AIRSIDE ECONOMIZERS

USE "FREE" AIR TO COOL DATA CENTERS AND REDUCE ENERGY COSTS

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Today's data centers not only require protection from the elements, but also need to save energy, as estimates indicate they consume about 1.5 percent of all power used in the U.S. According to the Natural Resources Defense Council (NRDC), data centers are one of the largest and fastest growing consumers of electricity in the country. In 2013, three million computer rooms in the U.S. used enough electricity to match the annual output of 34 large coal-fired power plants, and those statistics are expected to increase. Annual consumption is projected to increase by roughly 47 billion kilowatt-hours by 2020. As a result, the NRDC recommends the data center industry adopt best-practice efficiency behaviors as demand increases to unprecedented levels.

HVAC EQUIPMENT CAN CONTRIBUTE TO ENERGY SAVINGS

Traditionally, when a data center needs cooling, compressors engage and fans begin to cycle air from return air ducts across cooling coils. As the air travels across the coils, it is cooled and then moved into those areas of the building that require lower-temperature air. This process is extremely effective in terms of providing cool, conditioned air where it is needed, but requires costly compressor and fan energy, adding avoidable costs in areas where the external air temperature is lower than temperatures inside a building.

In fact, when outdoor air is cooler, it makes economic sense to shut off the compressor and bring the cool, outside air indoors to satisfy the cooling needs of the data center with "free" cooling. This is the job of an airside economizer – to shut off the compressor and bring in outside air. But using cooler outside air only makes sense if the air is not too humid to provide adequate cooling and comfort for building equipment and occupants. 75-degree air can be quite comfortable when humidity levels stand at 30 percent. But 75-degree air becomes uncomfortable when humidity levels increase to 80 percent.

So, an economizer must first measure the outside enthalpy (a combination of temperature and humidity) and determine if it is preferred over the inside enthalpy, meaning conditions are suitable for free or economizer cooling. If outdoor temperatures and enthalpy are optimal, the economizer locks out the compressor, allowing only the fan mode to run, moving outside air in and throughout the building. Otherwise, the economizer does not operate, and the advantages of free cooling are not realized until outside conditions are favorable for the economizer.

DAMPERS ARE CRITICAL TO ECONOMIZERS

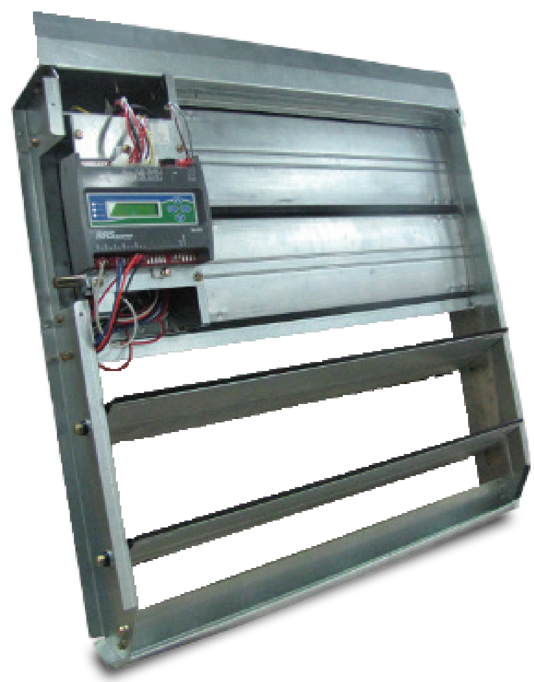
An economizer fits into the return air compartment of a rooftop air-conditioning unit. It is like a window that automatically opens, with the added advantage of moving air through the rooftop unit's filtration system, and includes outside air, return air and relief dampers that facilitate free cooling through the first and sometimes second stages of cooling. Outside air dampers bring in outside air, return air dampers bring air from interior spaces back to the air handler, and relief dampers allow excess air to exit the building and prevent building pressure control problems. The dampers work in unison and are controlled by the economizer actuator (motor) and sensors, based on outside conditions.

When a data center's rooftop unit receives a call for cooling, a signal is sent to the economizer. Although connected to the rooftop unit, the economizer has its own set of controls, with everything passing through a logic module. The economizer's enthalpy sensors relay information regarding outside conditions to the logic module, which then commands the actuator to open or close damper blades based on those conditions and sends a signal to the rooftop unit to turn the compressor off, if conditions are optimal for economizer cooling.

In some cases, codes require a minimum amount of outside air to be supplied to a building over a specific period of time, regardless of outside air conditions. In those cases, the economizer will operate at a minimal setting during normal cooling operations, putting additional stress on the rooftop unit to remove excess humidity from the outside air.

DAMPER BLADE IMPACTS PERFORMANCE

The most important parts of an airside economizer are the damper blades, which allow the control and supply of a fixed amount of outside air into the data center. Research supports that parallel-bladed dampers, which rotate in the same direction, parallel to one another, perform better when compared to opposed blade designs, in which adjacent damper blades rotate opposite one another. Static pressure increases significantly – 12 times more – with opposed blade economizers near the mid-stroke (50 percent open) position. This has the potential to starve the rooftop unit for air, unless significant size modifications are made to the ratio of damper openings. Additionally, if the rooftop unit does not sense the additional pressure and therefore increases the speed of the supply blower, the unit will not perform as specified. This is further clarified in ASHRAE 16 2010, which states in section 4.3.3.4, "Where outdoor air and return air dampers are controlled so that one opens when the other closes, both outdoor air and return air dampers should be parallel-blade dampers."



CONSIDER LEAKAGE RATE WHEN SPECIFYING AN ECONOMIZER

Whether the damper uses parallel or opposed blades, its sealing ability is essential to the success of the system, especially when dealing with temperature extremes outside the data center. A leaking damper will allow extremely cold or hot air to enter the building and lower or raise the inside air temperature, forcing the rooftop unit to turn on the compressor in an effort to return the inside air temperature to a more comfortable level, expending additional energy in the process. Consequently, leakage rate is important to consider when specifying an economizer.

The design of the damper blades can also impact economizer performance. For example, *Ruskin* Rooftop Systems' one-piece galvanized airfoil blades and stainless steel jambs (the area between the blade ends and the frame) deliver low-leakage performance. The blades' slightly rounded design allows air to flow easily over the blades, resulting in less static pressure. Additionally, the damper's sensing tubes and a blade position indicator can determine minimum airflow. This helps assist in mixed air temperature versus blade position field adjustments.

DAMPERS CAN PROTECT AGAINST SEVERE WEATHER

In areas of the country that experience high winds, whether from hurricanes, tornadoes or other severe weather events, it is advisable for data centers to install dampers in combination with Federal Emergency Management Agency (FEMA)-rated louvers and grilles (although, louvers and grilles are not always installed in combination with dampers). For instance, outside air dampers can be installed behind louvers downstream or in a common sleeve. These products have been tested against high wind loads and large missile impacts or flying debris. Outside air control dampers can seal up the center when necessary to reduce humidity and heat and provide a ventilation solution for near-absolute life safety requirements, which also protects valuable data center equipment that must be maintained at a consistent temperature.

Rain hoods are also available to prevent driving rain from entering a building, even as outside air is being delivered to the facility.

STANDARDS AND CODES DICTATE USE OF ECONOMIZERS

A series of standards and codes make it easier for manufacturers of economizers and design engineers to know where and how to use dampers:

- The International Energy Conservation Code (IECC), adopted by 16 states (see the states shaded in blue on this map: https://www.energycodes.gov/adoption/states) and many local jurisdictions, establishes minimum regulations for energy-efficient buildings using prescriptive and performance-related provisions. The prescriptive path of the code sets specific minimum performance levels for each component of the building envelope and requires cooling systems in commercial buildings to have economizers, depending on climate zone and cooling system capacity.

- **ASHRAE 62.1 and 62.2** are the recognized standards for ventilation system design and acceptable indoor air quality (IAQ).

- **ASHRAE 90.1** provides minimum requirements for the energy-efficient design of buildings, except low-rise residential buildings, and includes those applications where economizers are required.

- **ASHRAE 90.4-2016** establishes the minimum energy efficiency requirements of data centers for design and construction, creation of an operation/maintenance plan and utilization of on-site or off-site renewable energy resources.

- **California's Title 24** regulates the amount of economizer leakage. Economizers must be tested to meet or exceed requirements related to the square footage of the damper and the tonnage of equipment. Title 24 has been adopted in 21 states outside of California (see the states shaded in green and blue on this map: https://www.energycodes.gov/adoption/states).

Another useful tool, the AMCA International Certified Ratings Program, is a globally-recognized third-party program that gives buyers, specifiers and users assurance that manufacturers' published data for air movement and control products is accurate. In the case of economizers, AMCA requires dampers and louvers to successfully complete a 60,000-cycle test before they can be certified by the organization and the manufacturer's leakage rate verified.

CLIMATE IMPACTS ECONOMIZER EFFECTIVENESS

In addition to leakage rate, the effectiveness of an economizer depends in large part on the region where it is being used. For example, economizer cooling can represent a dramatic reduction in overall energy consumption in dry or marine climates, which is why ASHRAE 90.1 requires the use of economizers in western states with heating, ventilation and air-conditioning (HVAC) systems that are five tons or larger.

Economizers tend to be least effective in warm, moist climates where the cost associated with removing humidity from the air can negate potential energy savings. As a result, ASHRAE 90.1 does not require economizers in many south-central and southeastern states, although they may be installed in these areas to meet local IAQ requirements. In this case, an energy recovery ventilator (ERV) can be used to reduce the level of humidity in the entering outdoor air.

In fact, improving indoor air quality is a benefit of airside economizers. A confined, unaerated space within a data center allows gaseous fumes, odors, germs and even fungi to grow in concentration to the point that the indoor air can be qualitatively different from the ambient or normal indoor air. This, in turn, can negatively impact the health, comfort and productivity of building occupants and contribute to “sick building syndrome” (unacceptable indoor air quality). Using an economizer to introduce outside air into a building can eliminate these concerns and reduce operating costs through energy savings. Following the relevant ASHRAE standards that apply to ventilation air movement and exhausting of contaminants ensures that IAQ requirement will be met.

ECONOMIZERS CONTRIBUTE TO SIGNIFICANT ENERGY SAVINGS

But it is energy-efficiency concerns that most often support the use of economizers. A study of building control systems by Battelle Laboratories found, on average, that the normalized heating and cooling Energy Use Intensity (EUI) of buildings with economizers was 13 percent lower than those without economizers. When an airside economizer works properly, the savings are significant. Whether a company is looking to burnish its environmental credentials, lower the cost of operating its data center or both, a properly designed HVAC system that integrates an airside economizer can be the cornerstone of a strategy that achieves both goals while reducing the HVAC cooling load and extending the cooling system’s operating life.