

Fresh and crisp – Greengrow carrot store, Poland



The new Greengrow storage hall in Wikrowo, Gronowo Elblaskie

Line of Business:	Industrial Refrigeration
Application:	Fruit and vegetable cooling
Country / City:	Poland / Gronowo Elblaskie
Fluid:	R404A, glycol
Product:	Ceiling aircooler DGN, Aircooler GGHN, Condenser GVH

Everybody likes fresh fruit and vegetables, but hardly anyone thinks about how it can be possible to buy these foodstuffs fresh even in winter. The storage of fruit and vegetable requires a lot of expertise and experience. But what data do you need to have to be able to find the best plant concept and calculate the needed units for a given storage situation?

For the calculation and the optimised selection of the air coolers destined for a new fruit and vegetable store, the Polish Company Greengrow contacted Güntner, because they were looking for a reliable partner with experience in the storage of sensitive products. After all, the fresh fruit and vegetable should have optimal quality also at the end of the storage time. Highest quality is only preserved if, after a per-

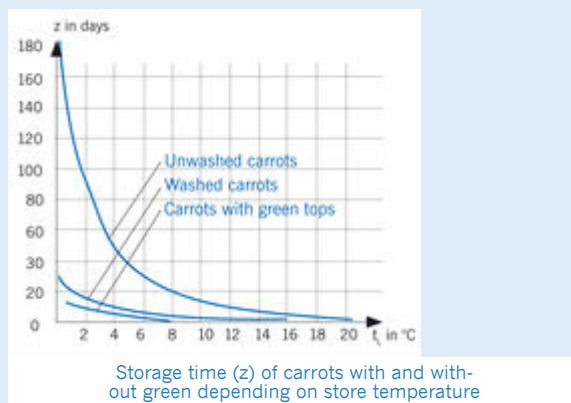
fect growth and the right harvest time, the right storage technology is used. As plant contractor in this case P.P.H. Cool was selected, as they are also known as reliable partner when it comes to storage applications.

Selection of the aircoolers

The storage hall is divided into five stores and designed in such a way that different sorts of fruit and vegetables can be stored. The main store product is carrots, so the design of the plant and the calculation of the air coolers were optimised for this vegetable. During the calculation, the whole complex of requirements was taken into account: product requirements, store technology (specifically stacking technology), requirements of the refrigerating plant, and especially the design of the air coolers. The realisation of the correct controls technology was another challenge, because the requirements are quite different during the warehousing and the storage phases.



Carrots (unwashed) stacked all the way to the ceiling



Storage time (z) of carrots with and without green depending on store temperature

Storage characteristics of carrots

Carrots are among those foodstuffs with low respiration intensity and can therefore be stored over several months. Their respiration is very sensitive regarding temperature changes in short time intervals. This increases respiration heat, thus compromising quality. Storing carrots with green increases the respiration heat considerably and therefore reduces possible storage time and the freshness cycle. For this reason, residual green should be minimal for long-term storage (residual green ≤ 20 mm).

The *storage temperature* has a large impact on the physiological processes of the stored carrots. Most important, damages caused by frost below freezing temperature (for carrots -2.2 to -1.2 °C) must be avoided. Frequent temperature fluctuations also have a negative impact on the storage quality; the temperature fluctuations should therefore not exceed ± 0.25 K. With a storage temperature of ± 0 to + 1°C, the *relative air humidity* should amount to ≥ 95 %. If only a storage temperature of + 4°C is attained, the relative air humidity must be lowered to ≤ 95 % to avoid formation of condensation water. The *air velocity* is another important influencing factor for keeping vegetables fresh during storage. If the air velocity close to the product is high, then the cold air with low water vapour pressure is led close to the surface of the vegetable. But if the air is ventilated only slightly, a layer will form around the product with higher air humidity. If this saturated air layer is not destroyed too often through cooling, the loss of humidity is lower.

Which types of stores exist?

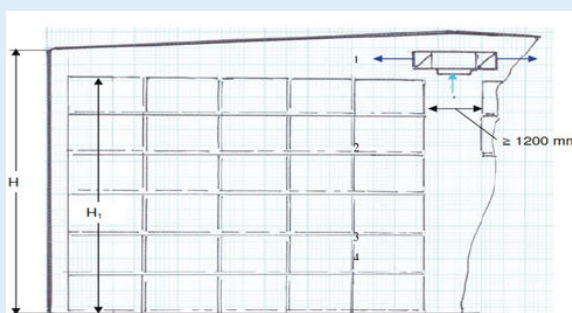
There are two types of stores for long-term carrot storage:

Bulk or heap storage: With this type of storage, a maximum stacking height of 2.5 m is possible due to the sensitivity of the stored goods. With forced ventilation that is led through the carrots in bulk from below, the supplied air is evenly distributed. An external pressure of approximately 150 Pa has to be observed for this. For this kind of storage, instead of carrots in bulk also stacked boxes with carrots can be supplied with cold air from below.

Storage in containers or boxes: This type of storage is suitable for most kinds of vegetables. The refrigerated goods are well protected against damage in the boxes; the size of the boxes can be adapted to the sensitivity of the storage goods and the ground surface of the store. The storage in boxes however requires optimal air guidance. It has to be assured that all boxes are equally supplied with air.

Arrangement of storage boxes

Of course, type and size of the box are important. For determining the arrangement of the stacked boxes, the dimensions of the boxes have to be defined already during the planning phase. When considering the store's dimensions, the stacking has to be designed in such a way that the air guidance conserves the product quality and that optimal storage capacity utilization can be achieved.



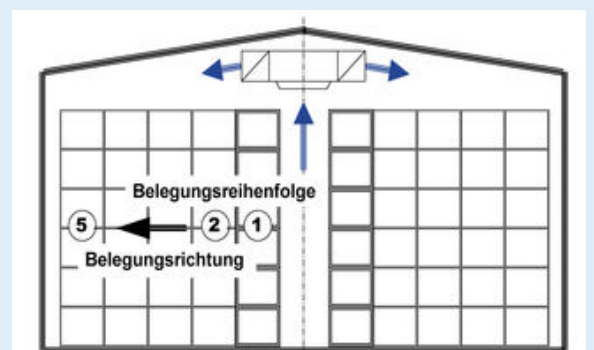
Front view of store with arrangement of stacked boxes; Clearance of store: $H = 8200$ mm; Stacking height: $H_1 = 7500$ mm; Number of boxes in height: 6

When calculating the air flow between and through the boxes, the distance between the boxes in air direction and crosswise to air direction has to be determined. Basis for the calculation is the required ventilation rate (air volume flow/store volume in empty store).



Arrangement of boxes in carrot store Green-grow, DGN aircoolers mounted in the middle

For achieving a good air distribution around the boxes, during warehousing and also for partial load of the store, it is important to stack the boxes successively:



Sequence of arrangement of boxes with successive stacking

For stacking it is important to precisely observe the defined distances between the boxes. Only in doing so, an equal quality of the stored goods can be achieved.



Technical data of the store

The storage hall is divided into five individual stores..

Store dimensions:	35 m x 19 m x 8.5 m
Insulation:	120 mm polyurethane panels
Area:	approx. 664 m ²
Capacity:	approx. 5,640 m ³
Storage capacity per store:	approx. 1,470 t
Number of boxes per store:	2,100
Storage capacity of the hall:	approx. 7,350 t
Products stored:	mostly carrots, but also other vegetables

Technical data of the refrigerating plant

Two glycol chillers, produced by PPH Cool, with 2 RefComp, semi-hermetic screw compressors. Removed heat is dissipated with air cooled condensers with axial fans, Güntner GVH series Compressors and condenser fans are continuously adjustable to be able to adapt to the different requirements.

Refrigerating capacity	950 kW
Refrigerant in primary circuit	R404A
Coolant in secondary circuit	Propylene glycol 30 Vol. %
Glycol temperature in/out	-3/-7 °C
Aircoolers in stores	5 x 6 pieces DGN, dual discharge
Aircoolers in sorting area	4 pieces GGHN
Aircoolers in packaging room	2 pieces GGHN
Aircoolers in ready products room	2 pieces DGN, dual discharge

Defrosting of the air coolers is done with warm brine which is heated with dissipation heat from the refrigerating plant.

Cooling load warehousing phase	approx. 250 kW/store
Cooling load storage phase	≤ 120 kW/store

Good solution

During the planning phase, different alternatives for the selection of the air coolers were reviewed (evaporators with direct evaporation, air coolers for coolants, design for wall mounting or dual discharge design). After visiting a reference project, the Polish Company Green-grow decided to implement Güntner DGN dual discharge air coolers.

There are 6 DGN air coolers with forced draught per store. The temperature difference $DT1 \leq 5 \text{ K}$ and therefore guarantees a humidity of at least 95 % during storage phase. The air coolers are mounted in the middle of the ceiling. Advantage of this position: Even air distribution to both sides with low air velocities and low pressure losses in the stacks.

A sorting area and the packaging room were equipped with four and two air coolers respectively, series GGHN. The new storage hall is in operation since autumn 2010. Since then, the refrigerating system has proved to be more than up to the job.