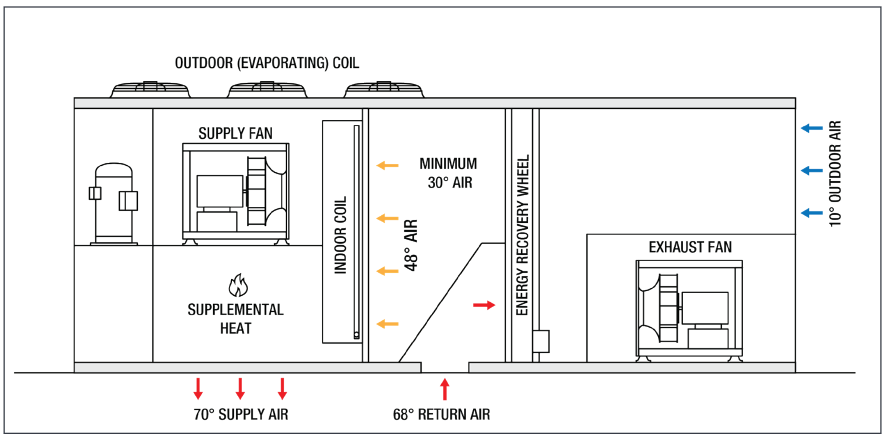
ACHIEVING CONSISTENT SPACE COMFORT WITH AIR SOURCE HEAT PUMPS

As the availability and use of air source heat pumps continues to grow, it is critical to make design choices that optimize HVAC system performance and reliability. Depending on the climate and unit features, air source heat pumps can be challenged while operating in heating mode. This guide outlines some of the key considerations when designing an air source heat pump unit to avoid wide swings in discharge air temperatures that create uncomfortable spaces for occupants.

TEMPER INCOMING AIR WITH ENERGY RECOVERY

Some areas are beginning to require electric heat vs. gas in new and renovated buildings regardless of climate. While air source heat pumps are an all-electric solution, extreme temperatures may cause the unit compressors to shut down, or fail to start, when using high amounts of outdoor air. To protect the compressors and ensure each compressor can start within its operating envelope, the air leaving the indoor coil must be at or above 30 °F. Therefore, it is highly recommended that a recirculation damper be available for unoccupied and "unit cold start" periods to ensure 30 °F air is present at the indoor coil for the initialization of the lead compressor. A recirculation damper allows ASHP units to utilize recirculated air as needed to achieve the refrigeration pressures required to start the lead compressor.



If a recirculation damper is not available, an enthalpy wheel and/or preheat coil may be able to deliver the necessary air temperatures during these periods. Optimizing the unit design efficiency by pairing energy recovery with a high outdoor air ASHP can help avoid this low-temperature issue and reduce energy consumption. Energy recovery devices temper incoming air using previously heated return/exhaust air, thus ensuring the incoming air is warm enough when it reaches the indoor coil.

Energy recovery can be accomplished with several different technologies. However, some air source heat pump units may not include the optimal energy recovery device. Choosing the right energy recovery technology can extend the applications where an air source heat pump is both efficient and effective.

Energy recovery options that offer both sensible and latent recovery are the most effective choices. Enthalpy wheels are highly efficient but have moving parts that require maintenance. If maintenance is not done on a routine basis, the wheels can fail and thus yield no system benefit. Alternatively, an enthalpy core device is a solution that has no moving parts and will typically meet ASHRAE 90.1 standards for efficiency. Manufacturers that offer several energy recovery options will enable each customer to choose an energy recovery technology that best fits their application.

ENERGY RECOVERY COMPARISON

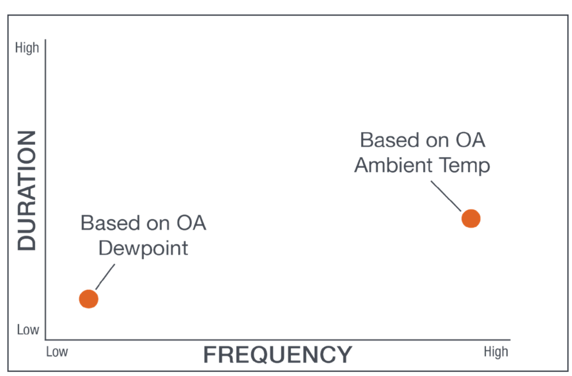
ENTHALPY WHEEL	CATEGORY	ENTHALPY CORE
Polymer or Aluminum	**Heat Transfer Medium**	Fiber or Polymer
70-85%	**Sensible Performance**	60-70%
65-80%	**Latent Performance**	35-50%
Moderate	**Internal Pressure Drop**	High
Low	**Leakage and Cross Contamination**	Very Low
Moderate, rotates	**Maintenance**	Low, no moving parts

UNDERSTAND DEFROST SEQUENCES AND THEIR IMPACT

Despite the benefits of providing an all-electric heating source, air-source heat pumps have an inherent application challenge where frost can accumulate on the outdoor (evaporating) coil in heating mode. Frost accumulation degrades the heating performance of the system and requires a defrost cycle to remove the frost and allow the coil to operate at maximum effectiveness. An effective defrost control sequence helps to mitigate potential frost issues on the outdoor coil and keep the compressors operating.

The ultimate goal is to reduce the frequency and duration of defrost cycles. When a refrigeration circuit is in defrost mode, the heat of the compressor is redirected away from distributing warm air to the space and instead toward the outdoor coil to melt the frost. To keep refrigeration circuits from going into defrost mode unnecessarily, the defrost sequence needs to be initiated based on the right data. Some HVAC unit manufacturers use outdoor air temperature as that trigger. However, the outdoor air dewpoint is more indicative of the possibility of forming frost. Cool (i.e. 40 °F), moist air on the outdoor coil of an ASHP unit can quickly create frost. Conversely, a cold (0 °F) day, with little to no moisture in the air, may not create frost conditions.

DEFROST MODE



Triggering defrost based on only the ambient temperature may cause refrigeration circuits to go into defrost mode regardless of whether the outdoor coil is truly frosted or not. Using additional data from the unit, such as compressor suction pressure and outdoor air dewpoint, is the best way to determine when there is frost on the outdoor coil and defrost mode is therefore required.

SECONDARY HEAT PROVIDES RELIABLE HEATING PERFORMANCE

Ensuring supply air meets the setpoint is a critical consideration when designing any HVAC unit and especially when designing an air source heat pump unit. While heat pumps are highly efficient, there are limitations to their cooling and heating capacity.

Generating enough heat to satisfy building needs can be challenging with air source heat pumps, which usually cannot operate below certain incoming air temperatures. While energy recovery devices help precondition entering air, additional heat is often needed to achieve proper space temperatures.

Secondary heating options allow owners to get the most out of the air handling unit, even in extreme temperatures. The use of secondary heat ensures consistent control over supply air temperatures. Secondary heat may be offered as an electric heater, hot water coil, or even a gas furnace. There are two different types of secondary heat:

- **Supplemental Heat** can run at the same time as the air source heat pump compressors.
- **Back-up Heat** is a source of heat that only kicks in when the air source heat pump compressors are locked out.

By combining an air source heat pump with secondary heat, the unit can generally meet the required space conditions, keeping occupants comfortable.

OPTIMIZING AIR SOURCE HEAT PUMPS

Designing a commercial air source heat pump HVAC unit to create consistent, comfortable spaces for occupants doesn't have to be challenging. However, it is important to understand the technology and its nuances to design the most efficient ASHP unit. By using energy recovery, understanding how and when the unit will activate defrost mode, and making the appropriate secondary heat selection, you can effectively, and efficiently, utilize air source heat pumps in many applications.