Energy Efficient Cooling Technology

Data Center Division
Munters history of innovation includes products developed for heat transfer, humidity control and evaporative processes. These products often provide efficient solutions for challenging air treatment scenarios. One example is the concept of using air-to-air heat exchangers to harness the cooling potential of ambient conditions while retaining a clean and controlled data center environment. This concept called “Indirect Air Side Economizer” or “IASE” for cooling data centers was pioneered by Munters in 2007 using a polymer tube heat exchanger that was invented in 1997.

Illustration: The concept of IASE originated in the mid 70’s with heat exchangers cooling large DC motors in dirty coal mines. It continued with cooling remote mounted electrical enclosures for telecom in the 90’s. By 2007, data center cooling was looking more like process air cooling making the IASE concept a simple and viable energy efficient solution.
When choosing a Munters cooling solution, there are a variety of considerations, including past experience, ambient design conditions, space operating envelope, and a balance between efficiency, cost, and reliability. Some large enterprise customers utilize direct air-side economizers, usually with direct evaporative cooling active during warm ambient periods. These data centers operate in a larger allowable temperature and humidity envelope. Other customers require more precise space control and are more sensitive to ambient pollution and humidity extremes, requiring a closed loop cooling solution. Closed loop cooling may also incorporate the benefit of air-side economization using an air-to-air heat exchanger. Ambient air (scavenger air) is drawn through one side of the heat exchanger while the hot return air from the data hall (process air) passes over the opposite side of the heat exchanger. Thus cooler scavenger air extracts heat from the process air, but the two air streams are completely segregated.

Munters provides solutions for both direct and indirect economizer solutions. For the indirect economizers, we utilize a variety of air-to-air heat exchangers that work either exclusively dry or with a combination of dry (during cooler ambient conditions) and wet (evaporatively, during warmer ambient conditions) to reject data center heat to ambient air without the introduction of outdoor air into the data hall. Dry solutions cool the process air toward ambient dry-bulb temperature while the wet (indirect evaporative cooling) solutions cool the process air toward ambient wet-bulb temperature. The approach of process air to ambient conditions is called heat exchanger effectiveness. Munters typically achieves up to 70% or better heat transfer effectiveness either dry (approach to DB) or wet (approach to WB). With our indirect solutions, we can often satisfy data center cooling demands with no mechanical refrigeration deployed for most annual operating hours. In some cases, usually dry and cooler climates, our wet heat exchanger solutions can eliminate the need for DX cooling completely.
Wet Solution:

Polymer Tube Heat Exchanger with Indirect Evaporative Cooling (Oasis™)

On cold and cool days, the Oasis heat exchanger operates dry and simply acts an air-to-air heat exchanger. Scavenger air indirectly cools the data center air through normal heat exchange, without the use of any water. The EPX polymer tubes have been extensively applied in both extreme northern climates and southern hot and humid climates. Once the ambient temperature rises to a certain point, the Oasis heat exchanger will not be able to provide enough cooling while operating in dry mode. When this happens, water is pumped from the sumps (internal or external) to the air handlers spray nozzles that wet the outside surface of the Oasis EPX heat exchanger tubes, cooling them with a thin film of water. The scavenger air evaporates water on the exterior of the tubes, which causes heat to be extracted from the recirculating data center air flowing internal to the tubes. In this evaporation mode, the Oasis heat exchanger will be able to cool the recirculated air against ambient wet bulb thus providing cooling even when ambient temperature is very high. Typically, the integral DX cooling is down sized significantly or in some cases completely eliminated. For installations in humid conditions, it is not unusual to see 25 tons of refrigeration for a 400 KW Oasis system.

Munters PVT Wet Solution Polymer Tube Heat Exchanger

<table>
<thead>
<tr>
<th>State Point</th>
<th>Summer - Design</th>
<th>Summer - Mild</th>
<th>Full Economist (Ambient WB)</th>
<th>Winter - Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer - Design</td>
<td>Summer - Mild</td>
<td>Full Economist (Ambient WB)</td>
<td>Winter - Design</td>
</tr>
<tr>
<td></td>
<td>DB (°F)</td>
<td>WB (°F)</td>
<td>ACFM</td>
<td>DB (°F)</td>
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<td>5 (O/A)</td>
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<td>76.8</td>
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</table>

Munters Oasis™ indirect air-side economizer unit consume water in an evaporative process to cool the data center against ambient wet bulb, which creates the greatest economist cooling potential.

- Dry operation below 40 deg. F (depending on operating parameters)
- Evaporatively cooled condenser for improved DX operation
- 50-100% reduction in peak mechanical cooling load (DX)
- 30-60% reduction in peak operating KW (vs. dry solutions)
- Annualized Mechanical PUE 1.1-1.15
- The most efficient packaged cooling system available

Munters Corporation / www.munters.com
Dry Solution:
Aluminum Plate or Heat Pipe Heat Exchanger with Sensible only Heat Transfer

For facilities that do not want to use water, our sensible heat exchanger solutions provide full economizer cooling up to an ambient condition 30 Deg. F below the hot return air temperature from the data center (dependent upon heat exchanger effectiveness). Above this point, DX operation is required to trim cool the supply air to target temperature. Economizer cooling will continue to contribute up the point that ambient condition equals the hot return temperature, thus maximizing energy savings. Whenever the ambient temperature is above the hot return temperature, the DX system will provide all of the cooling. Typically dry solutions require full sized DX systems as there is no load reduction on hot days.

Dry Heat Recovery - Plate Heat Exchanger

<table>
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<th>Summer - Mild</th>
<th>Full Econo (Ambient DB)</th>
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<tbody>
<tr>
<td></td>
<td>DB (°F)</td>
<td>WB (°F)</td>
<td>ACFM</td>
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</table>

Munters Dry Solution Indirect Air Side Economizers use efficient air-to-air heat exchanger to harness the cooling potential of ambient temperature.

- Full economizer cooling achieved 30-50 degrees below data center temperature
- Full DX operation only during occasions when ambient air is hotter than the data center (maximum economizer operation)
- Condenser is decoupled from scavenger air for increased efficiency and control
- Typically, no reduction in peak mechanical cooling load (DX)
- Annualized Mechanical PUE 1.15-1.20
- The most efficient packaged “Dry” cooling system available

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Features and Options

Packaged System:

- Thermally broken R-16 foam panel casing
- IEC solutions include all welded stainless steel sumps / scavenger air intake sections
- Integrated Heat Exchangers: Polymer tube (IEC designs), aluminum plate and heat pipe (dry designs)
- Optional Packaged DX including scroll compressors with variable capacity lead compressor
- High efficiency process and scavenger fans, direct drive with either EC motors or AC motors with VFDs
- Recirculation air filter options: MERV 8, MERV 11, or MERV 13 with other custom options available
- Scavenger air intake filters: Permanent, cleanable mesh
- Optional: supply and return air isolation dampers with direct coupled actuators, low ambient scavenger air dampers (natural convection control), integrated or stand-alone make-up air systems with humidification and/or dehumidification, unit certifications for seismic and wind

System Power and Controls Panel:

- Single point power connection standard
- BMS integration with VFDs & EC motors standard
- Units programmed for rapid restart after loss of power
- Flexible BMS interface protocols including BACnet, Modbus
- Touchscreen LCD control interface
- Optional: dual power feeds with ATS, control power UPS, phase/voltage monitor and/or power meters, LED lighting for interior (control and electrical panels) and exterior, installation of customer furnished controls (programming by customer), water leak detectors, supply and/or return air smoke detectors and make-up water flow meters

Refrigeration:

- Single or Multiple scroll compressors with variable capacity lead compressor
- Refrigerant suction and discharge pressure monitored
- R-410a or R-134a refrigerant
- Electronic expansion valves integrated with unit controls
- IEC solutions utilize an evaporatively cooled condenser coil for enhanced refrigeration efficiency
- Variable speed condenser fans for head pressure control
- Evaporator and Condenser coils selected for optimal system efficiency
- Optional: temperature controlled Crankcase heaters and compressor vestibules, isolating compressor noise
Mounting Configurations:

Roof Mount

Roof mount configurations can be steel or curb mounted. Curb mounted versions can include a base-frame that is designed to self flash over the roof curb for ease of installation. Utilities can be routed from below or above the roof line through factory provided chases and penetrations. Munters’ standard all welded stainless steel floor includes an upturn flange around all openings and unit perimeter to minimize the risk of water entering the data center.

Perimeter Mount

Perimeter mount configurations include supply and return air ducts on the same end. Typically, either a bottom plenum (shown) or top plenum routes air to or from the data center. Units can be grouped side by side to optimize layout.

Indoor Mount

Indoor mount is suitable for single or multi-story installations. Multi-Story configurations have become more popular for data center owners with limited real estate. Munters provided plenum’s route scavenger air and process air as needed. All unit sections are designed to fit efficiently in a container for global deployment. Units can be grouped side by side to optimize layout.
Cooling Media:

**GLASdek® IV**

Munters latest generation of fire rated evaporative cooling media for the North American market, GLASdek IV, is stronger and more durable than ever before. It has improved resistance to harsh, high purity water and is available with an upgraded TUfedg coating (optional).

- A stronger/ more rugged product
- More tolerant of water quality variations
- GREENVGUARD Gold Certification
- Improved fire rating, UL 900
- Available ½ inch TUfedg® coating
- Available 4”, 6”, 8” and 12” deep

Direct Evaporative Air-Handling System:

**Munters DASE (Direct Air-Side Economizer)**

Munters manufactures complete direct air-side economizing air-handling systems that utilize direct evaporative media for cooling data centers. These systems are usually installed in dry or mild climates with clean ambient air. During cooler ambient conditions, outdoor air is mixed with warm return air to achieve the desired supply condition. During such conditions it is possible to use the evaporative media to provide the required humidification. During warm ambient conditions these systems deliver 100% outdoor air to the data hall, cooled by the evaporative media, and all of the hot air from the servers is exhausted.

Cooling and Humidification Products:

- **Munters FA6™** Evaporative Humidifier/Cooler is available in a wide variety of sizes and is designed to provide easier maintenance at a lower cost than custom WETdek solutions.
- **The WETdek®** evaporative cooling modules are completely custom and allow Munters to meet exact project requirements.
- **Munters Humimax™** is a series of standalone humidifiers. Units are available in (3) different sizes for space or plenum* mounting (*model 5000 & 10000 only)
- **Munters patented MRM™** was invented to conserve water. Mineral Removal Media (MRM) is a disposable evaporative pad, installed upstream of the primary evaporative process, that uses the system bleed water to provide beneficial evaporative cooling. Systems using MRM have nearly zero wasted water sent to sewer.
“Munters takes a “project based” approach to managing Data Center accounts. The Munters Data Center project support team, consisting of Application Engineers, Project Managers, and Service Specialists, are committed to project success from conception to completion. Munters assigns a dedicated Project Manager (PM) to every Data Center Project to serve as a single point of contact/responsibility throughout the entire Project Life Cycle. Our Data Center Service Specialists are experts with Munters equipment in Data Center applications. Our team is focused on understanding our customer’s perspective in order to provide the highest quality support while adhering to Munters’ Core values”.

**Project Management**

- Dedicated Project Manager (PM) assigned to every Data Center Project. The PM serves as a single point of contact responsible for project delivery to our customer.
- Project specific schedule for customers to track manufacturing progress and plan factory visits, testing, and equipment delivery.
- Customer liaison to Munters Engineering, Production, Quality, and Service to ensure project success.
- Creates project specific documentation including Factory Acceptance Test (FAT) Scripts, Rigging and Installation Instructions, IOM’s, Start-Up Checklists, and Training Plans (if necessary)
- Oversees the implementation of project field activities including Equipment Delivery and Installation, Levels 3/4/5 Testing, Training, and Warranty Work

**Service**

- Americas Service Team consisting of 60+ Technicians, including trained Data Center service specialists to support Data Center Projects.
- Dedicated Team of Technical Support, Parts Specialists, Service Sales, and Field Technicians
- Project Field Support options include Delivery/Installation Supervision, Level 3 Start-Up (Required), Level 4 Commissioning Support, Level 5 Integrated Systems Testing (IST) Support, and On site Training.
- Preventative maintenance options include extended warranties, routine maintenance and inspections, technical support with remote monitoring, retrofits, and critical spare parts packages.
- 24/7/365 Technical Support Helpline
Sustainable value creation - We create a sustainable and lasting value in all things we do.

Passion for results - We deliver what we promise and strive to be the best.

There is always a better way - We are innovative and improve continuously.

Team spirit - We honor different perspectives, share ideas and common goals globally.
Munters is a global leader in energy efficient air treatment and climate solutions. Using innovative technologies, Munters creates the perfect climate for customers in a wide range of industries, the largest being the food, pharmaceutical and data center sectors. Munters has been defining the future of air treatment since 1955. Today, over 3,500 employees carry out manufacturing, sales and service in more than 30 countries. Munters reports annual net sales in the region of SEK 6 billion and is listed on Nasdaq Stockholm.

Global Locations  

Headquarters: Brentford, UK and Kista, Sweden

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Neil Yule  
President, Munters Data Center Division  
Responsible for Munters Group €100m Data Center Cooling business. 25 years experience in sales and business development for cooling & ventilation technologies including 10 years in Data Center Cooling.

Frank Pellegrino  
Director of Finance  
15 years of experience in the finance and accounting industry including the previous 5 years in various finance and compliance roles in Munters.

Hans Godden  
Director/Global Product Management  
Responsibilities are to manage & support Munters’ product portfolio at the various production & sales entities around the world with a focus on the Data Center & Telecom market.

Mike Herwald  
Senior Sales Manager - Americas  
23 years of experience engineering and promoting HVAC equipment with air-to-air heat exchangers and dehumidification capability for commercial, industrial and data center markets.

Keith Dunnavant  
Vice President of Sales - Americas  
27 years of HVAC engineering and sales experience, including extensive work with custom air-handling solutions utilizing air-to-air energy recovery, dehumidification, precision air conditioning and evaporative cooling. 17 years experience in Data Center Cooling.

Paul Dinnage  
President, Innovation & Technology  
30+ diverse years of experience in Munters R&D, Engineering, and Operations Management Roles. V.P. Technology Munters Group during 1997 Munters IPO. Hold over 20 patents and patents pending with Munters.

Michael Gantert  
Global Commercial Director  
15 years of experience in Project Management, Engineering, and Service in the Construction and Manufacturing industries. Developed several processes to support the Munters Data Center business, including the concept of Data Center Project Management.

Tiffinay Burgess  
Marketing Manager - Americas  
11 years of experience in Marketing, Design and Project Management at Munters. Responsibilities are to manage Munters Data Center marketing activities.