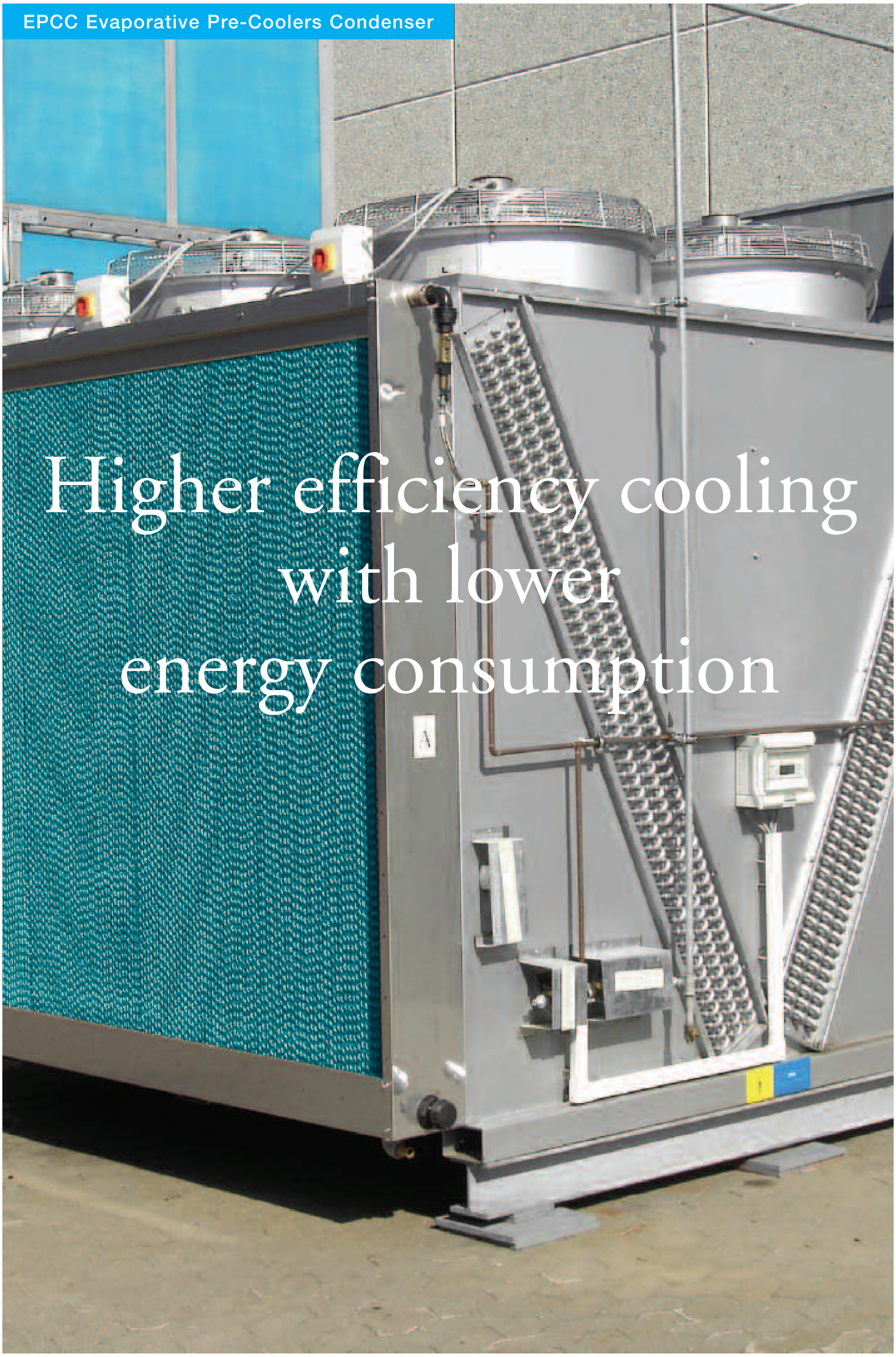
EPCC Evaporative Pre-Coolers Condenser



Higher efficiency cooling with lower energy consumption

Munters

A balance between cooling function, cost and energy

Air-cooled refrigeration units are the typical form of heat rejection systems used for air conditioning, ventilation and refrigeration today. Adequate cooling must be balanced between capital investment cost and physical installation space. In addition to operating costs, maintenance and rising energy costs as well as environmental impact (CO_2 emissions) are critical factors. As refrigeration plants account for nearly 10% of our global electricity consumption, energy conservation and cost consciousness play increasingly important roles in new condenser system design and in prolonging the life of existing installations.

An elegantly simple solution to a complex equation

In an air-cooled condenser system the ambient temperature of the air used to dissipate heat from the condenser greatly impacts its performance. As the ambient air temperature rises, head pressures also rise. As a result, energy demand and usage increase while cooling capacity falls.

Munters has developed an Evaporative Pre-Coolers Condenser (EPCC™) that increases the cooling efficiency of a condenser system while lowering energy consumption. The EPCC fits onto conventional single- and double-stage condensers and also roof-top units. It pre-cools the air entering the condenser system, which in most cases improves or at least equals condenser cooling performance with lower energy consumption. The EPCC has been designed as a natural addition to new air-cooled condenser systems thus making a positive contribution to running costs, extension of condenser life cycle and helping conserve energy and the environment. Existing installations also benefit from the EPCC's elegant design and installation simplicity.

(Right) Close-up of an EPCC. Here it can be seen that a metal frame holds the pre-cooler high performance media.
(Left) Each installation has its own special requirements as can be seen from the placement of pre-coolers on a refrigeration system on a building complex in La Habahera.

How the EPCC works

The EPCC contains Munters patented TURBOdek® high performance pre-cooler media, fitted upstream of the condenser coil. As air is drawn in by the condenser system fans, the high performance media pre-cools the air before it contacts the condenser coil. Water flows over the EPCC media and absorbs the heat energy in the air, causing the water to evaporate, resulting in cooler and more humid air passing through the condenser.

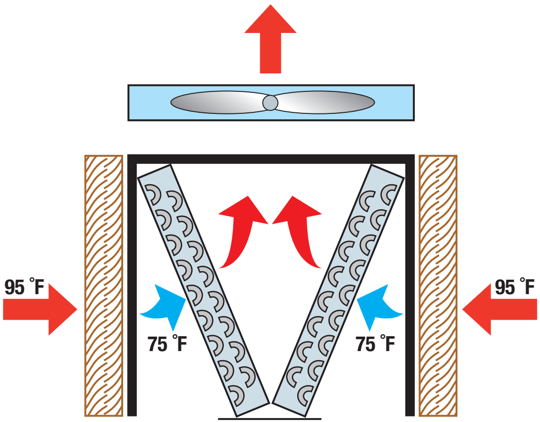
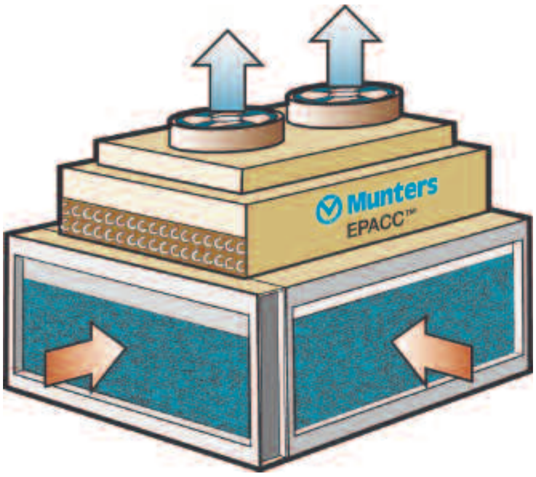


Fig. 1

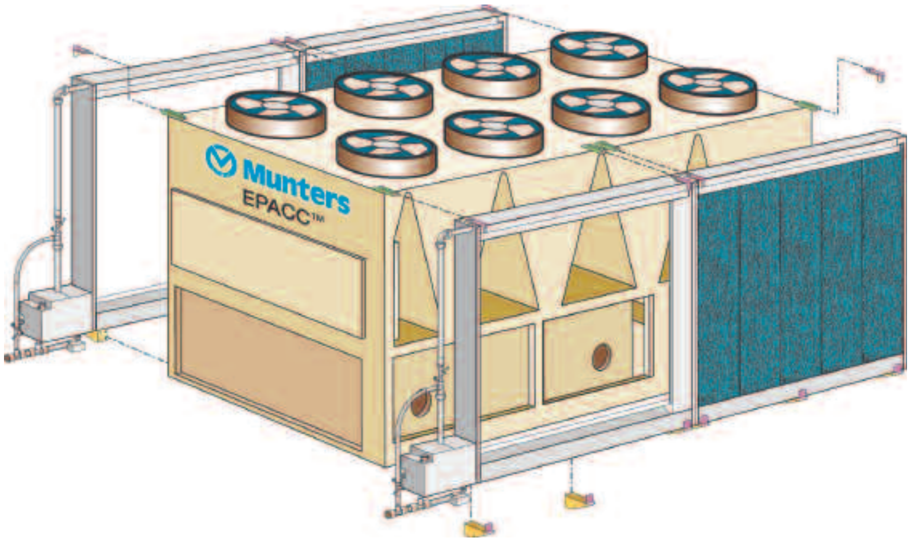
The EPCC can be fitted to condenser systems employing either a single coil or double (v-shaped) coil dry coolers for vertical and horizontal installations. TURBOdek high performance media is produced in two different depths, and the appropriate size is installed according to the specific configuration requirements.

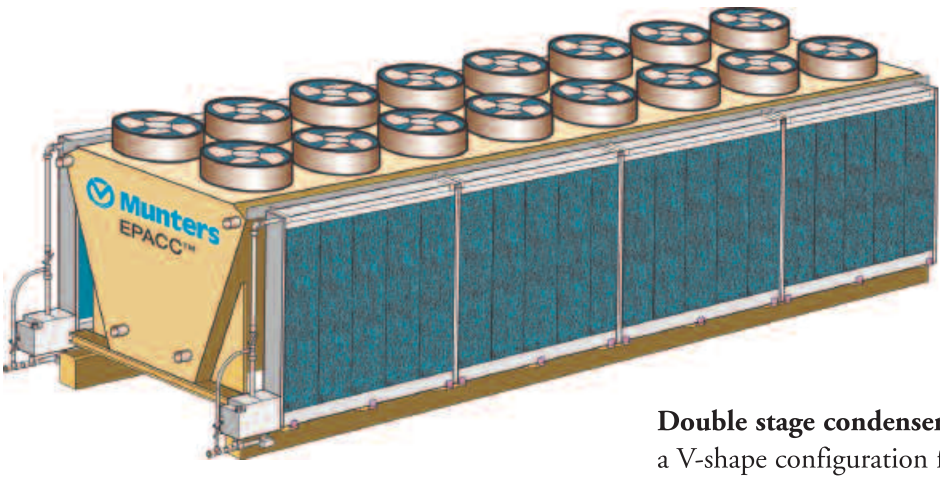
Fig. 1 *Warm air passing through the EPCC high performance media comes into contact with water that flows freely across the media. Heat energy is absorbed by the water causing evaporation of the water and cooling of the air. The pre-cooled air entering the condenser system allows heat energy from the condenser foil to dissipate more easily thereby increasing the cooling capacity for the same or in most cases less energy consumption.*



Single stage condenser. The condenser lies horizontally or stands vertically. The compressor is placed in a separate compressor room.

Roof-top chiller. The compressor is integrated into the unit and needs no separate room.





Double stage condenser. The condenser is built in a V-shape configuration for a large condenser surface. The compressor is placed in a separate room.

Key features and benefits of Munters EPCC

Quick facts about EPCC

- Developed for efficient cooling with energy savings. Allows optimized condenser unit performance and/or retrofitting existing condenser units.
- Air flow range of 140-4,600 f^3/s depending on configuration allows EPCC to be fitted to a wide range of cooling unit sizes.
- Patented TURBOdek high performance media technology provides 70-80% nominal cooling efficiency at airflows between 400-650 ft/min over the condenser surface with minimal pressure drop. This allows higher cooling efficiency with lower energy consumption.
- Designed for recirculating or direct water systems for flexible installation and optimum function according to the quality of the water supply.
- Complete emptying of the bottom tray, eliminating hygiene issues often associated with other cooling methods.
- Simple maintenance ensuring optimal performance with minimal downtime.

Higher pre-cooling efficiency provides improved condenser function

The patented design of the EPCC TURBOdek high performance media allows for optimum pre-cooling of the air passing through the condenser system. Pre-cooling of the air enables the condenser coil to reject more heat. This reduces head pressure and lowers the compression ratios. Cooling capacity is increased as a result. For every 1.8 °F reduction in temperature due to pre-cooling of the air a 2% increase in efficiency of the condenser is achieved. This means that even a small temperature reduction from the EPCC can give a significant effect in cooling capacity and energy savings. The pre-cooling effect of the EPCC in the summer can be up to 59 °F and above depending on the climate and season, a well over 20% improvement in condenser efficiency.

Table 1. *Annual energy savings (%) resulting from pre-cooling in air-cooled condenser systems for supermarkets in four different climates around the world.*

Application of refrigeration	Annual energy savings (%)			
	Riyadh	Los Angeles	Hamburg	Madrid
Ventilation	36	16	19	25
Freezer	33	7	3	10
Chiller	34	9	5	12

Table 2. *Increase in minimum cooling capacity (%) resulting from pre-cooling in air-cooled condenser systems for supermarkets in four cities around in the world.*

Application of refrigeration	Increase in minimum cooling capacity (%)			
	Riyadh	Los Angeles	Hamburg	Madrid
Ventilation	18	21	13	15
Freezer	34	28	23	25
Chiller	18	16	13	15

The energy savings with the EPCC reduces the compressor size needed to carry peak cooling loads. The capital investment and space requirements are lowered for new installations.

Retrofitting with the EPCC provides energy savings for existing systems and increases cooling capacity, eliminating the expense of larger and more costly replacement condenser systems.

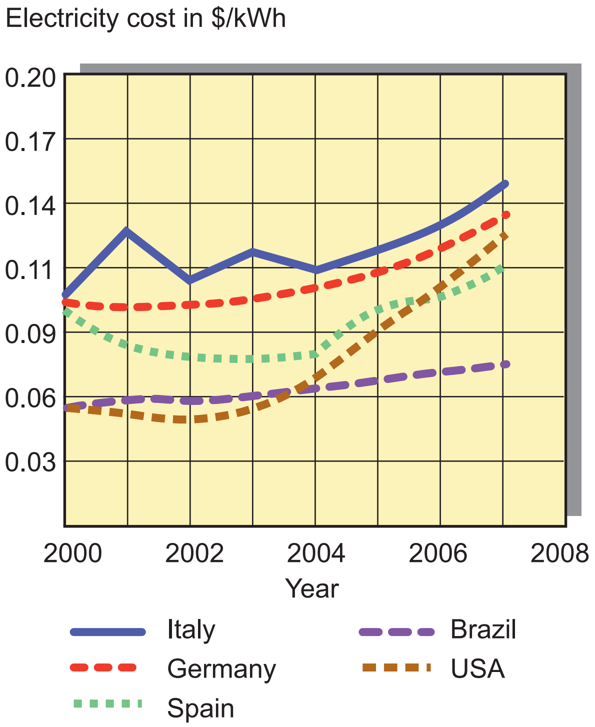


Fig 2. *Trends of increasing electricity costs globally.*

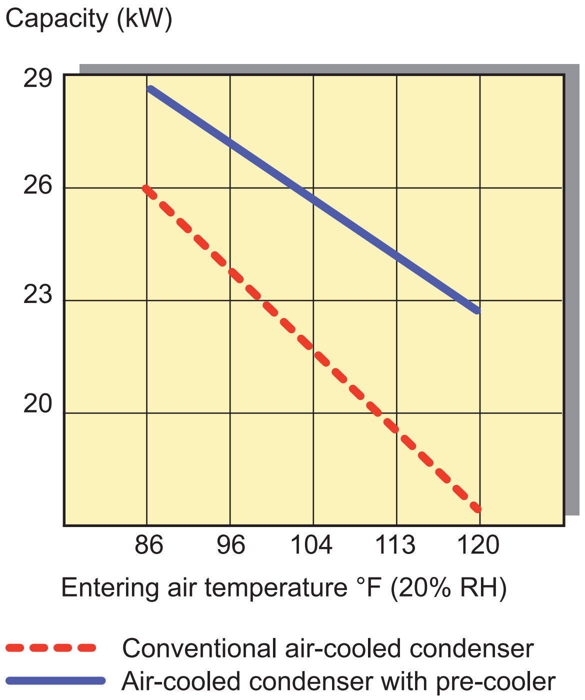


Fig 3. *The effect of condenser cooling capacity in relation to the temperature of the air entering the system with or without a pre-cooler. The condenser cooling capacity is greater when using a pre-cooler, allowing for savings in new equipment investment and/or extended utilization of the existing condenser system. Data based on a 26 kW (7.5 ton), air conditioner, R22 refrigerant.*

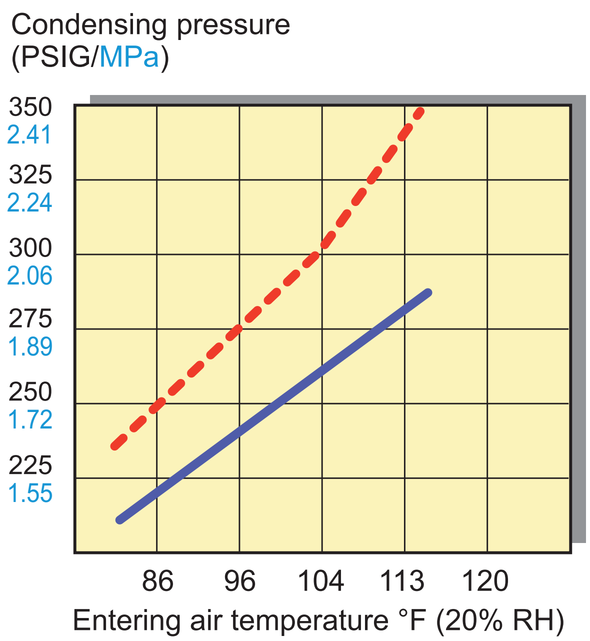


Fig 4. *The effect of condensing pressure in relation to the temperature of the air entering the system with or without a pre-cooler. The condensing pressure is less when using a pre-cooler, improving the lifetime of the compressor in the condenser system. Data based on a 26 kW (7.5 ton), air conditioner, R22 refrigerant.*

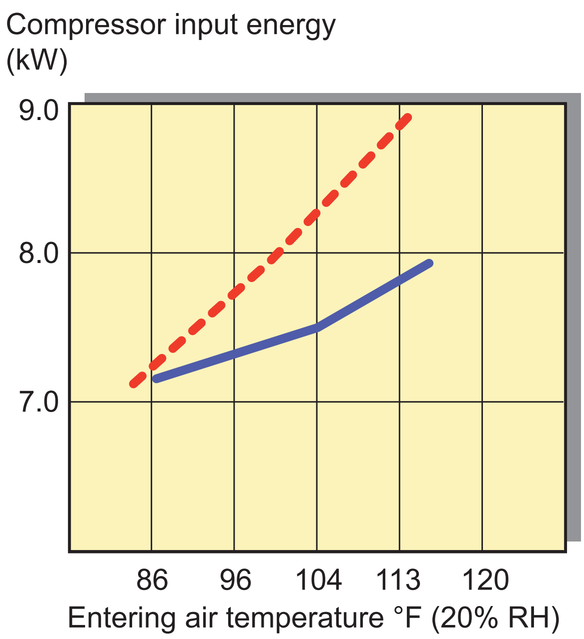


Fig 5. *The effect of input energy to the compressor in relation to the temperature of the air entering the system with or without a pre-cooler. The required compressor input power is lower when using a pre-cooler, allowing for direct savings in operating costs. Data based on a 26 kW (7.5 ton), air conditioner, R22 refrigerant.*

Example calculations

The diagrams compare theoretical estimations. Below is a table of actual values calculated for an installation in Johannesburg*.
**JHB moderate rooftop condition, 95 °F*

Air-cooled air conditioner without EPCC™		*Air-cooled air conditioner with EPCC™*	
Bitzer HSKC 7491-90		Bitzer HSKC 7491-90	
Superheat	45.5 °F	Superheat	45.5 °F
Sub-cooling	41 °F	Sub-cooling	41 °F
Expansion value	TEX-55 50	Expansion value	TEX-55 50
Barometer	11.970 PSI	Barometer	11.970 PSI
Altitude	5,577 ft	Altitude	5,577 ft
Evaporator Coil		**Evaporator Coil**	
Model		Model	
Typical (½" tube)		Typical (½" tube)	
1905 x1700 5r 12f 16.67c		1905 x1700 5r 12f 16.67c	
Airflow	25,000 cfm	Airflow	25,000 cfm
Velocity	717 fpm	Velocity	717 fpm
On coil	39.2 / 37.9 °F	On coil	39.2 / 37.9 °F
Off coil	33.8 °F	Off coil	33.8 °F
Pressure drop	0.041 PSI	Pressure drop	0.042 PSI
Condenser coil		**Condenser coil**	
Model		Model	
Typical (½" tube)		Typical (½" tube)	
2,134 x4,200 4r 12f 32.67c		2,134 x4,200 4r 12f 32.67c	
Airflow	42,378 CFM	Airflow	42,378 CFM
Velocity	439 fpm	Velocity	439 fpm
On coil	95 / 68 °F	On coil	74.66 / 68 °F
Off coil	114.3 / 72.9 °F	Off coil	93.6 / 72.9 °F
Pressure drop	0.0089 PSI	Pressure drop	0.0091 PSI
Refrigerant – R22		Refrigerant – R22	
Evap. temperature	21 °F	Evap. temperature	19.2 °F
Evap. abs. Pressure	58.7 PSI	Evap. abs. Pressure	56.9 PSI
Cond. Temperature	119.1 °F	Cond. Temperature	98.4 °F
Cond. Abs. Pressure	272.4 PSI	Cond. Abs. Pressure	206.4 PSI
Performance		**Performance**	
Cooling duty	147 kW	Cooling duty	163 kW
Heat rejection	203 kW	Heat rejection	209 kW
COP	2.62	COP	3.62

Duty difference	10.9%
COP difference	38.2%
Total difference net efficiency difference	**42.3%**

Munters EPCC pre-cooling systems come in the following standard sizes:

Standard height × with : 2.2 m h × 2.2 w
3.3 w
4.4 w
5.5 w
6.6 w

Custom sizes available to meet specific applications.

Robust construction and functional design for optimum performance

The EPCC comprises several TURBOdek™ media sections in a stable frame with a stainless steel water reservoir. Water is evenly distributed over the media via a specially designed water distribution system. When pre-cooling of the air is required, water is distributed over the adiabatic pre-cooling media. Part of the distributed water is evaporated by the hot, dry air, which is cooled down because the heat that is needed for evaporation is taken from the air itself. The rest of the water assists in washing the media, and is drained. The special design yields a high adiabatic pre-cooling efficiency while still operating with very low pressure drop (0.0044 psi or less).

No aerosols are generated and no water carry-over occurs due to the fact that water is directed to the air inlet side of the media, where most of the evaporation takes place. The edge coating of the TURBOdek media ensures protection against decomposition and rotting, and is a strong self supporting product with high absorbance. The TURBOdek media is specially manufactured by Munters for its pre-coolers.

The EPCC is essentially maintenance-free, requiring in some cases basic seasonal servicing, for example to remove the high performance media from the pre-cooler prior to periods of frost during winter months in some climates.

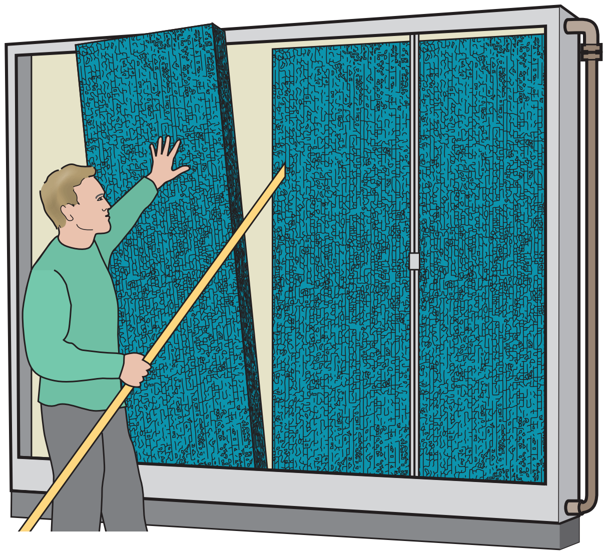


Fig 6. *Pre-cooler high performance media is easily removed / fitted for replacement, service, or storage purposes.*

Direct or circulating water systems for water conservation

Controlled water flow is a critical component in the evaporation cooling function. The EPCC has been designed to save water by controlling the flow through the TURBOdek media. The control of the water flow combined with the special design and properties of the high performance media itself such as water absorption, surface area, air-flow rate, and evaporation rate ensure an efficient pre-cooling operation.

Moreover, the water can be re-circulated to minimize the overall water consumption, and in cases where the water quality does not permit re-circulation, direct water flow is easily applied. An added benefit is that the process of evaporation ensures that only pure water passes out of the TURBOdek™ media, which means that no salt or mineral contaminants enter into the condenser. Salts and minerals instead are flushed out of the media and are subsequently drained away. In a recirculation system, salts and minerals accumulate in the reservoir tank. The tank needs to be occasionally flushed out and replaced with fresh water. This bleed off flow is calculated before the EPCC is started to optimize the system.

Water consumption is considerably less compared with other cooling methods such as cooling towers. Moreover, since the evaporation of water in the pre-cooler occurs at the molecular level there is no risk for water carry-over or droplets, that may carry dust particles and bacteria.

Simple utilities requirements for a straightforward installation

The EPCC only requires the standard utilities of an electricity supply, water line and drainage typical to most building complexes. No special rebuilding or extra dimensioning of these utilities is required, thereby ensuring a smooth and straightforward installation.

Standard and customized fittings for new or existing installations

EPCC is available in many standard sizes that fit the measurements of most common types of air-cooled condenser systems. Air flow range of 8,500-275,000 CFM (depending on configuration) ensures the EPCC can be fitted to a wide range of cooling unit sizes. Custom sized EPCC stystems are also available.

The EPCC is compatible with common air-cooled condenser systems and is easily fitted during installation of new systems. The pre-cooler can also be fitted to existing air-cooled condenser systems to provide all of the benefits of cost and energy savings. It also provides lifecycle extension of existing installations, by increasing the total cooling effect. This can help delay investments in new, larger dimensioned condenser systems.

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