WEBER
VACUUM COOLING

VACUUM COOLING OF INDOOR & VERTICAL FARMING

Premium performance - Affordable cost!

WeberCooling is a worldwide leader in Vacuum Cooling Technology.

Weber Cooling has been supplying vacuum cooler to indoor and vertical farming growers worldwide. Although crops are cooled nearby consumers, cooling still remains an essential part in the entire process in order to guarantee the preservation of the high produce quality to the end consumer.

Vacuum cooling has proven to be a very fast precooling technology for all leafy vegetables and herbs. With vacuum cooling you can cool leafy greens like rocket, watercress, baby kale, etc. and all herbs in less than 15 minutes down to 2-4°C/ 37/39°F after harvesting. In this way transpiration and respiration rates are rapidly lowered, allowing leafy greens to maintain their high quality and prolonging their shelf life.

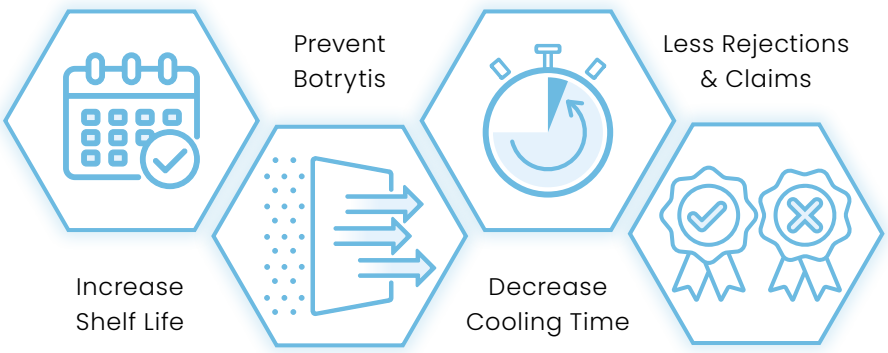
As an added benefit, residual moisture on the skin of the product is removed during cooling, , avoiding condensation on the leaves and the appearance of fungus!

The importance of Pre-Cooling

Pre-cooling refers to the rapid removal of field heat (normally around 80–85%) shortly after the harvest of a crop. Field heat can be defined as the difference in temperature between the temperature of the crop harvested and the optimal storage temperature of that product.

Pre-cooling is a very important step in the post-harvest stage as mushrooms get intro stress after the harvesting process. This results in transpiration (sweating, resulting in loss of weight and in the building of moisture on the skin of the produce), and high respiration (breathing = burning sugars), resulting in loss of life, but at the same time in an increase in product temperature, especially when packed tightly. Mushrooms at 20˚C produce 600% more heat energy compared to mushrooms at 2˚C! This is why it is critical to get them cooled quickly and correctly.

Both respiration and transpiration can be greatly reduced by rapid pre-cooling. On average both can be reduced by a factor of 4, 5 or even more, if cooled down from harvesting (on average at 20–30 ˚C/ 68–86 ˚F down to below 5 ˚C /41 ˚F). The perfect end temperature is defined by many factors, like produce to be cooled and the post harvesting steps following the pre-cooling.



Proper pre-cooling will:

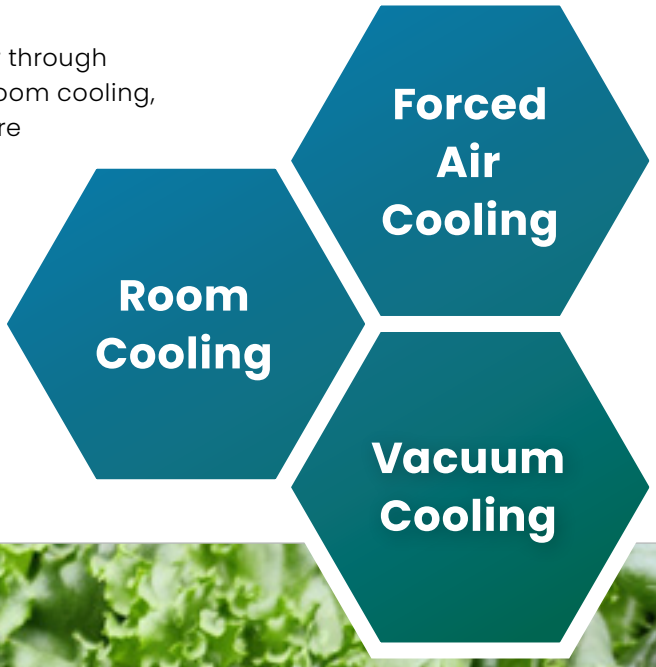
- Reduce respiration, resulting in quality preservation
- Preventing fungus by drying of the skin
- Slow the rate of decay by inhibiting microbial growth (fungi and bacteria)
- Reduce the rate of ethylene production
- Increase market flexibility through longer storage life
- Meet customer requirements on freshness and shelf life

With already a small ONE pallet system, indoor & vertical growers can cool up to 4 loads per hour. This seriously improves the capability of growers to deliver cooled produce to their customers, on the same day!

Available **Pre-Cooling Methods**

There are different alternative methods for the pre-cooling of mushrooms:

- **Room Cooling** (in a conventional cold storage)
  There is a trade-off with Room Cooling. It requires relatively low energy but is very slow.
- **Forced Air Cooling** (or blast air cooling, forcing cold air through your produce) Forced air will cool faster compared to room cooling, but it will always cool "outside-in" and will reach the core of the product only after long cooling
- **Vacuum Cooling** uses the boiling energy of water to cool down your produce.
  For the water in the product to boil, the pressure in the vacuum room must be brought down to ultra-low pressures. Cooling to the core of the boxes is easy – and fast.



Comparison of Pre-Cooling Methods

The table below compares pre-cooling methods as applied to fresh fruits and vegetables. In this document we will tell you more about the technology of Vacuum cooling, and the advantages for indoor farmers.

Variable	Cooling method				
	Ice	**Hydro**	**Vacuum**	**Forced-air**	**Room**
Cooling Times (h)	0.1 - 0.3	0.1 - 1.0	0.3 - 2.0 *	1.0 - 10.0	20-100
Water contact with the product	yes	yes	no	no	no
Product moisture loss (%)	0 - 0.5	0 - 0.5	1.0 - 3.0	0.1 - 2.0	0.1 - 2.0
Capital cost	high	low	medium	low	low
Energy efficiency	low	high	high	low	low

Source: Kader and Rolle, 2004

** It is decreased in the last 10 years down to 0.25 - 0.4 hours.*

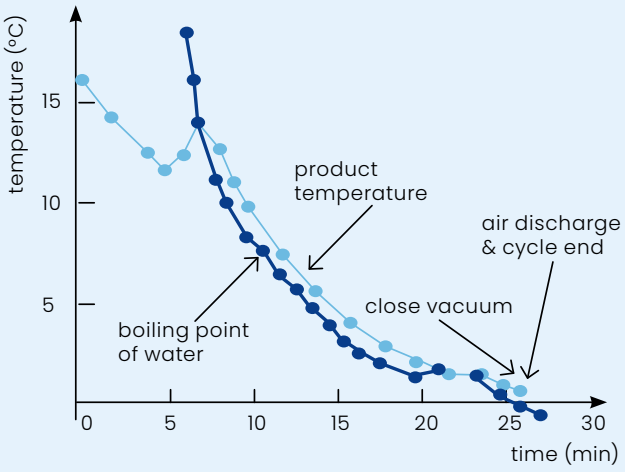
Vacuum Pre-Cooling

By far the most important part of maintaining the quality of herbs and leafy greens is ensuring that they are cooled as soon as possible after harvest and that optimum temperatures are maintained during distribution. Harvesting at indoor farms is normally done at around 20°C. As harvested produce is still alive, it continues to create heat (and moisture). To prevent excessive temperatures, to increase shelf life, to reduce rejects and to prolong the potential shipping times, quick pre-cooling right after harvesting or packing is vital.

Vacuum cooling is 5-20 times faster and more effective than conventional cooling!

Only vacuum cooling can cool ultra-fast and uniformly to the core down to 0-5 °C for most produce grown at the indoor farm can be cooled down to the core within 10 - 15 minutes, making vacuum a perfect cooling method for these farmers.

The final cooling temperature plays an important role in the time to cool. The first stage of cooling, down to around 5 °C, is always very fast (providing the vacuum cooler is fast enough), but cooling down to reach temperature around freezing point, some more time is needed.

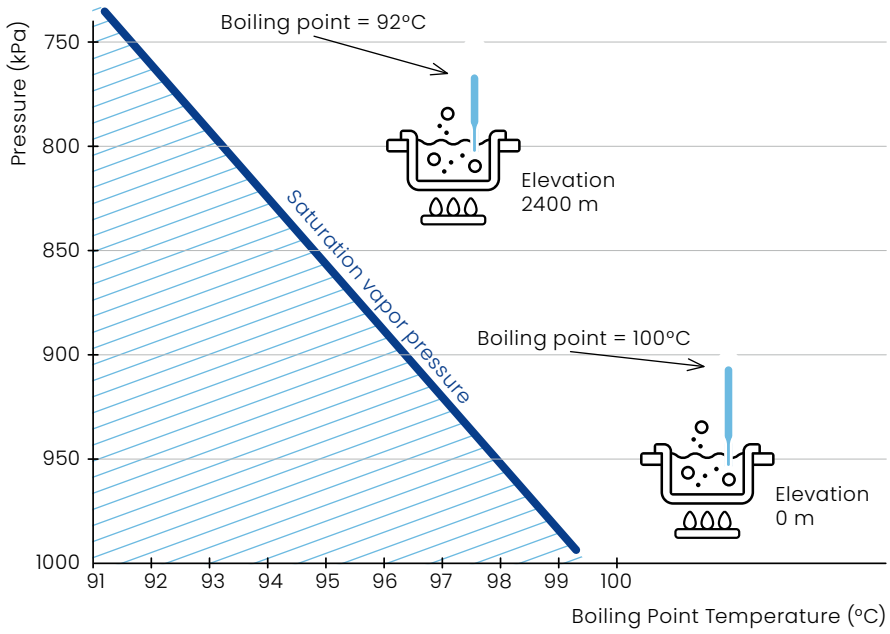


Flash point reached, cooling process starting

A huge advantage of vacuum cooling is that paper and plastic packaging materials in the boxes do not affect the efficiency of cooling, free water is removed, **boxes can be packed tightly** and stacked in any manner in the pre-cooler.

Vacuum Cooling **Technology Explained**

Vacuum works with pressure. There is a relation between the pressure level and the boiling point of water. The lower the pressure, the lower the boiling point of water. When introducing a product recently harvested into the vacuum room, vacuum pumps start evacuating the air in the room, lowering the pressure. When the pressure level reaches the product's temperature, a fraction (0,8-2%) of the moisture inside the product is being forced to evaporate. This evaporation process extracts energy (= heat) from the product. Because of the created vacuum, not only the outside is cooled down, but the product's core as well, as cooling takes place from inside the product.



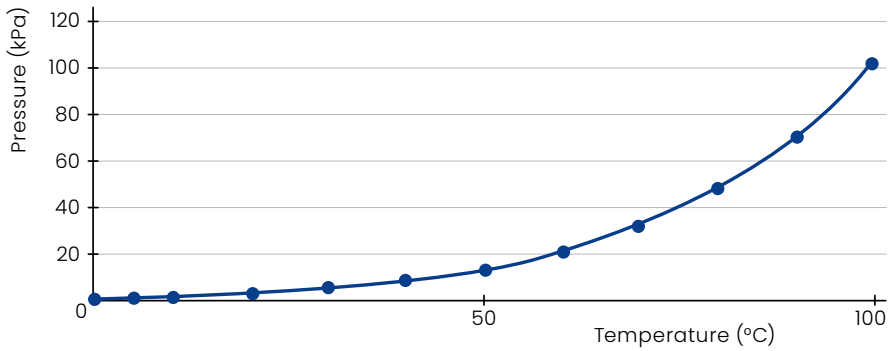


Table relation Pressure and Boiling point of water

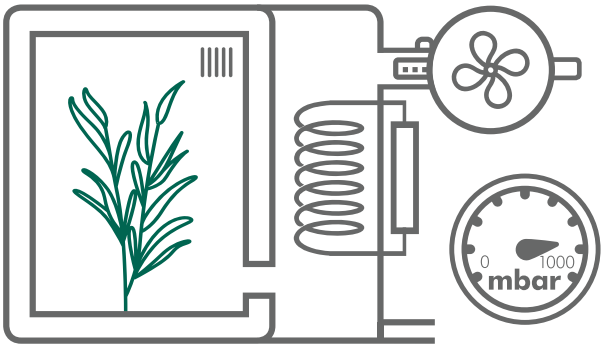
Pressure on system		Temperature at which water boils	
mBar	Torr mm Hg	°F	°C
1000	760	212	100
56.2	42.2	95	35
42.4	31.8	86	30
31.7	23.8	77	25
28.4	21.3	68	20
20.6	15.5	64.4	18
18.2	137.7	60.8	16
17.0	12.8	59	15
16.0	12.0	57.2	14
15.0	11.3	55.4	13
14.0	10.5	53.6	12
13.1	9.8	51.8	11
12.3	8.6	48.2	9
10.7	8.0	46.4	8
10.0	7.5	44.6	7
9.3	7.0	42.8	6
8.7	6.5	41	5
8.1	6.1	39.2	4
7.6	5.7	37.4	3
7.1	5.3	35.6	2
6.6	5.0	33.8	1
6.1	4.6	32	0

A condensing system is used to condensate the water vapor coming from the produce. This system is being cooled by a refrigerant, or by (glycol) water. Based on intensive research, and hundreds of vacuum coolers installed in the market – Weber Cooling has optimized the vacuum – cooling balance for each product to be cooled. For mushrooms, we offer systems which allow cycle times of even 10 minutes or less. In this **»VIDEO«** you can see we can even cool down the mushrooms in 2-3 minutes if needed!

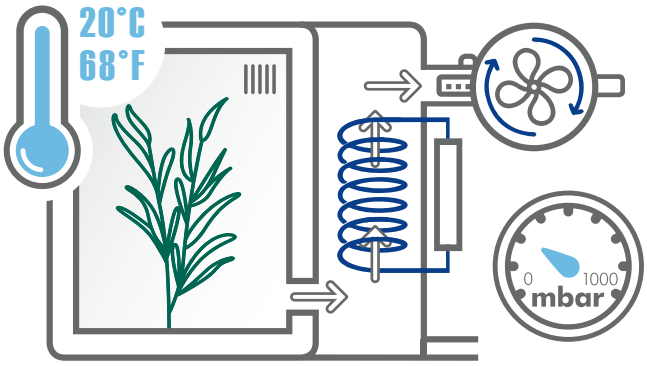
Note: For every 6-7°C reduction in temperature, approximately 1% of the produce weight needs to be turned into water vapor. In an average cycle of 15-25 minutes, weight loss can vary between 2-3%.

Vacuum Cooling **Cycle**

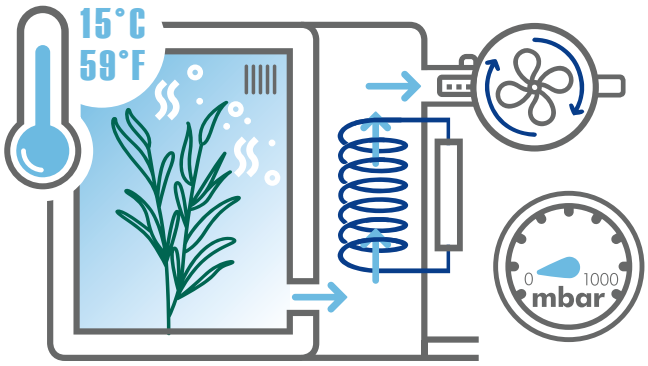
CLICK ME and WATCH THE VIDEO!



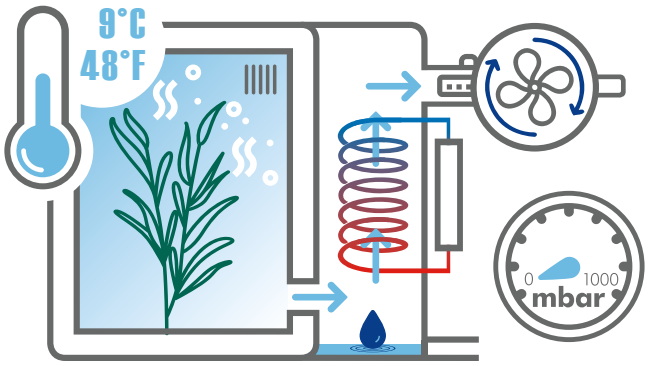
1 The product is placed in the vacuum room and room is closed.



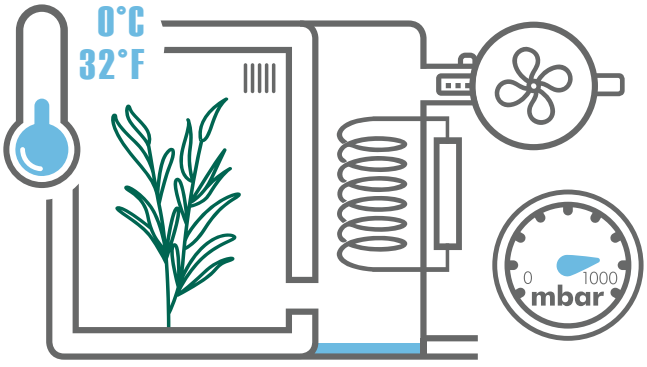
2 The vacuum pump starts and reduces the air pressure in the room from 1000 mbar to the desired pressure.



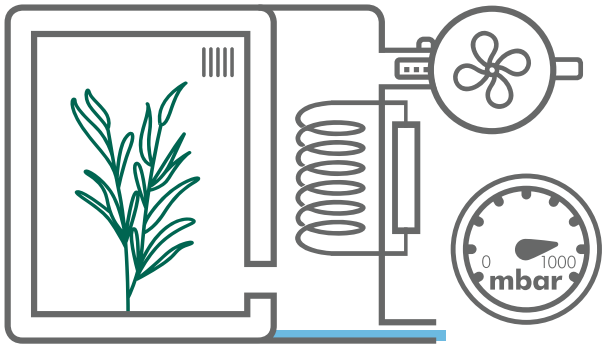
3 A small amount of water within the product will start boiling when pressure reaches temperature level of the product. This boiling process requires heat that is extracted from the product, enabling the cooling.



4 The water vapor is condensed by passing a "cold wall". The dried air goes out through the vacuum pump.



5 The cycle ends when the product is cold and the pressure returns to 1000 mbar.



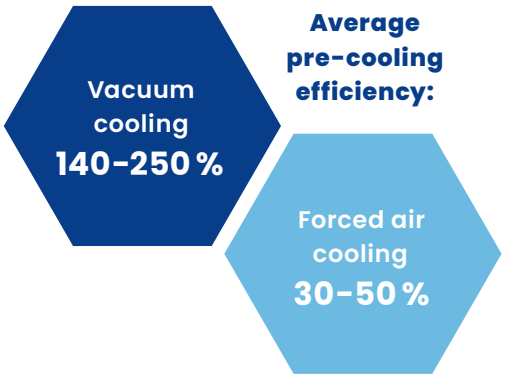
6 The condensed water is drained and the vacuum cooler is ready for the next load.

Energy consumption comparison

There is no discussion about the fact that vacuum cooling is the most energy efficient method for cooling down mushrooms and can be applied more efficiently than forced air. As a rule of thumb, you can say that due to the difference in energy coefficient, forced air cooling will need up to 4 or 5 times more energy compared to vacuum cooling!

To cool 100 kg of produce in a vacuum cooler, you will need roughly 1 kWh of energy (+/- 20 %), to cool down from 23 °C to 3 °C. The energy needed will be lowest for flowers and highest for vegetables & herbs (as they have a higher specific heat).

Beside the energy efficiency of vacuum cooling, it also reduces the energy requirement or workload of a cold store system.



The importance of Cold Chain Management for optimal Logistics & Shelf Life

Vacuum cooling is the perfect pre-cooling method for all mushrooms and has been successfully implemented at many mushroom farms. Why is vacuum cooling so perfect?

The technical story:

Vacuum cooling significantly lowers the superoxide generation of mushrooms, which causes many types of cell damage and is associated with the aging process and several diseases of mushrooms. The significant lower number of superoxides **increases shelf life and prolongs freshness and quality**.

On top of that, a significant increase of peroxidase activity can be found in mushrooms after vacuum cooling treatment. Peroxidases play an important role in defending against pathogens, having a positive effect on the shelf-life of the mushroom. Vacuum cooling reduces the level of lipid peroxides, thereby **reducing cell damage and preventing oxidative injury to the mushrooms**.

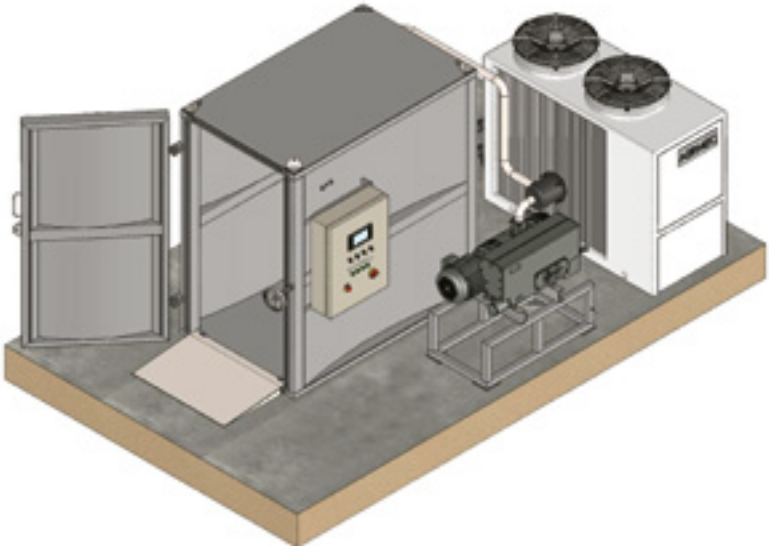
The practical story:

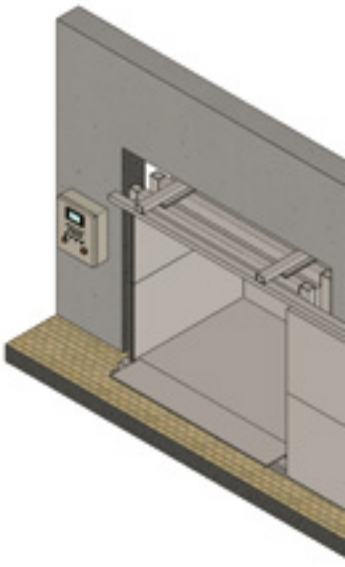
With vacuum cooling, you can quickly reduce the temperature of mushrooms down to 1-3°C, to the core, normally within around 15 minutes. This brings the mushroom into hibernation, minimizing respiration & transpiration, preserving freshness and maximizing storage and shelf life. **The mushroom stays firm & strong, for longest time.**

An additional advantage is that with vacuum cooling you dry the skin; this minimizes the risk of browning. Browning of the mushroom cap, which is the main criterion of quality, can be measured as loss of whiteness using a reflectometer. There is a significant difference in reflectance between vacuum cooled and conventionally cooled mushrooms if the cold chain is broken. Here you see that the vacuum cooled mushrooms remain much less brown than those conventionally cooled, again maximizing storage and shelf life.

The mushroom stays perfectly white or brown.

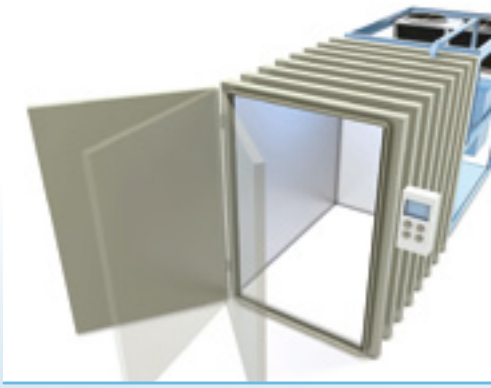
Weber Vacuum Coolers – The best choice fo





Indoor Farming Specials

For indoor farms we design small & tailor made vacuum rooms. On request available in stainless steel. Weber is currently supplying many of the leading growers worldwide.

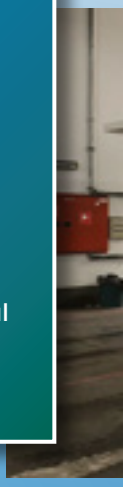


Compact Range

Front loading rooms for one or two pallets. For easy installation Weber offers a plug & play solution or a modular build system for maximum flexibility on placement.

Next Gen Systems

Weber supplies standardized solutions up to 12 Industry or Euro pallets with space saving double room configurations for optimal logistics efficiency and flexibility.



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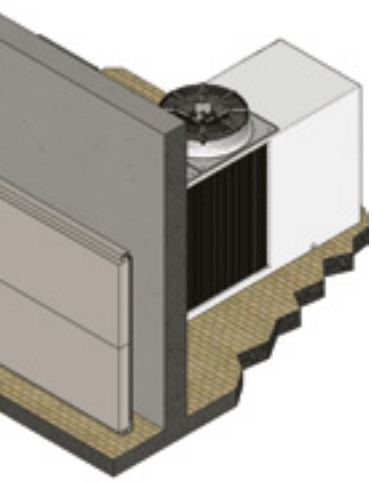
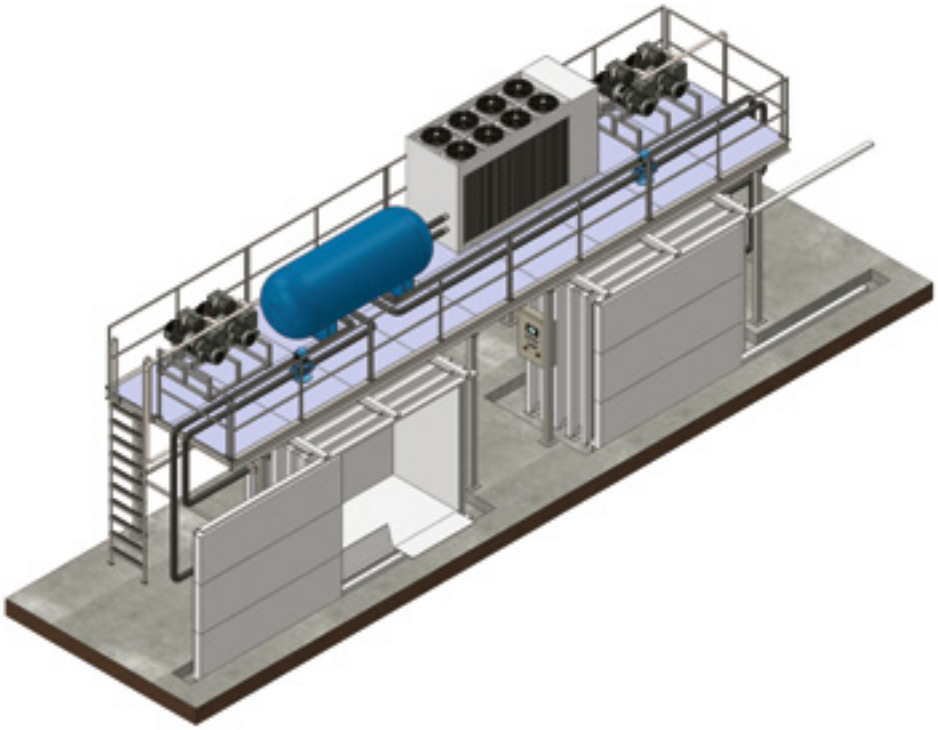
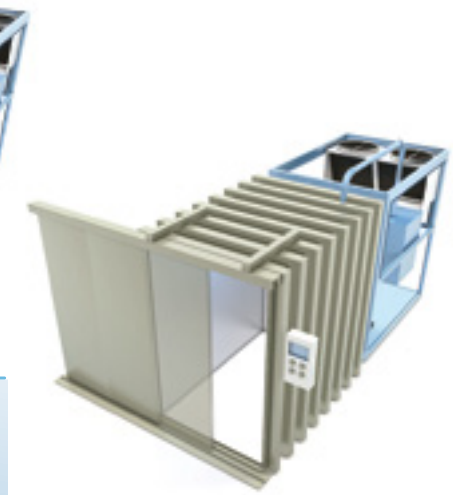
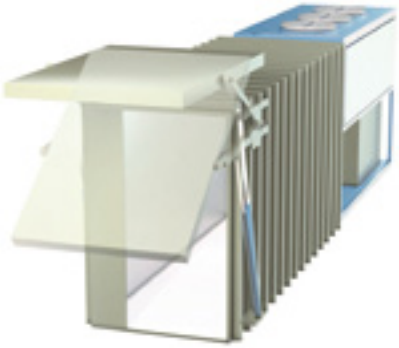








Weber XL solutions

Our large front loading solutions grow more and more popular for high volume cooling of mushrooms & leafy greens. Build to your specification ensuring the highest capacity.

Some online articles about vacuum cooling of Indoor Farming

La Corsaria

While perishability is in the nature of fresh produce, some products are more perishable than others and therefore require extra attention and innovation to ensure that its shelf-life is as long as possible, and that the product arrives to the customer with the best quality achievable. To ensure that their products are as fresh as possible upon arrival, this Colombian herb grower and shipper invested in an innovative vacuum cooling system ...

Read more >>

PURA HOJA

Producing a healthy crop year-round is a big challenge. Technologies controlling climate, disinfection and sanitization, the fertilization, and crop management are extremely important. For additional shelf life, Pura Hoja has been working with a vacuum cooler for the past two years. This cooler, provided by the Dutch company WeberCooling, helps them to keep the lettuce as fresh as possible before it reaches the grocery shelves.

Read more >>

Vacuum cooling is known as a rapid evaporative cooling technique for any porous product which has free water. The aim of this paper is to apply vacuum cooling technique to the cooling of the iceberg lettuce and show the pressure effect on the cooling time and temperature decrease. The results of vacuum cooling are also compared with conventional cooling (cooling in refrigerator) for different temperatures.

Read more >>

SCHROLL FLAVOURS

FRESH CUT HERBS

Schroll Flavours produces many different types of herbs - parsley, chives, basil, thyme, rosemary and more. After cutting, our herbs are cooled a maximum of 1 hour after harvest in a Weber vacuum cooler. This stops the decomposition process and prolongs the shelf life significantly.

Read more >>

THE GROWER

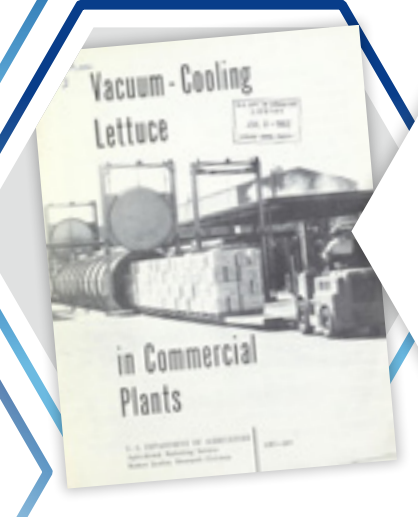
It takes one hour to harvest six pallets of produce for these efficient workers. The trailer is then driven to the farm warehouse where the pallets are placed into the vacuum chamber. This is repeated every 30 minutes to cool all the skids of lettuce. The success of this growing and (vacuum) cooling system has encouraged Droogendyk to experiment with baby greens and spinach as well...

Read more >>

FRUITS & VEGETABLES

In the case of lettuces, pre-cooling is an indispensable operation if we search for an optimal quality of the produce, since the time of preservation decreases as the number of hours between the harvesting and the temperature drop at 2°C increases. The temperature must be lowered to 1°C; the most suitable methods to do so are vacuum cooling, forced humid air and water cooling. In the most suitable one, the vacuum method, the lettuce is already packaged. The packages must bear ventilation orifices so as to enable a more uniform cooling.

Read more >>



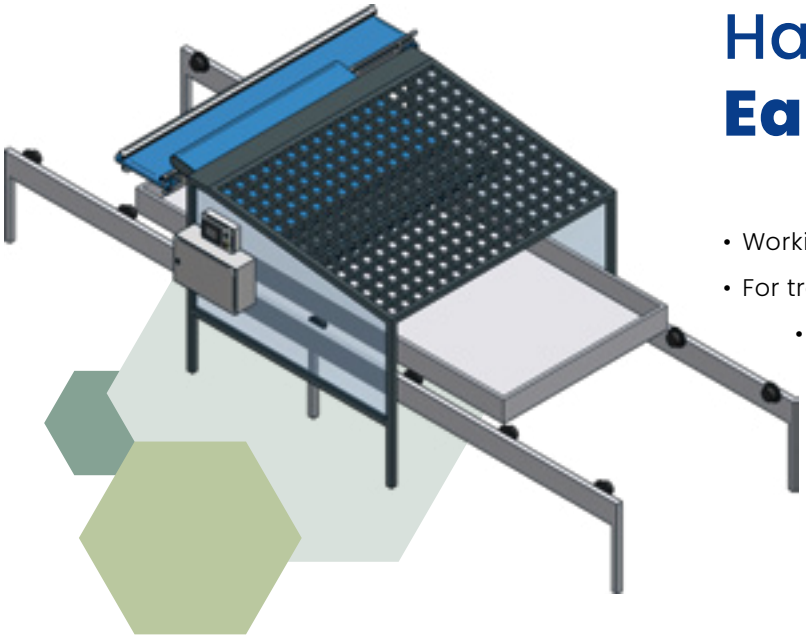
INTERNET ARCHIVE

Carton-packed lettuce can be cooled to a vacuum tank, without danger of freezing. Controlling the pressure, the lettuce can be brought down to an average temperature of 34 F / 1 C in about 15 minutes. There is a tendency during high season to sacrifice some cooling in the interest of moving more volume through the chambers. For lettuces, vacuum resulted in more thorough cooling, with result an improved market quality and reduced wastage.

Read more >>

WEBER VACUUM COOLING

VEGHANDS Vertical farming **processing**

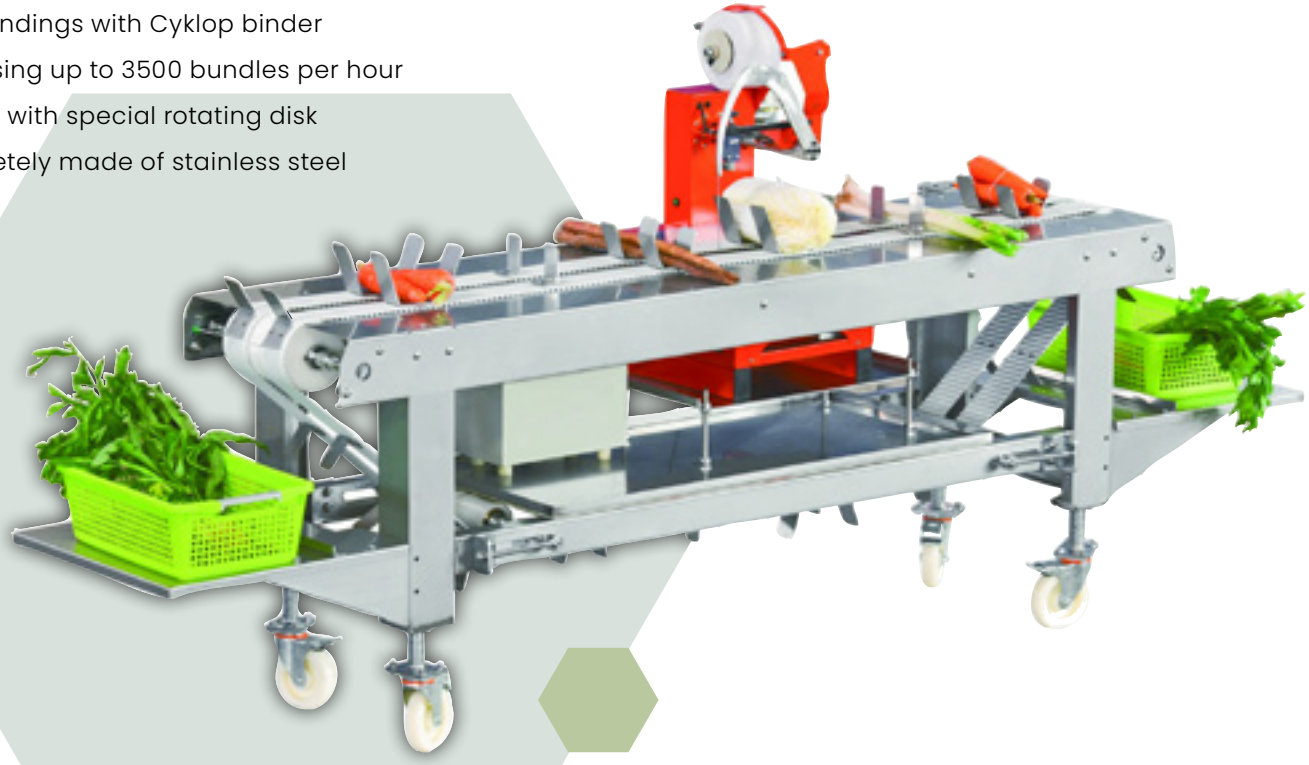


Harvesting with the **EazyCut harvester**

- Working widths of 600 / 1200 / 1600 mm
- For trays, plates and tables
- Clean cut without damages
- High capacity

Binding / cutting of bundles with the **VegKing processing lines**

- 1 or 2 bindings with Cyklop binder
- Processing up to 3500 bundles per hour
- Cutting with special rotating disk
- Completely made of stainless steel



solutions

INTERMEZZO

Weighing/ sorting / packaging with the **VegSmart weighing systems**

- Check weighers or Multihead weighers
- European electronic components used
- Vertical Flowpack or plastic cup filler attached to Multihead
- Operated by touchscreen

Weber Cooling
Your FIRST choice for vacuum cooling!

Weber Cooling is worldwide leading in vacuum cooling solutions. We ONLY produce vacuum coolers, and supply tailored solutions for all six application areas where vacuum is being used for cooling.

FRESH APPLICATONS
Vegetables & Herbs
Flowers & Cold Chain | Turf & Compost

FOOD APPLICATONS
Bread & Pastry
Food & Kitchen | Rice & Sushi

Weber Cooling ONLY builds vacuum coolers – this is where we excel. All vacuum coolers are designed by our Dutch engineering team and built using premium (European) components. As a result of our economies of scale (we produce up to 100 systems/year), our intelligent design and strategically, positioned and highly efficient production locations in Europe and Asia, we are able to offer a premium price/performance level.

Our global presence ensures our availability for maintenance and service worldwide. No other supplier has more knowledge and experience on (pre-)cooling than Weber Cooling.

For our Next Gen range we exclusively work using **"Hydronic Technology"**, with which cooled water (generated by a chiller) is used in a secondary cooling system for the "Cold Wall" inside the vacuum cooler. Hydronic Technology offers many advantages: It gives you faster cooling, it reduces the amount of refrigerant in the system and it minimizes maintenance and TCO.

For our export markets we also offer the conventional Base Gen range, using **DX (direct expansion) technology**, in which you cool the "Cold Wall" directly with your refrigerant. Simple & effective. Requiring minimum installation, and at lowest cost (especially for smaller systems).

Weber Cooling B.V.
WESTERN EUROPE & INTERNATIONAL
The Netherlands
+31 884 256 250
europebv@webercooling.com

Weber Cooling Europe Kft.
EASTERN EUROPE & SERVICE CENTER
Hungary
+36 309 926 048
europekft@webercooling.com
service@webercooling.com

Weber Cooling China Ltd.
PRODUCTION & CHINA SALES
+86 2150 6890 19
info@webercooling.cn

Weber Cooling Asia Ltd.
ASIA-PACIFIC
Hong Kong
+852 5803 0317
asia@webercooling.com

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www.webercooling.com