EvaPack™ Selection

LET'S START WITH SOME BASIC DEFINITIONS

WHAT IS EVAPORATION ?

Evaporation is a phenomenon that occurs at free water surface and converts water from liquid to gaz phase, by using air energy.

WHAT IS AIR ENERGY ?

Air energy is the sensible energy. The dryer and hotter is the air, the higher is the evaporation.

EVAPORATION YES

- free water contact surface
- air energy

EVAPORATION NO

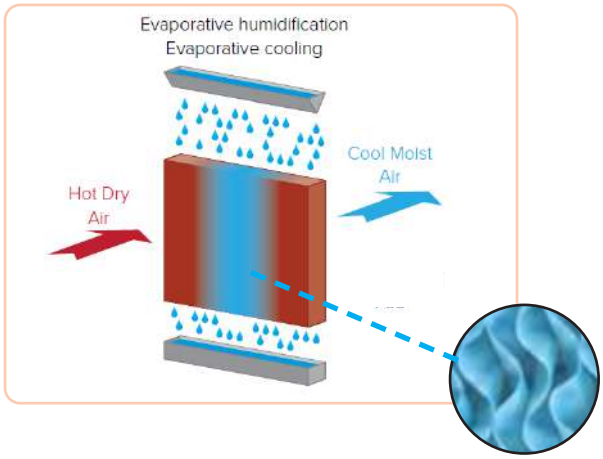
- no free water contact surface (top)
- no air energy (closed bottle)

WHAT DO WE NEED FOR GOOD EVAPORATION ?

Contact between air and water;
Continuous (hot ans dry) air flow.

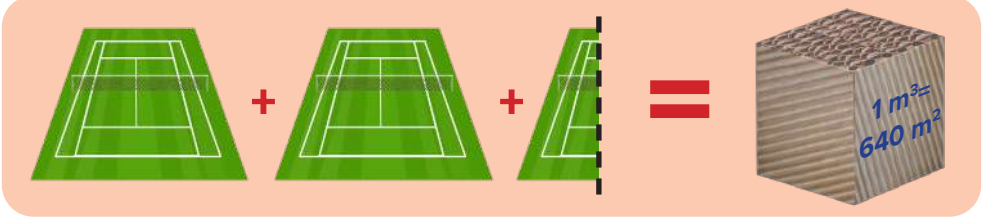
WHAT ARE EVAPORATION CONSEQUENCES ?

Air cooling;
Air humidification;
Liquid water consumption.



EvaPack™ Series has an evaporative pad which is "continuously" wetted.
EvaPack™ pad allows air/ water contact.
Dry air passes through the corrugated wet pad, by using the sensible air heat to evaporate the water.

Air/ water contact surface depends on pad volum, which can be obtained as it follows :
pad thickness * high * width.
EvaPack™ pad offers around 640 m^2 of air/water contact surface (m^3), the equivalent of 2.3 tennis courts.
EvaPack™ pad is not a sponge, it is a bloc constitued of thiny fiber glass sheets of 0.3 mm thickness.



Calculation Steps

What does the quick selection consists in ?

- sizing the right pad contact surface according to the given/ required air conditions and the installation data.
- giving the outlet air conditions after the selected EvaPack™ unit.

What do we need for this quick selection ?

-AHU/DUCT internal width/ height dimensions;
-EvaPack™ inlet conditions: temperature, humidity and air flow rate values;
-required setpoint conditions: temperature and/ or humidity.

What are we going to use this data for ?

a) With dimensionals installation data, we can quickly :
-size the EvaPack™ width and height;
-calculate air velocity through the pad.

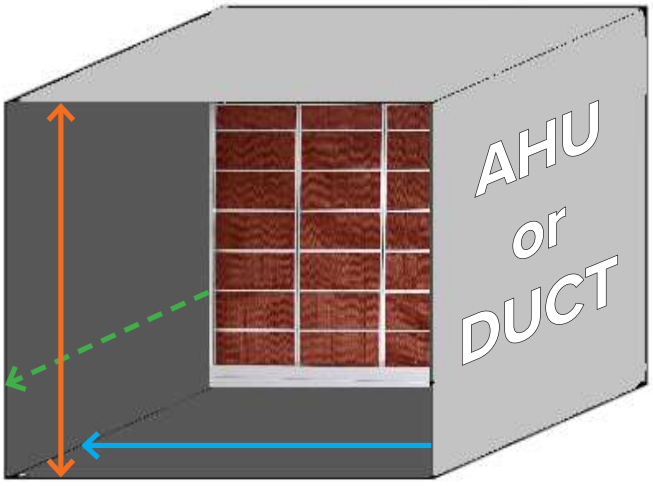
b) With given/ required air conditions, we can quickly :
-calculate the required pad efficiency and thickness;
-determine nominal pad performance by using the graphics;
-calculate the outlet air conditions, after the EvaPack™.

CALCULATIONS

1 - EvaPack™ sizing

For quick calculation, use directly the AHU/ DUCT dimensions :

- EvaPack™ total width = internal AHU/ DUCT width
- EvaPack™ total height = internal AHU/ DUCT height
- The AHU/DUCT length does not influence the selection but it is important to take it into account for the installation. (*See EvaPack™ Installation and Operation Manual*)

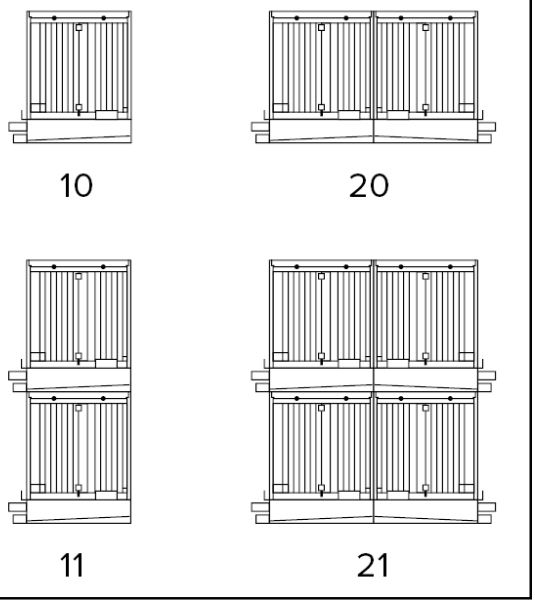


2 - Pad front surface estimation

Depending on the size of the installation there are 4 possible configurations of EvaPack™.
The simplest is configuration 10, consisting of a unique EvaPack™ element (or module).
Configurations 11, 20 and 21 are the result of the juxtaposition of several identical and symmetrical modules 10.

➔ *Configuration 10 can be from min. 400 mm to max. 3000 mm.*

Modular Configuration



Modular configuration	10					20				
EvaPack™ width	≥ 400 & ≤ 636	≥ 636 & ≤ 1236	≥ 1236 & ≤ 1836	≥ 1836 & ≤ 2436	≥ 2436 & ≤ 3000	≥ 3000 & ≤ 3636	≥ 3636 & ≤ 4236	≥ 4236 & ≤ 4836	≥ 4836 & ≤ 5436	≥ 5436 & ≤ 6000
Cassettes N°	1	2	3	4	5	6	7	8	9	10
Estimated net pad width (mm)	EvaPack™ width in mm - (36 + cassette N° * 31)					EvaPack™ width in mm - (72 + cassette N° * 31)				
Estimated net pad height (mm)	EvaPack™ height in mm - 220									

Modular configuration	11					21				
EvaPack™ width	≥ 400 & ≤ 636	≥ 636 & ≤ 1236	≥ 1236 & ≤ 1836	≥ 1836 & ≤ 2436	≥ 2436 & ≤ 3000	≥ 3000 & ≤ 3636	≥ 3636 & ≤ 4236	≥ 4236 & ≤ 4836	≥ 4836 & ≤ 5436	≥ 5436 & ≤ 6000
Cassettes N°	2	4	6	8	10	12	14	16	18	20
Estimated net pad width (mm)	EvaPack™ width in mm - (36 + cassette N° * 15.5)					EvaPack™ width in mm - (72 + cassette N° * 15.5)				
Estimated net pad height (mm)	EvaPack™ height in mm - 440									

3 - Pad surface calculation

Pad surface (m^2) = EvaPack™ width (mm) * EvaPack™ height (mm) / 1 000 000

➜ *Use at least 4 decimals after the comma*

4 - Net air front velocity

Net air front velocity (m/s) = (Air flow rate (m^3/ h) / 3 600) / Pad surface (m^2)

5 - Reading Nominal Pad efficiency

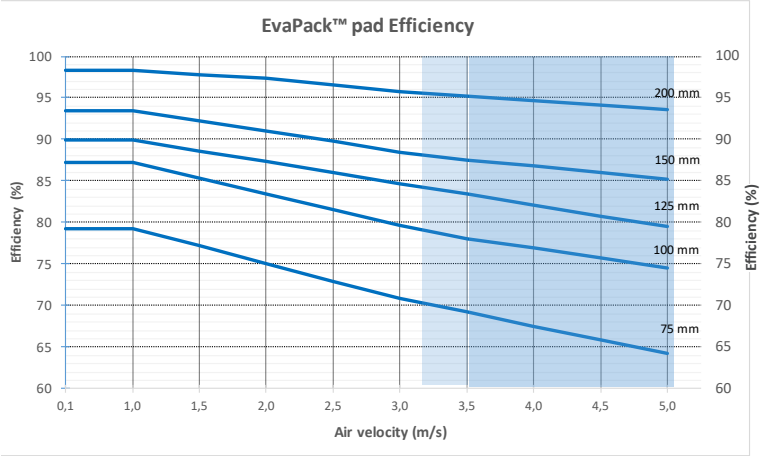
Once you have : Air velocity (m/s), just read the graphics below

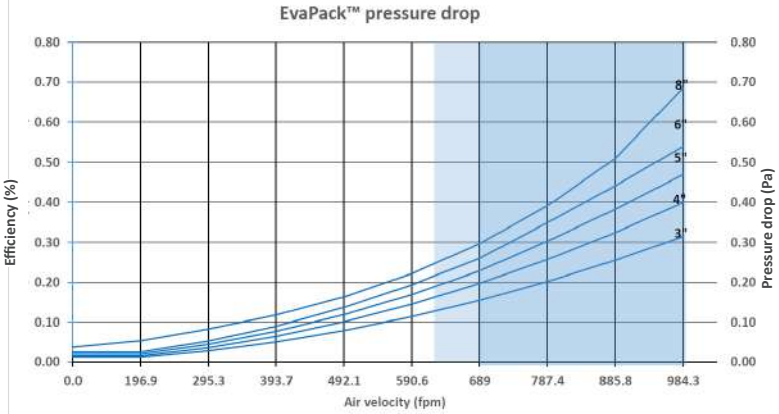
$\eta_{cooling}$ = Real cooling/ Ideal cooling = $(Tdb_{in} - Tdb_{out}) / (Tdb_{in} - Twb_{in})$

$\eta_{humidification}$ = Real humidification/ Ideal humidification = $(X_{in} - X_{out}) / (X_{in} - X_{twb})$

Pad efficiency graphics

There are 5 different pad thicknesses: 75 mm, 100 mm, 125 mm, 150 mm and 200 mm. Choosing a nominal efficiency is basically the same as choosing a pad thickness.





Droplet separator recommended

Droplet separator necessary

(*) maximal air front velocity recommended: 4,5 m/s

Inlet air wet bulb temperature must be positive to avoid water freezing on the pad. Do not exceed 55 °C when the pad is not wetted.

6 - Outlet air conditions

Inlet air dry bulb temperature = tdb_{in}

Inlet air wet bulb temperature = twb_{in}

Required air dry bulb temperature = tdb_{req}

Outlet air dry bulb temperature = tdb_{out}

Pad efficiency (between 0 & 1) = η

$\eta = tdb_{in} - tdb_{req} / tdb_{in} - twb_{in}$

$tdb_{out} = tdb_{in} - \eta (tdb_{in} - twb_{in})$

Example 1

The end-user is looking to install an EvaPack™ in the AHU of his company to freshen the air during summer period.
By installing our equipment he would like to obtain an air temperature of 24°C.
He communicates the following information to a sales representative in charge of the project:

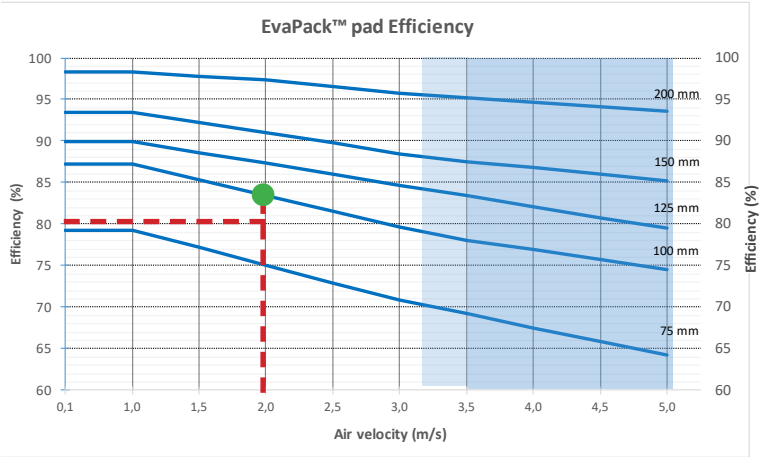
Internal AHU Width ➜ 1500 mm
Internal AHU Height ➜ 1500 mm
Tdb_{in} ➜ 40°C
Twb_{in} ➜ 20°C
Air flow rate (m^3/h) ➜ 12 635 m^3/h

CALCULATIONS

EvaPack™ Total Width: 1500 mm
EvaPack™ Total Height: 1500 mm
Net pad surface (m^2) =
(EvaPack™ width in mm - (36 + cassette N° * 31)) * (EvaPack™ height in mm – 220) / 1 000 000
Net pad surface (m^2) = (1500 - (36 + 3 * 31)) *(1500 – 220) / 1 000 000 = 1,75488 m2
Net air front velocity (m/s) = (Air flow rate (m^3/h) / 3600) / Pad surface (m^2) =
(12 635 /3600) / 1,75488 = 2,0 m/s ➜ (*no droplet separator required*)

Minimum required cooling efficiency :

$\eta_{cooling} = tdb_{in} - tdb_{req} / tdb_{in} - twb_{in} = 40 - 24 / 40 - 20 = 0.8 = 80\%$



Selected pad thickness : 100 mm with 83 % efficiency at 2 m/s

The tdb_{out} is then :
$tdb_{out} = tdb_{in} - \eta (tdb_{in} - twb_{in}) = 40 - 0.83 (40 - 20) = 23.4°C$

Which equipment will be provided to our customer ?
An EvaPack™ Eva-1-1500-1500-100-0 will cool the air up to 23.4°C.

Example 2

The end-user is looking to install an EvaPack™ in the AHU of his company to humidify the pre-heated air during winter period.
By installing our equipment he would like to obtain an air humidity ratio of 8 g/kg.
He communicates the following information to a sales representative in charge of the project:

Internal AHU Width ➜ 1500 mm
Internal AHU Height ➜ 1500 mm
Tdb_{in} ➜ 35°C
Twb_{in} ➜ 13.6°C
X_{in} ➜ g/kg (Alt = 0, X = 9.75, tdb = 13.6 / RH = 100%)
Air flow rate (m^3/h) ➜ 12 635 m^3/h

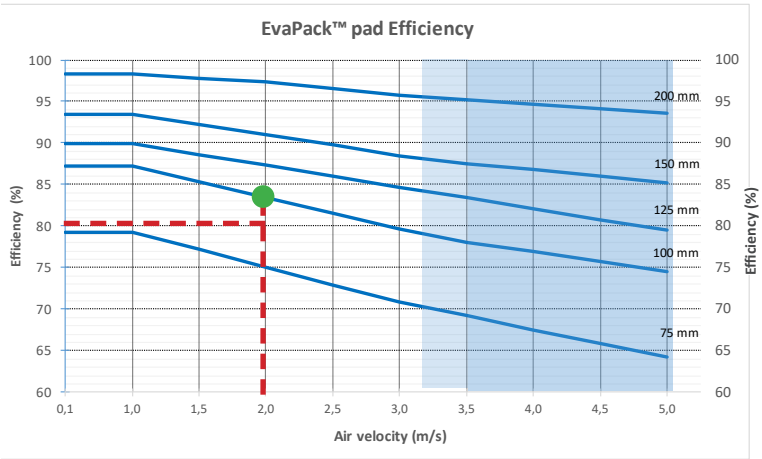
CALCULATIONS

EvaPack™ Total Width: 1500 mm
EvaPack™ Total Height: 1500 mm
Net pad surface (m^2) =
(EvaPack™ width in mm - (36 + cassette N° * 31)) * (EvaPack™ height in mm – 220) / 1 000 000
Net pad surface (m^2) = (1500 - (36 + 3 * 31)) *(1500 – 220) / 1 000 000 = 1,75488 m2
Net air front velocity (m/s) = (Air flow rate (m^3/h) / 3600) / Pad surface (m^2) =
(12 635/ 3600) / 1,75488 = 2,0 m/s ➜ (*no droplet separator required*)

Minimum required humidification efficiency :

The evaporative process can be considered adiabatic. It means that the evaporative efficiency can be estimated by:

$\eta_{humidification} = X_{in} - X_{req} / X_{in} - X(at\ tbw_{in}) = 1 - 8 / 1 - 9.75 = 0.8 = 80\%$



Selected pad thickness : 100 mm with 83 % efficiency at 2 m/s

The tdb_{out} is then :
$tdb_{out} = tdb_{in} - \eta\ (tdb_{in} - twb_{in}) = 35 - 0.83\ (35 - 13.6) = 17.24°C$

Which equipment will be provided to our customer ?
An EvaPack™ Eva-1-1500-1500-100-0 will cool the air up to 17.24°C and humidify up to 8.24°C

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Through the design, manufacture and application of humidification equipment, Armstrong has pioneered countless savings in energy, time and money. Armstrong University courses will help you better understand HVAC components.

For more information, we especially recommend :

EVAPORATIVE PAD ADIABATIC HUMIDIFIERS

https://store.armstronginternational.com/product?catalog=evaporative-pad-adiabatic-humidifiers-M2181

FUNDAMENTALS OF HUMIDIFICATION

https://store.armstronginternational.com/product?catalog=fundamentals-of-humidification-M2049

PSYCHROMETRICS

https://store.armstronginternational.com/product?catalog=psychrometrics-M2157

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