical Guidance for Epidemic Operation of Energy Recovery Ventilation Systems, https://bit.ly/33uUsVm (June 17, 2020)

HVAC Systems with Air-to-Air Energy Recovery

Stand-Alone Systems

It is important to maintain ventilation. **Re-entrainment** of contaminants from exhaust air occurs in ALL building design.

Stand-Alone System:

AAERV has an entirely separate duct system

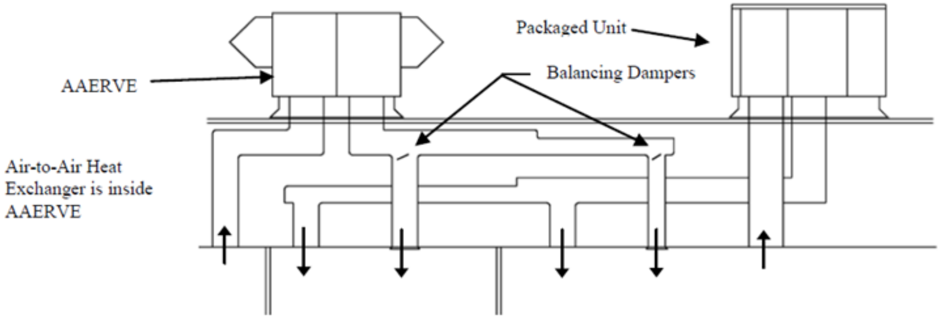


Figure C1. Typical Stand Alone System - Rooftop

Stand-Alone Coupled System:

AAERVE that is all, or partially, ducted to the system of an air-conditioned system

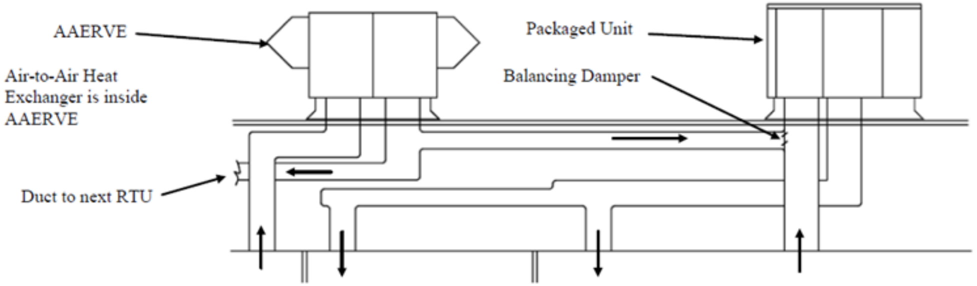
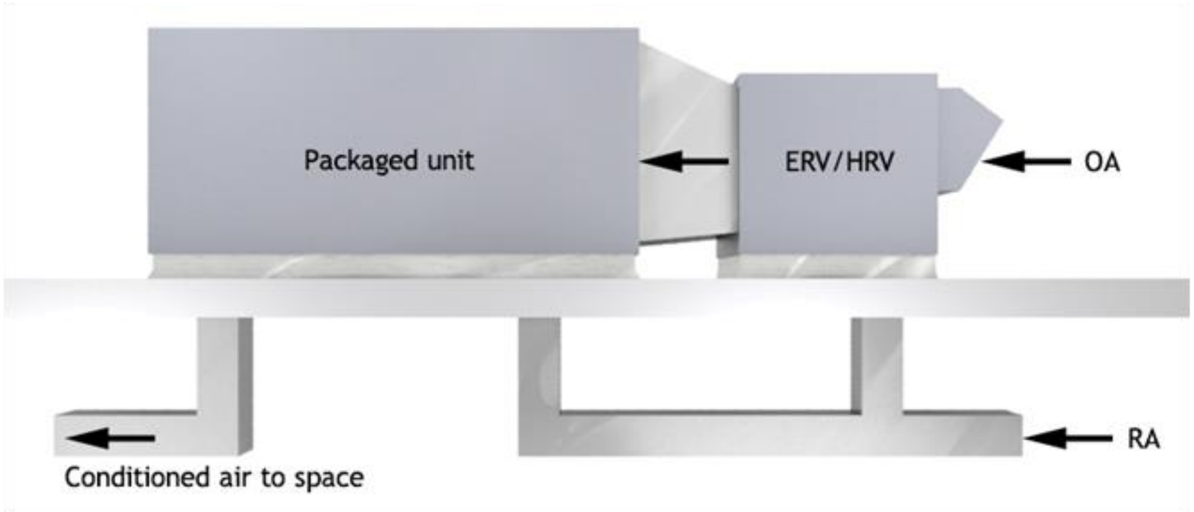


Figure D1. Typical Stand Alone-Coupled System (one of many possibilities)

HVAC Systems with Air-to-Air Energy Recovery

Unitized System:

An AAERV accessory attached directly to a unit air conditioner, typically in the field



Integrated System:

AAERV component is incorporated into an Air Handling Unit or along with a refrigeration system and controls

HVAC Systems with Air-to-Air Energy Recovery

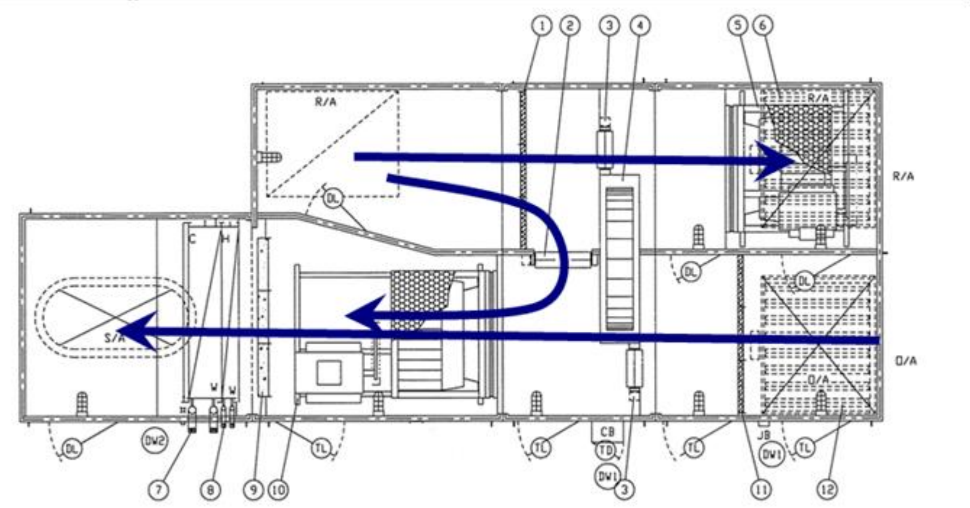
Integrated Systems

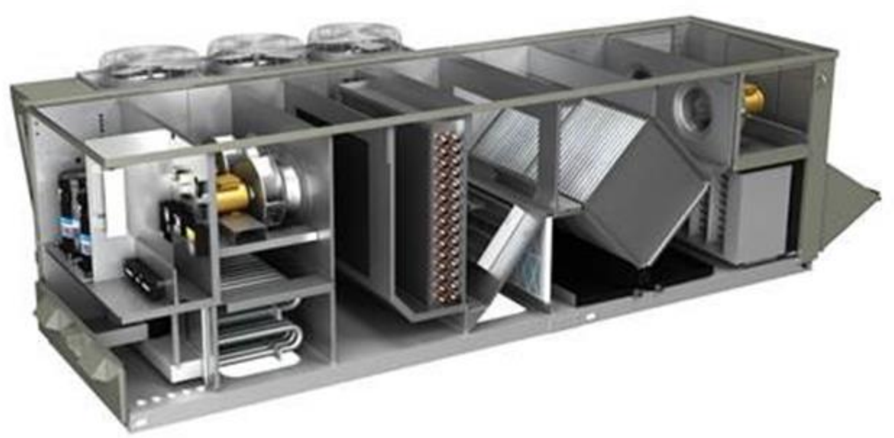
Air-Handling System

AAERV component is incorporated within the AHU; no refrigeration, no controls

Packaged System

AAERV component is incorporated along with a refrigeration system and controls





ASHRAE Standard 62.1-2013

Ventilation for Acceptable Indoor Air Quality

§ 5.18.2 Redesignation

Excluding the provisions outlined in § 5.18.2.1 Air Cleaning and § 5.18.2.3 Ancillary Spaces, a mixture of air is classified with the highest classification among the air classes mixed per § 5.18.2.2 Transfer.

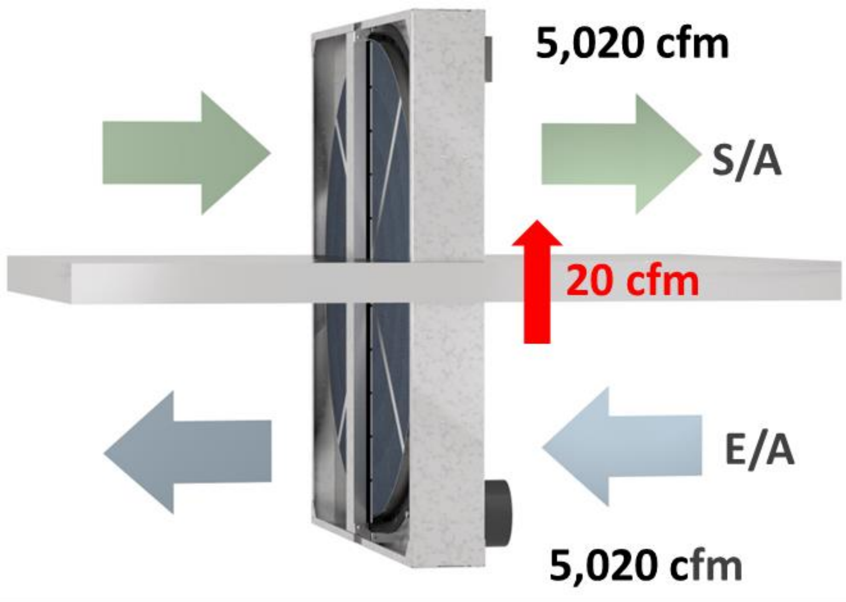
However, a certain amount of mixing is allowed without having to redesignate when air-to-air energy recovery is used under § 5.18.3 Recirculation Limitations.

Exception: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted, provided that **Class 2 air shall not exceed 10%** of the outdoor air intake flow and **Class 3 air shall not exceed 5%** of the outdoor air intake flow.

Class 4 air shall not be recirculated or transferred to any space.

EATR: Exhaust Air Transfer Ratio (EATR)

- EATR helps to determine compliance with the §5.16.3 Recirculation Limitations and to select the correct technology for your application
- EATR = the ratio of the tracer gas concentration difference between the leaving supply airflow and the entering supply airflow and the difference between the entering exhaust airflow and the entering supply airflow (expressed as percentage)



EATR = 0.4% = 20 cfm*

*EATR percentage is not exactly equivalent to cfm, but we can safely use this assumption for a general discussion related to leakage.

Select the Correct Technology

Classification of Exhaust Air and Dilution Limits (Refer to ASHRAE 62.1 Addendum Y)	Recommendations
Class 1 Air – General space conditioning recirculation permitted	Use EATR and OACF to calculate adjusted intake rates and insure that proper outside air ventilation is provided.
Class 2 Air – Toilet exhaust, etc. Supply air is susceptible when no more than 10% is Class 2 air.	Minimize EATR to reduce recirculation of exhaust air. Most devices will require no special measures to achieve this level of dilution. System design, including multiple exhaust points from a variety of spaces can increase dilution performance.
Class 3 Air – Education lab, dry cleaning etc. Supply air is acceptable when no more than 5% is Class 3 air.	Minimum EATR to reduce recirculation of exhaust air. System design, including separate exhaust air duct systems for Class 3 exhaust, multiple exhaust points including Class 1 and 2 air, purge, etc., will influence dilution performance.
Class 4 Air – Biohazard facility, etc. Recirculation prohibited.	AAERVE may not be an acceptable technology. Only specific designs with zero EATR and not susceptible to failure should be used in this application.

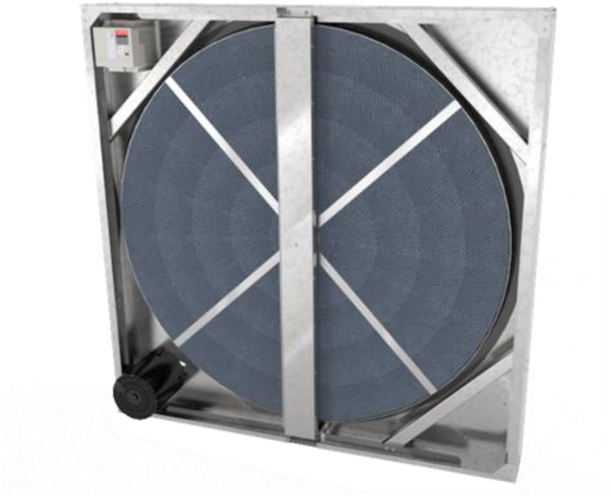
For speciality applications such as laboratory exhaust or healthcare facilities, specific standards and guidelines should be consulted (i.e. ASHRAE/ANSI/ASHE Standard 170-2017 Ventilation of Health Care Facilities).

EATR: Air-to-Air Energy Recovery Technology Limitations

- **Class 2 Air:** Heat pipes, fixed plates, and heat wheels will all generally easily exceed the **10% EATR** requirements with little to no effort
- **Class 3 Air:** Heat pipes and fixed plates will generally meet **the 5% EATR** requirements and some heat wheels can meet these requirements, depending on the application and product used
- **Class 4 Air:** Use a run-around loop or similar technology where the airstreams are completely isolated from one another

EATR: Typical Ranges for EATR

For Certified AAERV Technologies



Heat Pipes
EATR: 0%*

Not influenced differential pressures

Sensible Plates
EATR: 0 to 5%

Enthalpy Plates
EATR: 0 to 5%

Heat Wheels
EATR: 0.5 to 10%

Highly dependent on differential pressures

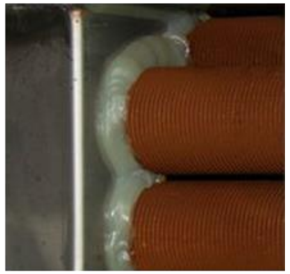
*A device with a nominal 0% EATR may still have some leakage, which is why AAERV should still not be used for Class 4 applications

EATR: Leakage within Passive AAERV Devices

Leakage affected by Pittsburg lock or banked assemblies



Leakage potential at center partition

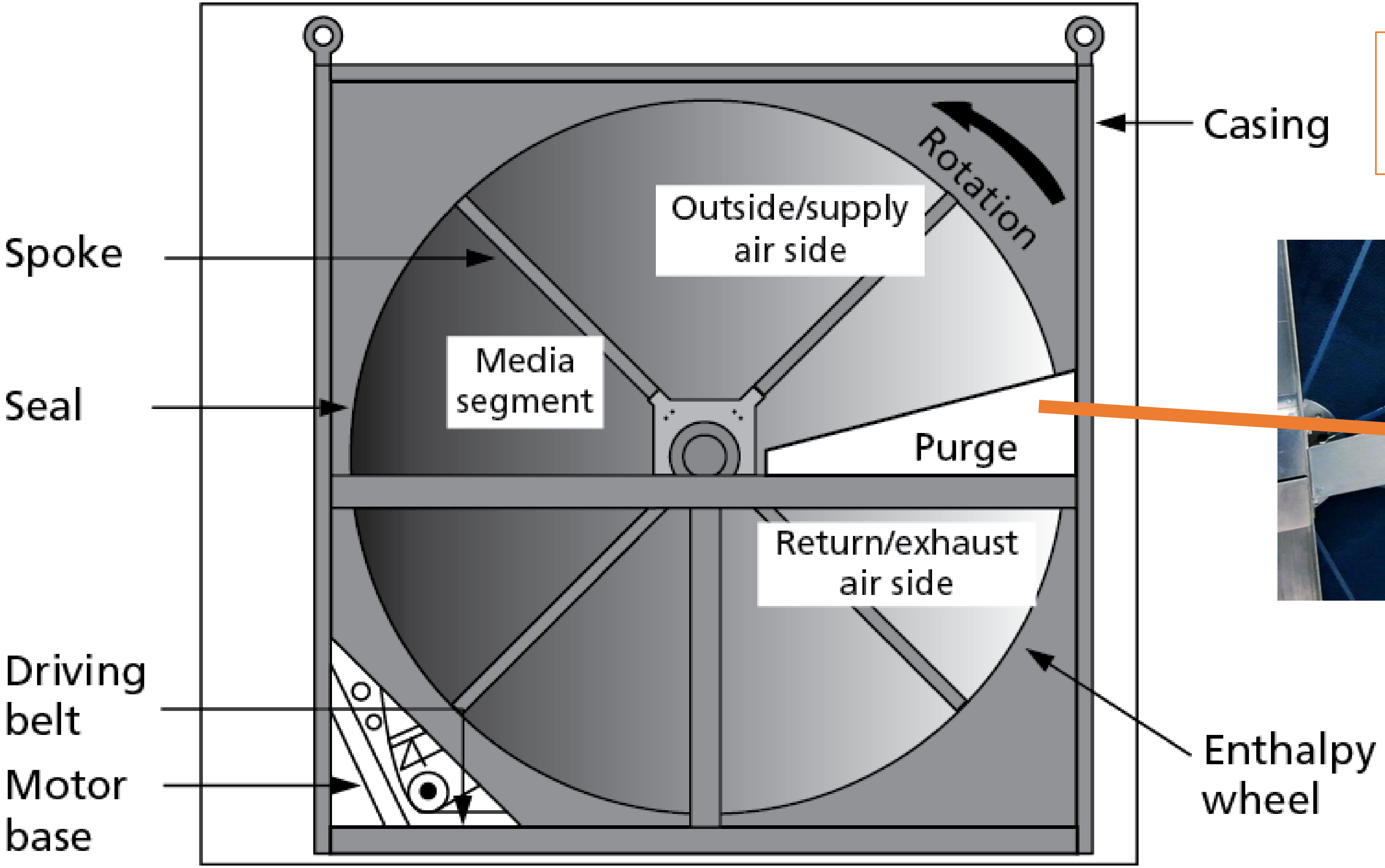



Be conscious of leakage potential for critical applications; potential leakage paths within air handling equipment also exist.

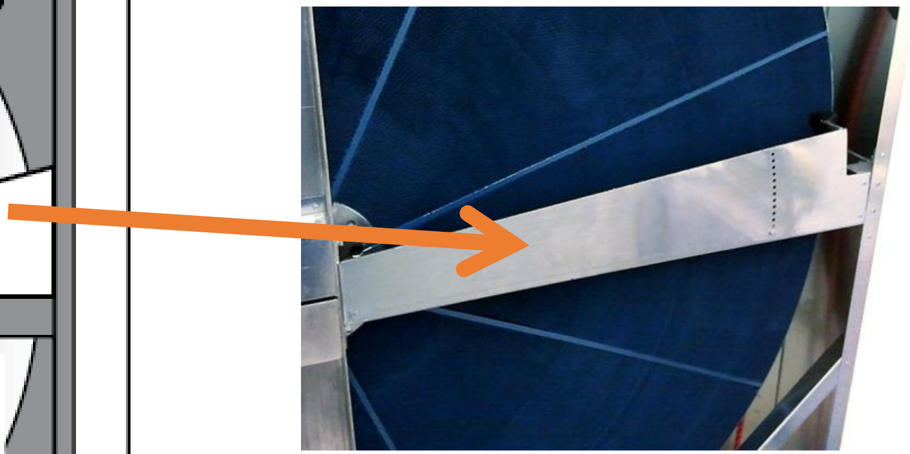
EATR: Leakage Within Active AAERV Devices

- Leakage between airstreams is affected by the perimeter and face seals
- The largest amount of leakage occurs at the face seal and is influenced by differential static pressures

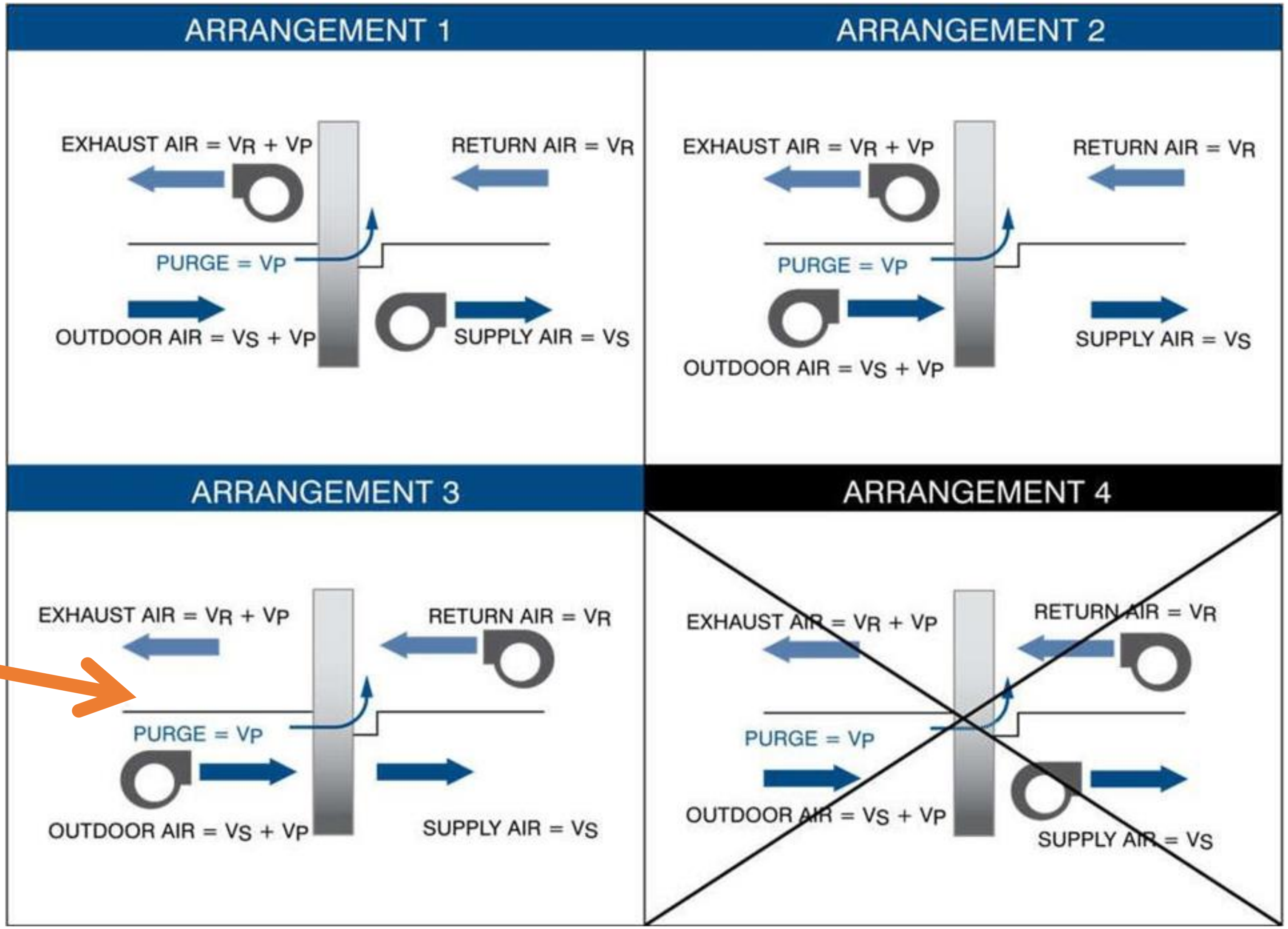
EATR: Anatomy of an Enthalpy Wheel



EATR can be reduced by implementing a purge (for 100% OA systems)

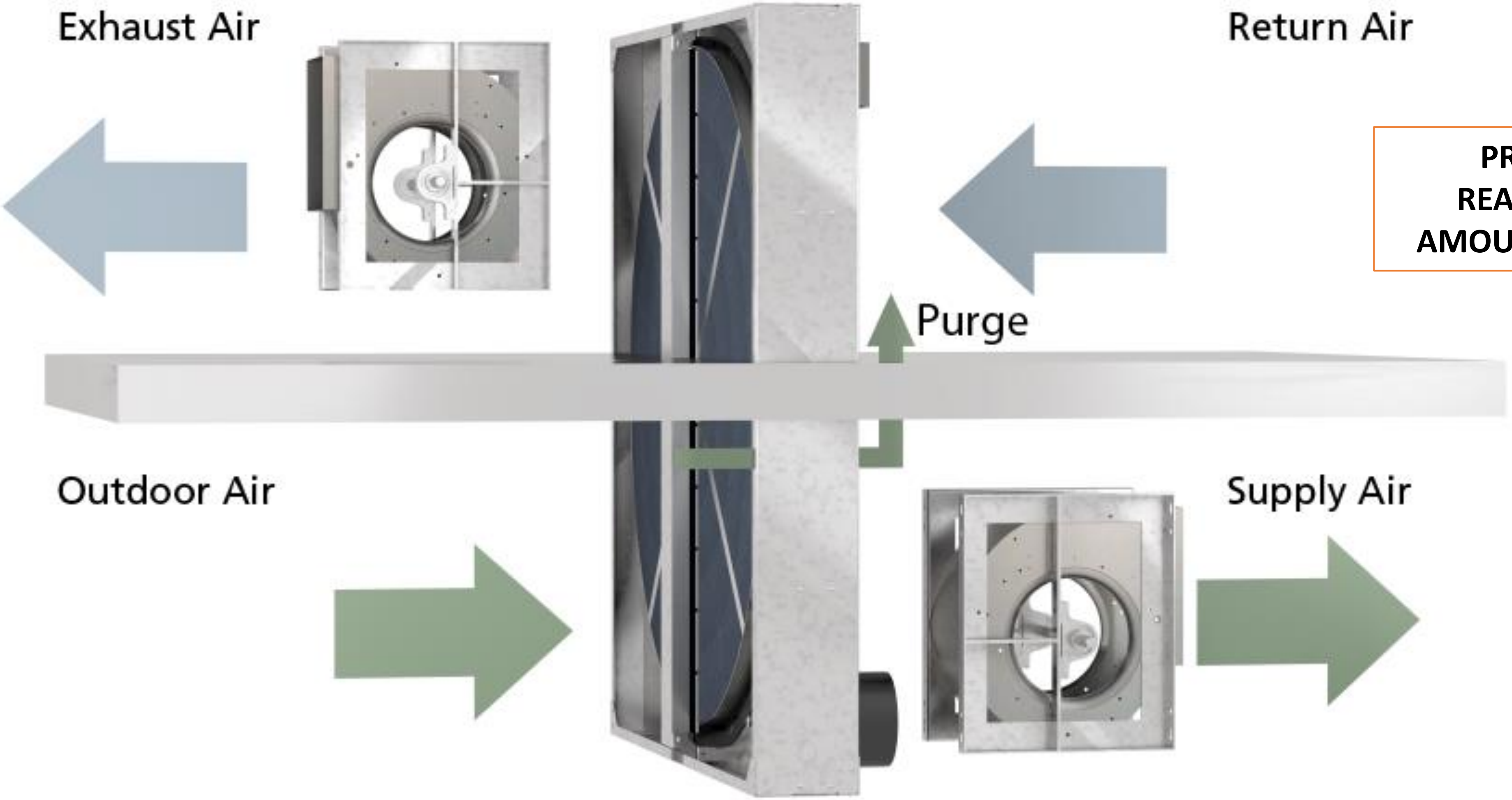


System Design Considerations: Fan Placement



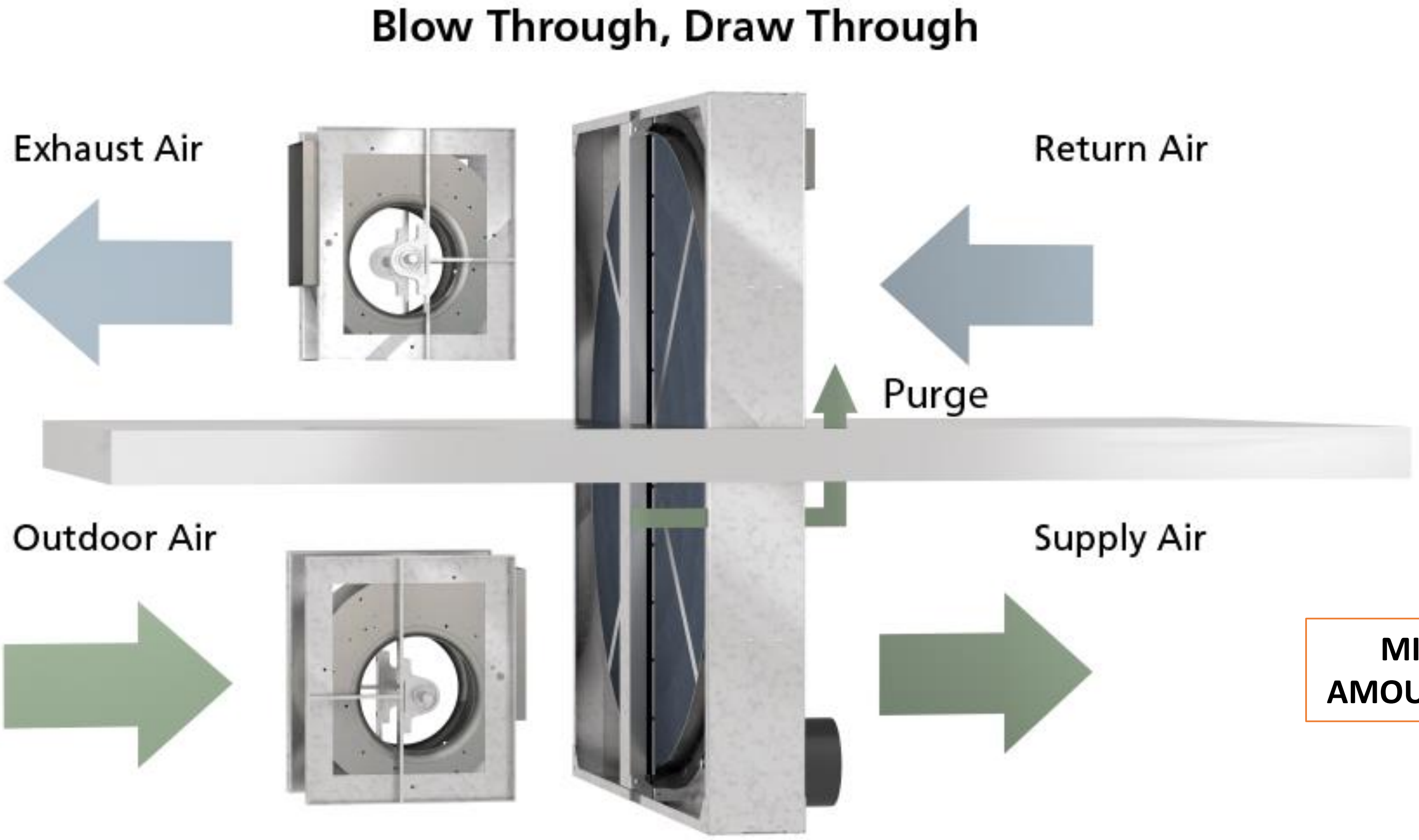
Should only be used with aluminum heat pipes and fixed plate heat exchangers

System Design Considerations: Arrangement #1



PROVIDES REASONABLE AMOUNTS of EATR

System Design Considerations: Arrangement #2



MINIMIZES AMOUNT OF EATR

AAERV On-Site Inspections

- If there is an infectious outbreak, or if there is an out-break is anticipated the AAERV system should be inspected for proper operation and be evaluated
- Normal system operation should NOT be modified as there may be unintended consequences (i.e. reduced ventilation)

AAERV On-Site Inspections: General

- The requirements for an on-site inspection are not very different in the context of COVID or otherwise (i.e., clean the unit with a vacuum, check for leakage paths between compartments, check the dampers, check filters, pressure differentials)
- The biggest change is with respect to changing filters:
  - *WARNING: If it is thought that an ERV system might have been exposed to virus-laden aerosols, treat filters, exchangers and surfaces with the assumption they have active microbiological material on them. Use N95 respirators, gloves and other PPE; ventilate the space; and bag and dispose of the filters. Please see more here: (https://www.nafahq.org/covid-19-corona-virus- and-air-filtration-frequently-asked-questions-faqs)*

Remediation: AAERV Systems

General Information
- Building Readiness Intent
- Building Readiness Team
- Building Readiness Plan

Epidemic Conditions in Place (ECiP)
- Systems Evaluation
- Building Automation Systems (BAS)
- Ventilation per Code / Design
- Increased Ventilation above Code
- Increased Ventilation Control
- Building and Space Pressure
- Pre- or Post-Occupancy Flushing Strategy
- Equivalent Outdoor Air
- Upgrading and Improving Filtration
- Filter Droplet Nuclei Efficiency / Particle Size Expectations
- Energy Savings Considerations
- Exhaust Air Re-entrainment
- Energy Recovery Ventilation Systems Operation Considerations
- UVGI Systems
- Domestic Water & Plumbing Systems
- Maintenance Checks
- Shutdown a Building Temporarily-FAQ
- System Manual
- Reopening During Epidemic Conditions in Place

Post-Epidemic Conditions in Place (P-ECiP)
- P-ECiP: Prior to Occupying
- P-ECiP: Operational Considerations once Occupied
- P-ECiP: Ventilation
- P-ECiP: Filtration
- P-ECiP: Building Maintenance Program
- P-ECiP: Systems Manual

Additional Information
- Acknowledgements
- References
- Disclaimer

Information in this document is provided as a service to the public. While every effort is made to provide accurate and reliable information, this is advisory, is provided for informational purposes only, and may represent only one person's view. They are not intended and should not be relied upon as official statements of ASHRAE.

For recommendations on developing the best remediation strategies and re-commissioning after an extended shut-down refer to the Building Readiness document: https://www.ashrae.org/file library/technical resources/covid-19/ashrae-building-readiness.pdf

Remediation: Pros and Cons of Adding a Purge

- Wheels will typically meet standard EATR requirements without a purge:
  - Class 2 air ≤ 10% EATR
  - Class 3 air ≤ 5% EATR
- Adding a purge can significantly reduce EATR but will increase energy costs associated with operation
- For high pressure and low EATR applications requirements, examine plates and heat pipes
- If a purge is added the operating characteristics of the fan, the airflows, and the pressure differential will change, required the system to be re-balanced for proper airflows and pressure differentials.

Not required for minimum OA applications (i.e., recirculation damper is present)

Conclusions

AAERV in the context of combatting airborne transmission of infectious diseases

- Ventilation should be used to reduce the risk of exposure;
- Leakage occurs in all types of AAERV but does not provide undue additional risk (for standard commercial applications) of exposure
- Fan Placement can positively or negatively effect EATR and should be considered when design AAERV systems
- Inspection and remediation strategies fairly closely correspond to inspection and remediation under normal circumstances but one should consult the ASHRAE guidelines from the Epidemic Task Force for details on variations that may apply to your application

Useful References

Guidelines:

- AHRI Guideline V, Calculating the Efficiency of Energy Recovery Ventilation and Its Effect on Efficiency and Sizing of Building HVAC Systems (2011)
- AHRI Guideline W, Selecting, Sizing and Specifying Packaged Air-to-Air Energy Recovery Ventilation Equipment (2014)

ASHRAE Learning Institute:

- Latest in High-Performance Dedicated Outdoor Air Systems (DOAS), presented by Arthur D. Hallstrom, P.E., Fellow/Life Member ASHRAE, BEMP
- Air-to-Air Energy Recovery Best Practices, presented by Paul Pieper, P.Eng., Member ASHRAE

Standards:

- ASHRAE Standard 55-2017
- ASHRAE Standard 62.1-2019
- ASHRAE/IES Standard 90.1-2019
- ASHRAE Standard 84-2020
- AHRI Standard 1060-2019

Websites:

- TC 5.5 Air-to-Air Energy Recovery: http://tc0505.ashraetcs.org/
- AHRI Certification: http://www.ahridirectory.org
- Books:
- ASHRAE Design Guide for Dedicated Outdoor Air Systems (DOAS), developed with the support of ASHRAE TC 8.12, TC 8.10, TC 5.5, and TC 1.12
- ASHRAE, June 9, 2020, TC5.5 Practical Guidance for Epidemic Operation of Energy Recovery Ventilation Systems, https://bit.ly/33uUsVm (June 17, 2020)

QUESTIONS ?

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