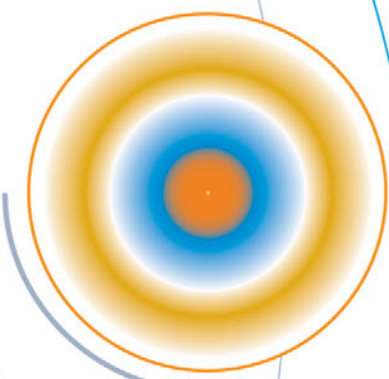
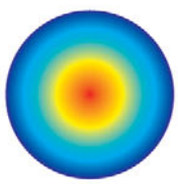
MAX.e²

2 Stage Heat Recovery Economizer





Damvent

to reach...and exceed

MAX.e²

Concept Solution, not just a product!

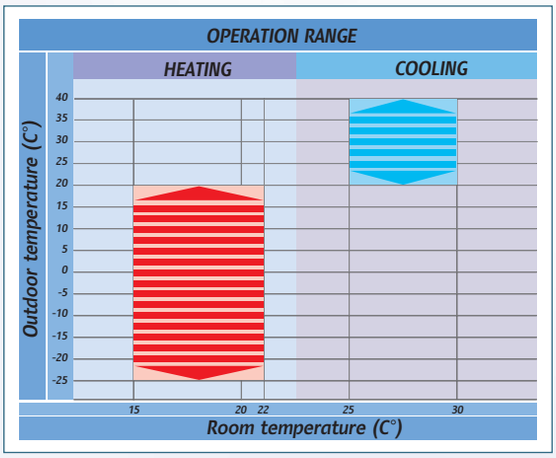
It is obvious that the global climate is changing. Energy costs are exploding and the trend suggests it will continue to increase. Therefore, saving energy is more important than ever!

Achieving a comfortable microclimate is directly related to the presence of quality ventilation. Unfortunately, it has been proven that a significant part of the energy consumed within buildings is lost when using poor ventilation systems. This fact produces financial consequences for the users and contributes to pollution of the environment.

Theoretical research and standard practices show that reducing energy costs and increasing the efficiency of a ventilation system could easily be achieved by re-using the warmth contained in the extract air within a room. This is where Damvent's MAX.e² *solution becomes important.*

It is a fact that people spend most of their life-time inside buildings. According to some researchers, the time spent inside buildings is equivalent to 90% of our daily lives. Therefore, the quality of indoor air has a high influence on the health of its occupants. Elderly people and children are particularly sensitive to the quality of air. High quality indoor air has a positive influence on the productivity of its occupants. This is especially important within office buildings, banks, conference rooms, classrooms, hospitals, etc.

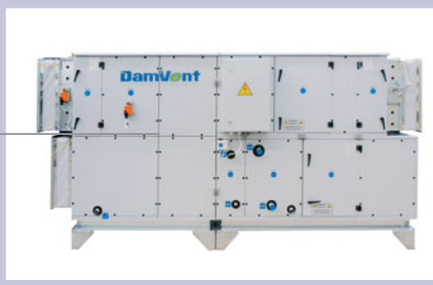
3 e CONCEPTS



- *1e Every Climate - from -20°C to +45°C*
- *2e Every Application - suitable for every application where 100% fresh air is needed, by means of covering all possible air treatment processes:*
  - *Filtration*
  - *Recirculation*
  - *Heat recovery*
  - *Heating*
  - *Cooling + Dehumidification*
  - *Proces Ventilation*
- *3e Every Installation - suitable for all types of mounting, indoor (machinery rooms, technical floors, etc.) and outdoor.*

3 IN 1 CONCEPTS

- *"3 in 1" concepts: The MAX.e² is an autonomous module heat recovery ventilation unit containing an implemented heat pump, automation, and a control system.*



•The MAX.e² is an autonomous module heat recovery ventilation unit containing an implemented heat pump, automation, and a control system.
The MAX.e² e-conomizer with 2 stage thermodynamic heat recovery technology, recovers up to 100% of the extract heat. This is achieved consecutively in 2 stages:

I st stage – passive heat recovery – using the air-to-air plate heat exchanger to recover up to 65÷70% of the extract heat from the room.

II nd stage – active heat recovery – using the evaporator of the air-to-air heat pump to recover between 65÷100% of the extract heat from the room.

A conventional air cooled heat pump uses the ambient air for the evaporation process and during the winter this air can reach temperatures of -10°C, -15°C or even -20°C. Extracting heat from the ambient air is an inefficient process. In comparison, the MAX.e² uses the extract air from within the room. Under normal conditions, this air ranges in temperatures from 20÷24°C. Firstly, 60÷65% of the heat is recovered in the plate heat exchanger and then at a temperature between 4÷10°C, the air enters the evaporator of the heat pump, thus recovering the other 30÷35%. Using this method, we achieve a COPsystem of 10 and avoid frost formation on the evaporator (which commonly occurs in all conventional heat pumps).
Thus, MAX.e² delivers "defrost" = 0min.

$$COPnet = \frac{Q\ plate\ heat\ exchanger + Q\ \ heat\ pump}{Nfans + Ncompressors}$$

where:

- Q plate heat exchanger - recovered heat from the plate heat exchanger (kW)
- Q heat pump – recovered heat from the condensor of the heat pump (kW)
- N fans – energy consumed from the fans (kW)
- N compressors - energy consumed from the compressors (kW)

100% TEST

High reliability and reduced installation costs are achieved by our 100% test procedure. Each unit is tested under factory conditions as follows:

- Leakage check;
- Vacuuming and loading the system with the exact refrigerant quantity;
- Functional testing of fans and compressors;
- Loading the controller's software;
- Temperature and pressure checks;
- Setting up the required air flow;
- Recording all parameters of the system on the test list

100% Plug & Play -

standalone, "one-piece" unit which only needs a power supply for its start up.

CONSTRUCTION

MAX.e² *is a single, "1 piece" (standalone) unit.*

The construction is manufactured from high quality profiles made of extruded aluminum characterized by high strength and resistance to adverse weather conditions. Size 13.0 consists of two blocks. The connection between the two blocks is carried out by aluminum connection plates.

Unit enclosure panels care double skinned and are comprised of a 1.0mm inner skin manufactured from galvanized sheet steel, 50mm mineral wool insulation having a density of 75kg/m³ , and a 1.0mm outer skin manufactured from galvanized sheet steel. Both the inner and outer skins have a powder polymer coating. The insulation material is thermal and sound absorbing, fire and high temperature resistant, mineral wool which is CE certified in accordance with EN14303.

Gaskets – Closed cell structure gaskets made of Ethylene Propylene Diene Monomer (EPDM) are used for internal insulation and separation between the air flow sides (supply and exhaust), as well as on all doors and panels to protect the unit from internal and external leakages.

The components wherein condensation may occur (such as direct expansion coils and plate heat exchanger) are equipped with a condensate drain pan. The condensate is removed via drain outlets connected to siphons (detailed schematics are provided with the documentation of the unit). The condensate drain pans are a welded steel structure made from 1.2mm thick galvanized steel sheets with a powder coating.

PLATE HEAT EXCHANGER

MAX.e² *uses a plate air-to-air heat exchanger made from aluminum fins with a condensate drain pain and a mounted motorized damper (bypass and "free-cooling"). Efficiency (Sensible) – E ≤ 65÷70%.*

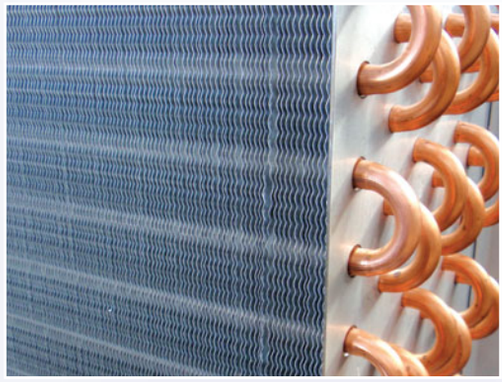
EUROVENT Certificate: 03.01.242.

REFRIGERANT CIRCUIT

The refrigerant circuit contains 1 or 2 circuits, depending on the type of the unit. There is a possibility for capacity control (optional). The refrigerant used is eco friendly R407C.

MAX.e² *03, 06, 09 and 13.0 use "Scroll" Compressors (1, 2 or 4 pcs. – depending on the type of the unit).* MAX.e² *uses a "Rotary" compressor. The main components of the refrigerant circuit are: Electronic expansion valves (EEV), check valves, solenoid valves, filter dryer, receiver, suction line accumulator, thermostats – high/low pressure, and differential pressure transmitter – high/low pressure, etc.*

All of the MAX.e² *units contain high efficiency direct expansion coils which are made from copper tubes and aluminum fins and are equipped with a condensate drain pan.*



EUROVENT Certificate: 10.02.450.

STEPLESS CAPACITY CONTROL

• Precise Control and Efficiency - Digital Scroll™ technology provides continuous, stepless modulation over a wide range (from 10÷100%), with no operating envelope restriction. As a result, ambient temperature and humidity can be tightly controlled for superior comfort and load variations can be quickly followed for improved seasonal efficiency

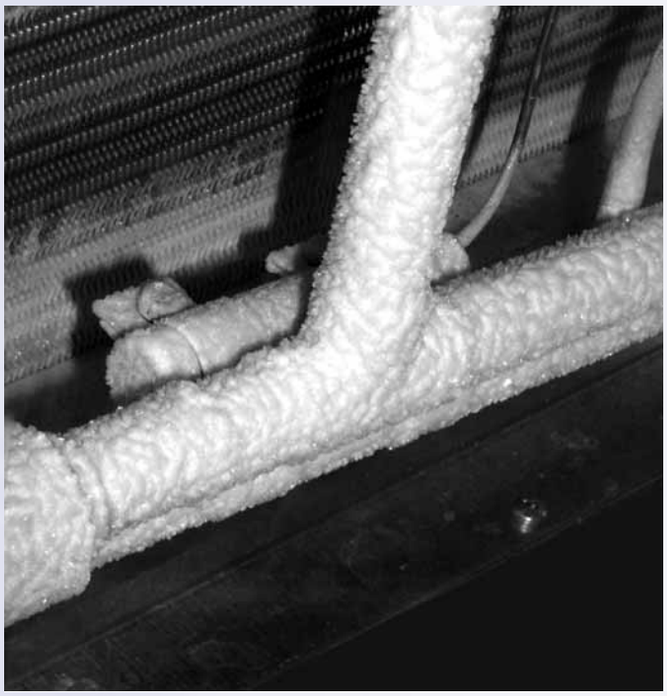
• Stepless heating/cooling capacity control

• Increased ESEER/IPLV (European Seasonal Energy Efficiency Ratio/Integrated Part Load Value) values achieved by reducing the power input in part load operations

• Constant Supply Temperature - superior control of the supply air temperature (±0.5÷1°C) is managed, avoiding unpleasant temperature differences, and thus significant improvement to comfort in the room

• Higher Reliability - Compressor cycling is reduced to a minimum ensuring optimum system efficiency and longer life expectancy of the equipment

"DEFROST = 0MIN"



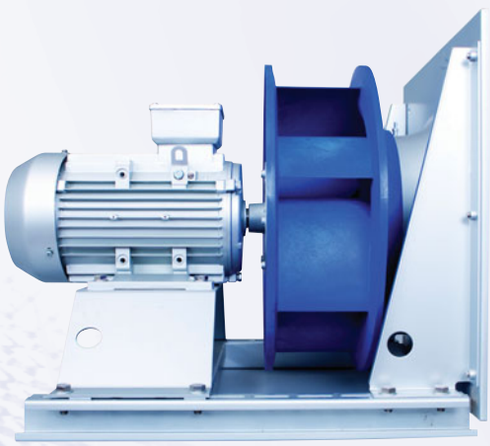
When an air-cooled heat pump is operating in heating mode, the outdoor air is relatively cool and the outdoor coil acts as an evaporator. Under certain conditions of temperature and absolute humidity, frost might form on the surface of the evaporator. This layer of frost will interfere with the operation of the heat pump by making the pump work harder and, therefore, inefficiently. The heat pump unit will "defrost" regularly when frost conditions occur.

The defrost cycle should be long enough to melt the ice and short enough to be energy-efficient, but still takes 9÷20min/cycle and might happen several times/day. This reduces the comfort in the air-conditioned room.

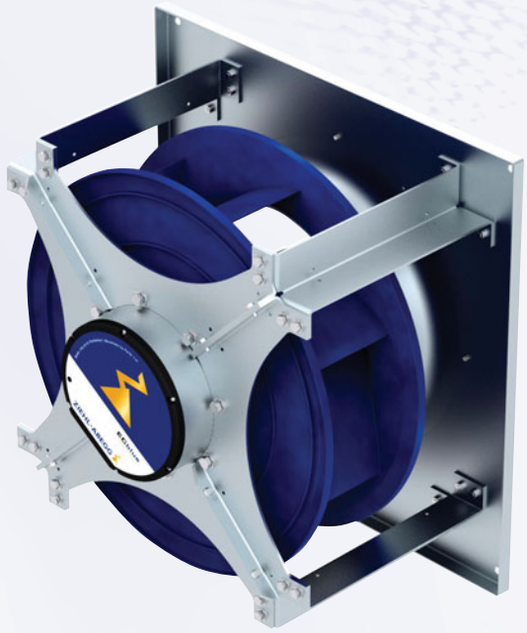
MAX.e² *practically has "Defrost=0min" because at any ambient condition, the air temperatures before the evaporator are always positive, away from the frost form conditions. If under any circumstances there are such conditions, an "improvement" on the refrigerant circuit does not allow the evaporator to "frost" and thus the unit will continue to supply hot air to the room.*

FANS

MAX.e² *02, 03, 06, and 09 use "EC (Electronically Commutated) Blue Plug Fans" with a Cpro frequency inverter manufactured by Ziehl-Abegg. The fan wheel is statically and dynamically balanced on the axis of the direct-driven motor. Both the fan wheel and the motor are mounted on a common base frame with vibration dampers. Using EC Blue fans ensures the highest IE4 Premium Efficiency and ErP conformity - 2015/EC controller integrated. The high-performance composite material Cpro ZAmid®, developed using the latest insights, makes the impeller significantly lighter than those made of steel and offers superior mechanical properties. Cpro ZAmid® provides new opportunities for system runtimes, enables lower power consumption and leads to a drastic reduction in noise. Cpro ZAmid® is manufactured using a one-shot injection moulding process in a highly complex injection moulding machine, resulting in no welded joints. This highly technical process ensures the highest system reliability.*



Innovation at a glance:



- *Significant weight reduction, which reduces motor bearing loads and increases the system service life.*
- *Drastic reduction in noise generation leads to tonal noise reduction up to 5 dB.*
- *Significant increase of the impeller efficiency which reduces the absorbed power.*
- *Reduced power consumption - up to 15% energy savings during operation.*
- *Significant CO_2 reduction – improved mechanical properties, compared to steel.*
- *No weld seams - high peripheral velocities up to 70 m/s*
- *Suitable for operational temperatures from -20°C to +80°C, compared to steel impellers.*
- *Corrosion-free*
- *No toxic gas emissions*
- *Colour-stable*

MAX.e² *13.0 uses Plug Fans complete with an IE2 efficiency motor and a separate frequency inverter mounted within the unit. The fan wheel is statically and dynamically balanced on the axis of the direct-driven motor.*

SFP – SPECIFIC FAN POWER

Specific Fan Power - one of the most important energy indicators for every AHU (air handling unit)

SFP ≤ 1800 W/m³/s total for the unit and lower values can be reached by MAX.e²

The SFP values, expressed in W/m³/s, indicate the demand on power efficiency of all supply air and extract air fans in a building.

The electrical energy needed for ventilation fans and AHUs plays an increasing role in the energy demand for buildings. Recent studies show that the electrical energy consumption can rather easily be reduced from the "traditional" level (between 2000 and 5000 W/m³/s) to a new level (1600 to 1800 W/m³/s) when using proper design and installation.

MAX.e² *- designed by the latest EUROVENT requirements for coil face velocities up to ≤2m/s, which leads to:*

- *No droplet separators on both supply and exhaust side*
- *Significant reduction of the total internal pressure drops of the unit by 75÷100%!!!*

AUTOMATION SYSTEM

MAX.e² *is fully equipped with all necessary automation and all executive mechanisms. The electric switchboard is integrated into the unit and located on the operation side.*

The "Brain" of MAX.e² *is a CAREL controller which controls and manages all processes and protects the unit from eventual cut-offs. The software is developed with a high level of know-how and it automates all processes. Only the parameters (temperature and relative humidity) of the room need to be input. The controller automatically chooses in which of the 4 processes to work depending on variables input for the outside temperature, the set point temperature, and the supply and room temperatures.*

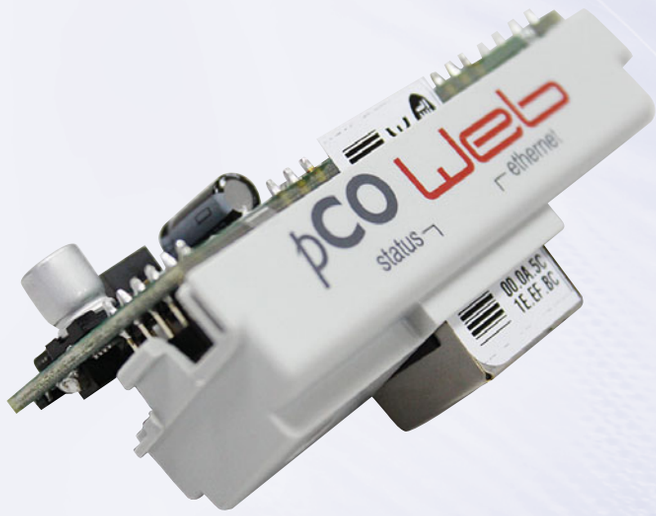
Programmability – CAREL EasyTools development system allows customisation of the software.

Communication – the automation system allows the use of multiple communication protocols with BMS, as the standard is PLan.

***Options** – Modbus®, BACnet®, TCP/IP, SNMP, Metasys®, LonWorks® (Echelon®).*

INTERNET CONECTION

A specialized electronic card (pCO WEB) is mounted within the corresponding connector of the pCO controller to provide an internet connection. This allows you to make an adequate adjustment in situations requiring fast and accurate solutions to the problem. It also allows you to connect the air-handling unit directly to the internet and perform the following actions: monitoring of the operation mode of the unit; making changes to the software of the unit; graphic logs; notification by e-mail; and changing the operation modes of the air-handling unit.



FILTERS

Filters are installed at the entrance of the unit to ensure normal operation of the AHU and to prevent contamination of the components.

Microcell filters are used in the units MAX.e² 02, 06, 09 and 13.0. These filters are made of plated micro glass paper and spaced with hotmelt adhesive beads which are uniformly positioned to deliver optimum airflow. The frame is constructed with composite material (plastic) and 130mm Galvanized steel sheets. The Classes of filtration are F6 (standard), F7, F8 and F9 (optional).

One of the benefits of using this type of filter is that despite the turbulence, variable air volume, and vibration found in the system, it performs perfectly. Since the air passes equally through Microcell filters, a maximum service life is achieved. Microcell filters are unaffected by fan shut down or start up, can resist up to 1000 Pa. of differential pressure, and work perfectly in humid conditions.

EUROVENT N: 09.07.434.

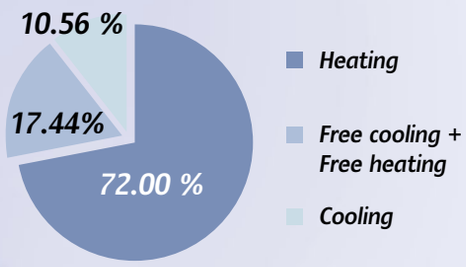
Benefits:

- *More filtration area - 50% higher filtration area, compared to EU5 bag filter.*
- *Lower Pressure Drops - being compact and rigid the pressure drops are lower than bag filters.*
- *Higher Final Pressure Drops - resist up to a differential pressure of 1000 Pa.*
- *Longer Service Life - lower initial and higher final pressure drops increases the service life.*
- *Reduced labor and service costs - due to shorter time for changing the filters.*
- *Lighter than the metal frame version for a smaller environmental impact and easier handling.*
- *Reducing the SFP factor due to lower pressure drops Ultra compact - only 130mm.*

MAX.e² *02 and 03 units use so called plated filter cells made of "glass micro fiber" material. The frame is made of galvanized sheet steel at a thickness of 98mm. The class of filtration is F5 (standard), F6, F7, F8, or F9 (optional).*

DISTRIBUTION OF WORKING MODES

BASED ON YEARLY OPERATING HOURS (8760H/Y)

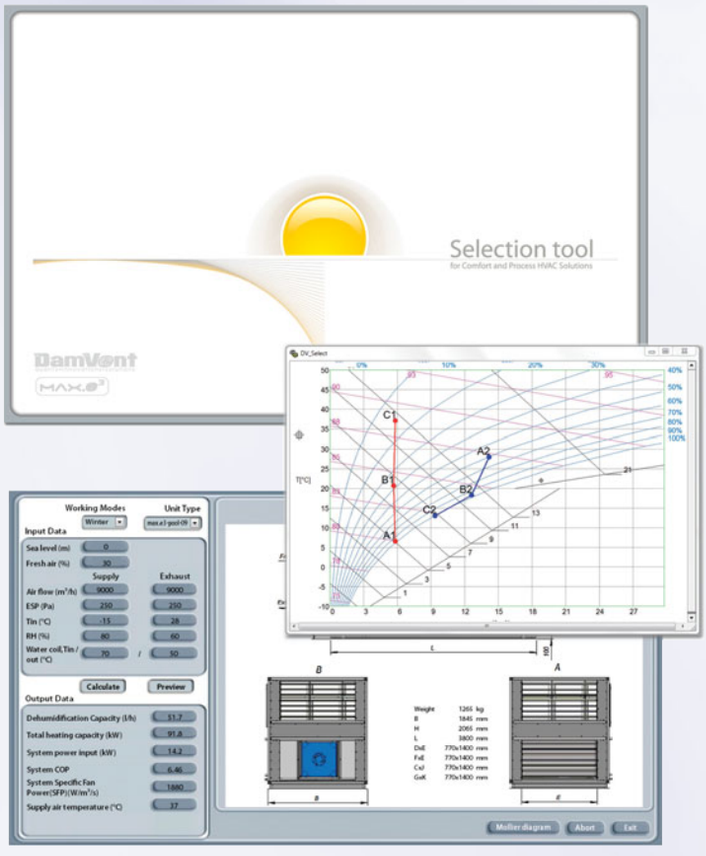


**Note: This data is based on yearly operating hours for Central Europe (Vienna)*

- *Heating Mode operates 72% of the unit working time, where COPsystem = 5 ÷ 8, depending on the ambient temperature*

- *Free Cooling and Free Heating Modes operate 17.44% of the unit working time, where compressors are switched off (non - refrigerant cooling and heating)*

Ambient Temperatures(°C)	-15	-10	-5	0	5	10	15	20	20	30	35
Hours(h)	0	21	370	1179	1501	1535	1701	1528	788	131	6
Working Modes	Heating							Free Cooling + Free Heating	Cooling		



DV_SELECT

DV_Select is the specialized software used for technical calculations of the "e-conomizer". DamVent is among very few companies that have developed such a powerful tool used for calculations in AHUs that contain "2 stage heat recovery technology" (air-to-air plate heat exchanger and implemented heat pump) which recover up to 100% of the extract heat.

The main features of the software are:

- *Friendly interface*
- *Light, fast and easy to work with, minimum input data*
- *Winter/Summer mode calculations*
- *Technical data and drawing printouts can be exported to a PDF file*
- *Visualisation of the processes in the Mollier's diagram*
- *Printouts consist of detailed info for: pressure drops for all components, plate exchanger, evaporator and condensor, compressor, fans, sound pressure level and dimension and weights*
- *General data includes the most important parameters of the unit such as: Total cooling/heating Capacity (kW), Supply air temperature (°C), Total Power Input (kW), System COP/EER, Specific Fan Power (SFP) – total for unit (W/m³/s), Refrigerant type and more ...*

ADVANTAGES

For Investors:

- Initial investment cost reduction
- Installed electricity power reduction
- Lower operating (energy) costs
- Saves space
- Absence of “defrost” mode and maintains continuous working of the unit
- Easy maintenance – only one unit
- Internet monitoring
- 100% test in factory conditions
- Low sound parameters

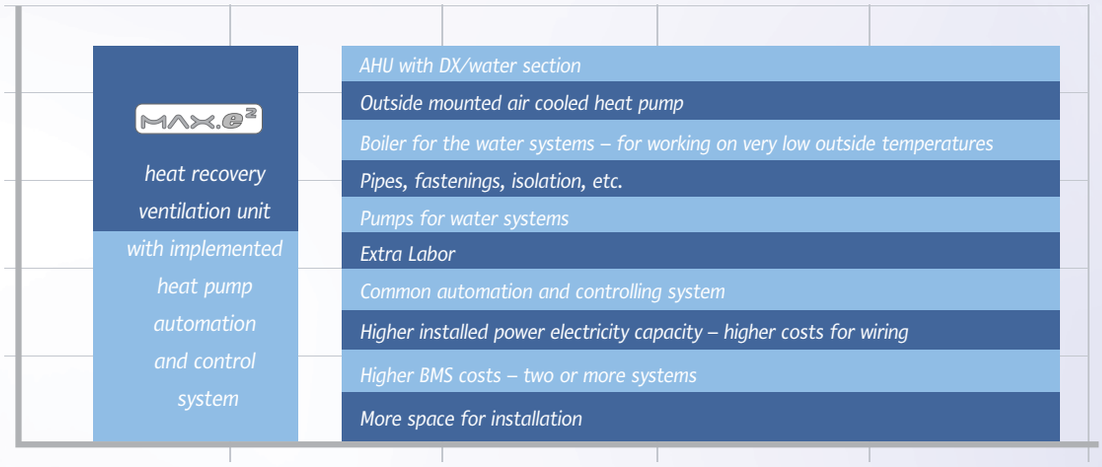
For designers/consultants:

- Selection software is available
- Saving time during the process of design
- Flexibility when there is lack of space
- Fast and easy calculations for yearly operation (energy) costs
- Absence of “defrost” mode

For installing companies:

- Easy installation (needs only duct connections and power supply)
- BMS connection via different protocols
- Settings via internet
- No need for refrigeration work

CAPITAL COST COMPARISON



The capital cost *of* MAX.e² *compared with the conventional air cooled heat pump is equivalent or lower! The benefits of lower energy consumption with the* MAX.e² *brings immediate cost savings!*

ENVIRONMENT

- *Low refrigerant content*

Each unit size has a limited refrigerant content, according to Regulation No. 842/2006 issued by the European Parliament and Council which make obligatory controls more frequent as the load of each individual circuit increases. MAX.e² only requires sporadic controls - once per year.

- *Refrigerant - eco friendly* **R407C**

- *Respect for the environment*

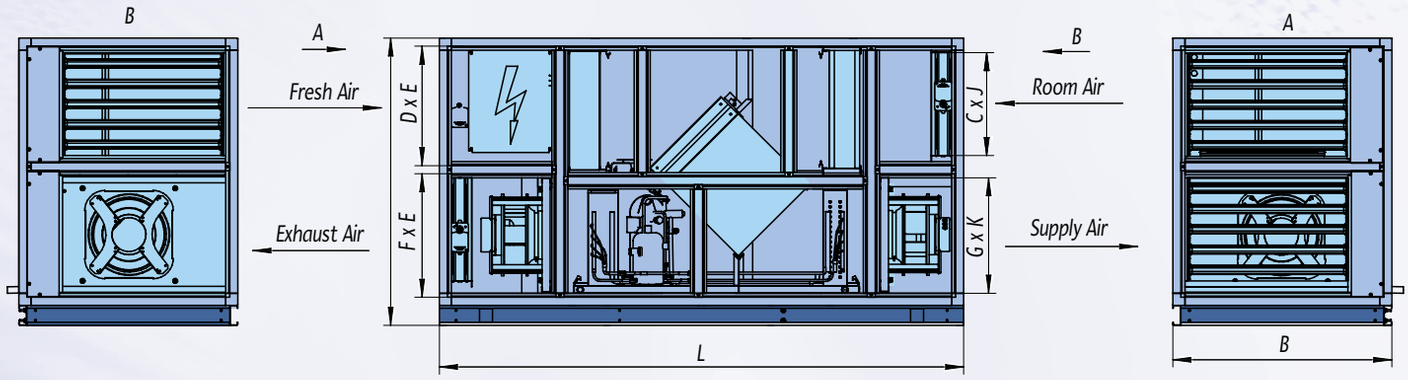
The low refrigerant content and the excellent energy performances allow CO_2 emissions in the atmosphere produced during operation to be kept down. While producing 1 kWh of useful heating capacity at -15°C ambient temperature, MAX.e² emits 62÷65 g of CO_2

GENERAL TECHNICAL DATA

AHU Type		MAX.e² 02	MAX.e² 03	MAX.e² 06	MAX.e² 09	MAX.e² 13.0
Min/Max Airflow	m^3/h	1000/2000	2000/3200	4000/7000	5500/10000	9000/14500
General Technical Data						
Nominal Airflow	m^3/h	1500	2500	6000	9000	13000
Total Cooling Capacity (summer mode)	kW	11.2	19.4	43	60.7	87.5
Total Heating Capacity (winter mode)	kW	20.3	34.2	79	114	166
Total Installed Power (compressors + fans)	**kW**	**7.70**	**9.95**	**16.9**	**18.4**	**33.8**
Total Power Input (compressors + fans) (summer mode)	**kW**	**3.4**	**5.9**	**11.8**	**16.9**	**25.6**
Full Load Current	**A**	**20.8**	**22.1**	**39.4**	**39.8**	**85.4**
Unit's Power Supply	**V/ph/Hz**	**400 / 3 / 50**				
System COP (winter mode)	-	**8.7**	**8.75**	**9.58**	**10.08**	**8.98**
System EER (summer mode)	-	**3.12**	**3.1**	**3.46**	**3.6**	**3.42**
Fans						
Type		**EC Plug fan**				
Motor Efficiency		IE4 Premium Efficiency, ErP conformity - 2015/EC controller integrated				IE2
Specific Fan Power (SFP)	$W/(m^3/s)$	1732	1480	1688	1785	2115
Supply / Exhaust static pressure Hst	Pa	250	250	250	250	250
Installed Motor Power	kW	2 x 2.5	2 x 2.5	2 x 3.5	2 x 3.4	2 x 7.5
Installed Current	A	2 x 4.0	2 x 4.0	2 x 5.6	2 x 5.4	2 x 14.5
Protection Class	IP	55				
Plate Heat Exchanger						
Material		**Aluminum**				
Efficiency (winter mode)	%	65	65	67.4	66.8	65
Recovered Heating Capacity (winter mode)	kW	16	26	54.2	74.4	103.5
Compressor						
Type		**Rotary**	**Scroll**			
Number of compressors		1	1	2	2	4
Power Input (winter mode)	kW	1 x 2.4	1 x 2 .55	2 x 2.44	2 x 3.37	4 x 2.55
Power Input (summer mode)	kW	1 x 2.6	1 x 4.7	2 x 4.37	2 x 6.03	4 x 4.51
Max. Full Load Current	A	1 x 12.8	1 x 14.1	2 x 14.1	2 x 14.5	4 x 14.1
EER (summer mode)		3.3	3.24	3.61	3.72	3.6
COP (winter mode)		5.16	5.0	5.53	5.99	5.3
Filters						
Type		Glass Micro Fiber		Microcell		
Filtration Class	F	F5	F5	F6	F6	F6
Filtration Efficiency	%	55	55	60 - 80	60 - 80	60 - 80
Total Filtration Area	m^2	4.34	6.4	55.8	74.4	99.2

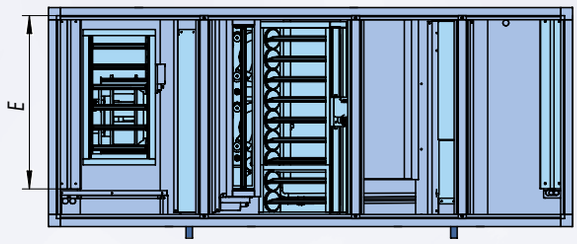
(summer mode) Room Air 26°C/50%, Fresh Air 34°C/44%, (winter mode) Room Air 22°C/50%, Fresh Air -15°C/80%

GENERAL APPEARANCE, WEIGHT AND SIZE

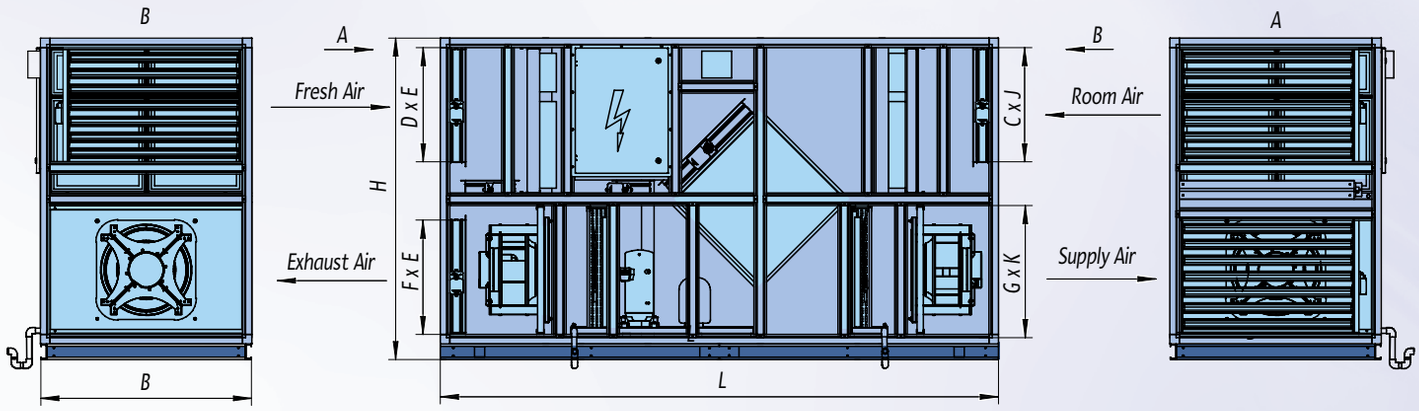


MAX.e² 02

MAX.e² 03

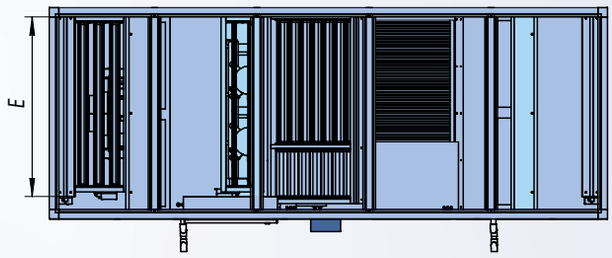


Type	B	H	L	DxE	FxE	CxJ	GxK	weight
	mm	mm	mm	mm	mm	mm	mm	kg
MAX.e² 02	760	1430	2610	580x535	630x535	580x535	630x535	570
MAX.e² 03	1090	1430	2610	580x845	630x845	580x845	630x845	640

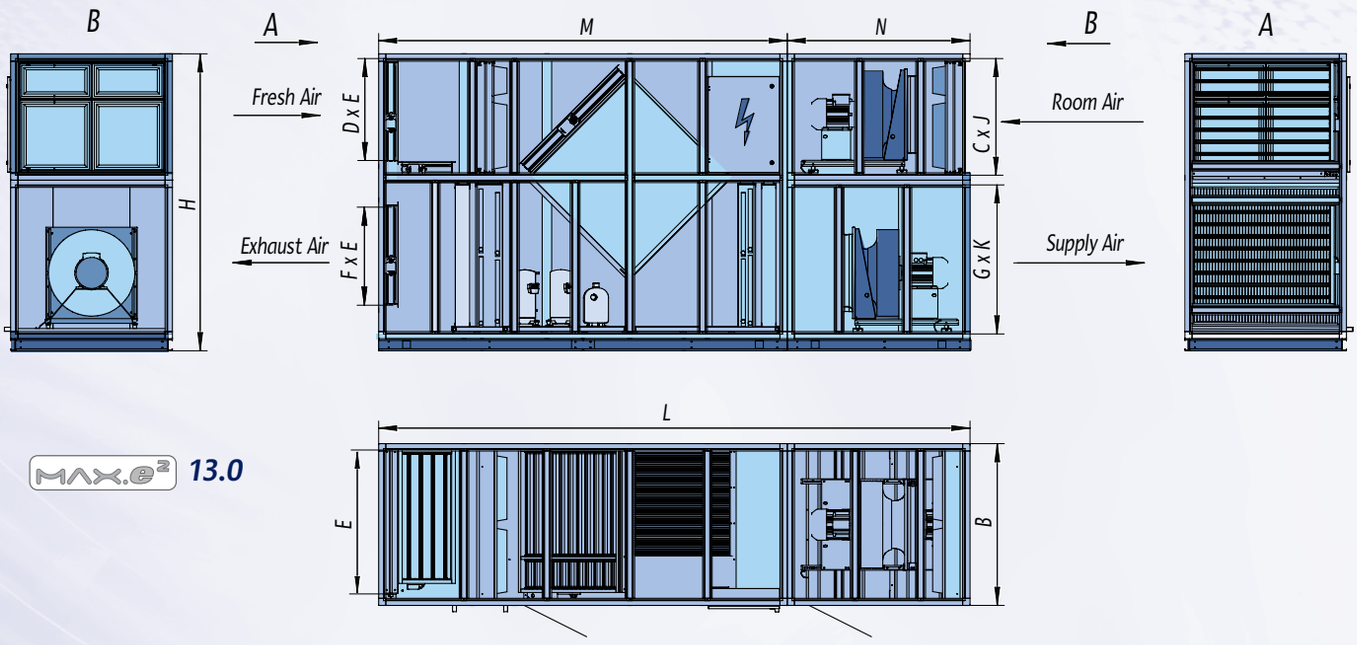


MAX.e² 06

MAX.e² 09



Type	B	H	L	DxE	FxE	CxJ	GxK	weight
	mm	mm	mm	mm	mm	mm	mm	kg
MAX.e² 06	1345	2045	3550	765x1135	765x1135	765x1135	860x1135	1180
MAX.e² 09	1845	2045	3550	765x1340	765x1340	765x1340	860x1340	1460



MAX.e² **13.0**

Type	B	H	L	M	N	DxE	FxE	CxJ	GxK	weight
	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg
MAX.e² 13.0	1345	2470	4920	3400	1520	876x1265	876x1265	970x1265	1240x1265	2200

MAX.e² is the subject of continuing improvement and future development! Following its policy of continuous improvement, Damvent reserves the right to make any further changes without the need to inform its customers and partners.

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