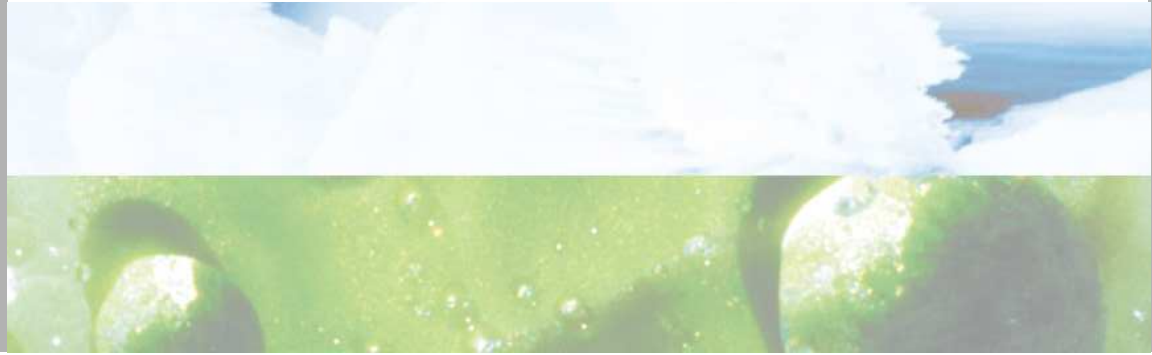


euramm<sup>o</sup>n

refrigerants delivered by mother nature





**Natural refrigerants –  
Growing strong, acting smart,  
moving forward**

Schaffhausen, June 22nd, 2012



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## Success with NH<sub>3</sub>/CO<sub>2</sub> cascade

by

Janos Winter, Consultant, Dipl. Ing., Qplan Ltd Hungary

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## The theme: The first NH<sub>3</sub>/CO<sub>2</sub> Cascade, Auchan Miskolc



## Success with NH<sub>3</sub>/CO<sub>2</sub> cascade

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- **The themes of the lecture:**

- A short history of the design and the realization of Qplan's CO<sub>2</sub> cascade plants
- Discussion about the energetically comparison of supermarkets
- Evaluating of the NH<sub>3</sub>/CO<sub>2</sub> cascades.

## A short history of Qplan's CO2 cascade plants

- Founding of the engineering company Qplan Ltd. for designing of industrial refrigeration plants. The main target was the food processing industry, based on the Hungarian agricultural products.
- After changing of the political system, Hungary was invaded by international actors of the food processing, who has dragged their own companies for refrigeration tasks and the Hungarian market collapsed. New areas for activities needed.
- At the same time began the reconstruction of the outdated Hungarian shopping chain by building of big supermarkets with participation of the major supermarket chains. But unfortunately the refrigeration jobs still were made by their familiar companies.
- Marketing analysis showed that the only way to resurrection was to restore our firm by
  - recording production and installation of our activities,
  - focus to natural refrigerants,
  - concentrating on supermarket area.
- We did it!

## How to get in the market with natural refrigerants

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- **The Strategy:**

The far target was to minimize environmental impacts and to achieve better economy than in the HFC plant.

- **The way**

- Better solution than the existing ones.  
Stepwise increasing the complexity.
- Further development of systems by continuously monitoring and evaluating the operation.
- Evaluating of the system.

## Better solution than the existing ones

- Most of the competitors were coming from the commercial refrigeration, who are mostly using standard solutions, not seeking for improvement of the thermodynamic circuit.

With our experience from industrial refrigeration, we were convinced on that any kind of flooded evaporation was more efficient than DX ones because of

- the possibility of lower temperature difference,  $\Delta T$ ,
  - less complexity due to the lack of expansion valves,
  - more safety from the same reason.
- High pressure level of CO<sub>2</sub> refrigerant belongs qualities and technologies closer to NH<sub>3</sub> than HFC's system, where we were at home.
  - It was clear that future supermarkets need remote monitoring systems, with just in time services. At former projects, we applied such solutions and we were familiar with them.
  - Out from the natural refrigerants seemed CO<sub>2</sub> being the most general applicable one.



## Stepwise increasing the complexity

- CO2 was also new for us. We have sought information everywhere and found mostly in Denmark and Holland. Cooperation by Co. Th. Witt and Trantner has given good initial help. Commencing with a R404A/CO2 cascade helped for gathering experience about the behavior of both cascades and CO2. This plant had already our basic system architecture, but was studded with some safety, maintaining and monitoring equipment, which later proved to be unnecessary.
- The very first system formed the base for further development in two directions:
  - NH/CO2 cascades,
  - pure CO2 system both cascades and boosters

## NH/CO2 cascades

- **Description of the plant**

- The HT plant is actually an NH<sub>3</sub> indirect cooling system where CO<sub>2</sub> serves as a two phase coolant. The NH<sub>3</sub>/CO<sub>2</sub> heat exchanger is gravity feed from NH<sub>3</sub> side, while the CO<sub>2</sub> is circulated by pumps

The real cascade is the LT system, where the condenser is cooled by the HT ammonia. The LT cycle is formed as DX, because of that's low capacity did not justify application of a flooded system.

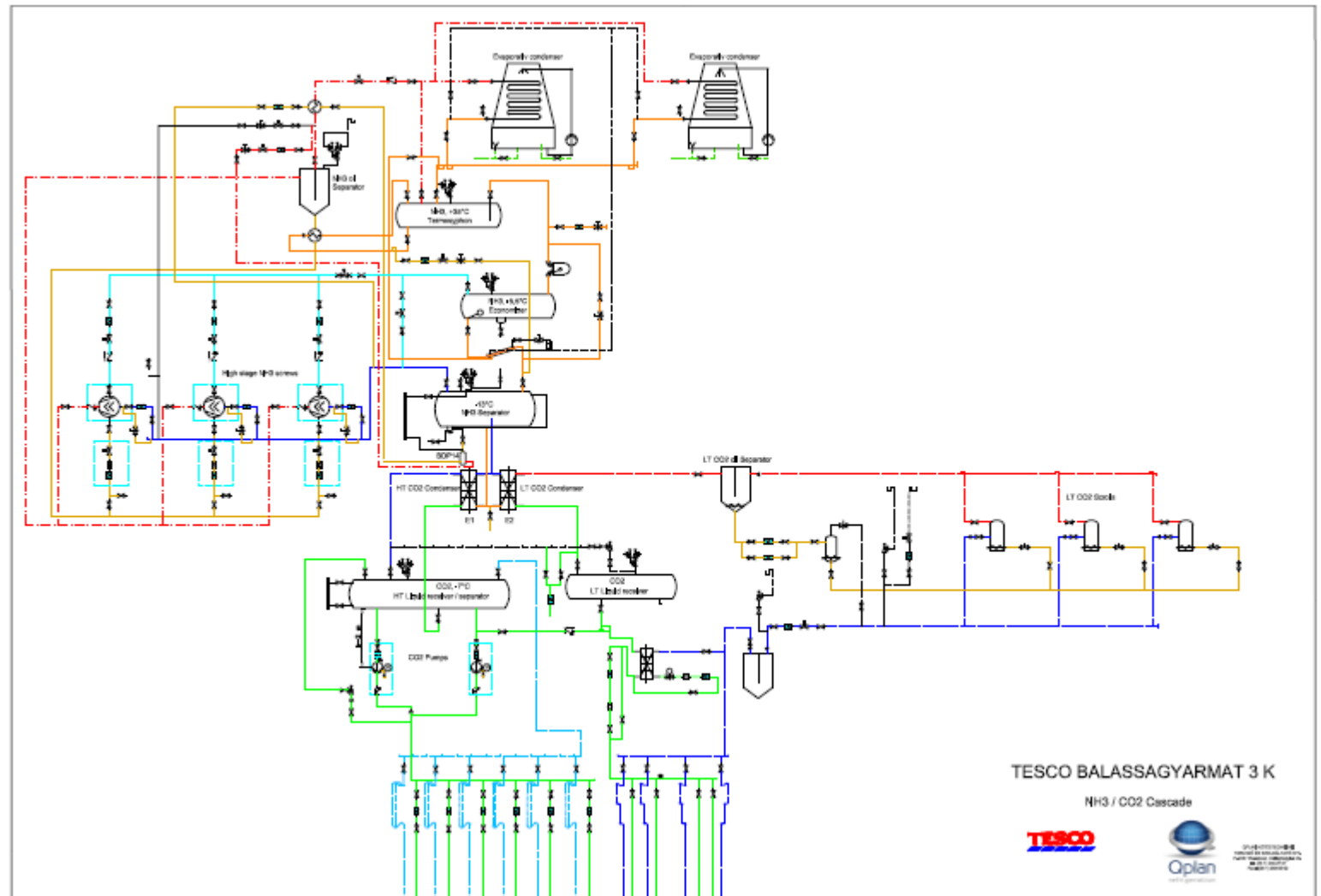
- The most important thing at NH<sub>3</sub> system in a supermarket is the automatic operation to such a degree that it does not require regular, manual monitoring. That's main issue is to ensure the proper oil return and the sufficient automation, inclusive capacity control of compressors and safety monitoring.

Using our experience from industrial cooling, we have solved these problems without any troubles.

The plant was built in three levels:

- on the upper level are the evaporative condensers situated,
- on the middle level are the equipment placed for the NH<sub>3</sub> system,
- on the lower level are the CO<sub>2</sub> equipment and the switch-boards.

# NH3/CO2 cascades: Circuit diagram



## NH3/CO2 cascades: Further improvements

- The continuous monitoring and evaluating of the operation made it possible to make improvement in the subsequent systems such as:
  - Applying open type economizer at NH3 stage (HT), as applied on the diagram
  - Bypassing pumps in HT secondary refrigerant,
  - To simplify oil return system,
  - Omitting not necessary parts, like valves, sensors etc.
  - Improvement of control strategy

## NH3/CO2 cascades: more business

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- The first order by Auchan was immediately followed by the second one from Tesco Hungary and this second one was put first into the operation in September 2008.  
In total there are four such cascade in operation and we are going with the fifth one.
- The success did not lead to growth in order backlog in the domestic market, rather on abroad in Eastern Europe.  
Per time the refrigeration market in Hungary shrunk to minimum.

## About the strategy of evaluation

- It is hardly to find such a controversial topic as documentation of energy consumption.
- In particular in case of comparison of two items in the supermarket business.
- There are two coherent statement that one must be extremely careful:
  - „identical supermarkets” and
  - the magnitude of the energy savings.
- In the reality, there do not exist identical supermarkets in the point of view of the refrigeration load. The most significant parameter which have influences to that, are the business related facts like
  - turnover of goods,
  - setting of indoors temperature on the air conditioner ,
  - discipline at the filling of the cabinets,
  - inlet temperature of the incoming goods,
  - the social environment, etc.and the refrigeration system related facts, like
  - setting of the control,
  - defrost strategy,
  - existing of U –traps at display cases and refrigerated rooms, etc

## About the strategy of evaluation

- Considered the above named uncertainty in the comparable parameter I dare to say that savings of 5 -10% do not provide qualitative statements. Even higher values should be taken with some skepticism. By the evaluating of our NH<sub>3</sub>/CO<sub>2</sub> cascade, we compared it the energy consumption for refrigeration with data yielded form a supermarket of same size with an R404A plant. The observation during one month gave a tremendous energy saving of 42%. However a closer control has shown that a staff of new personals were not informed to maintain night covers on display cases. A new corrected measurement gave 23 saving. A compensation by calculation of evaporative versus air-cooled condensers reduced it to 17%.



## Evaluation

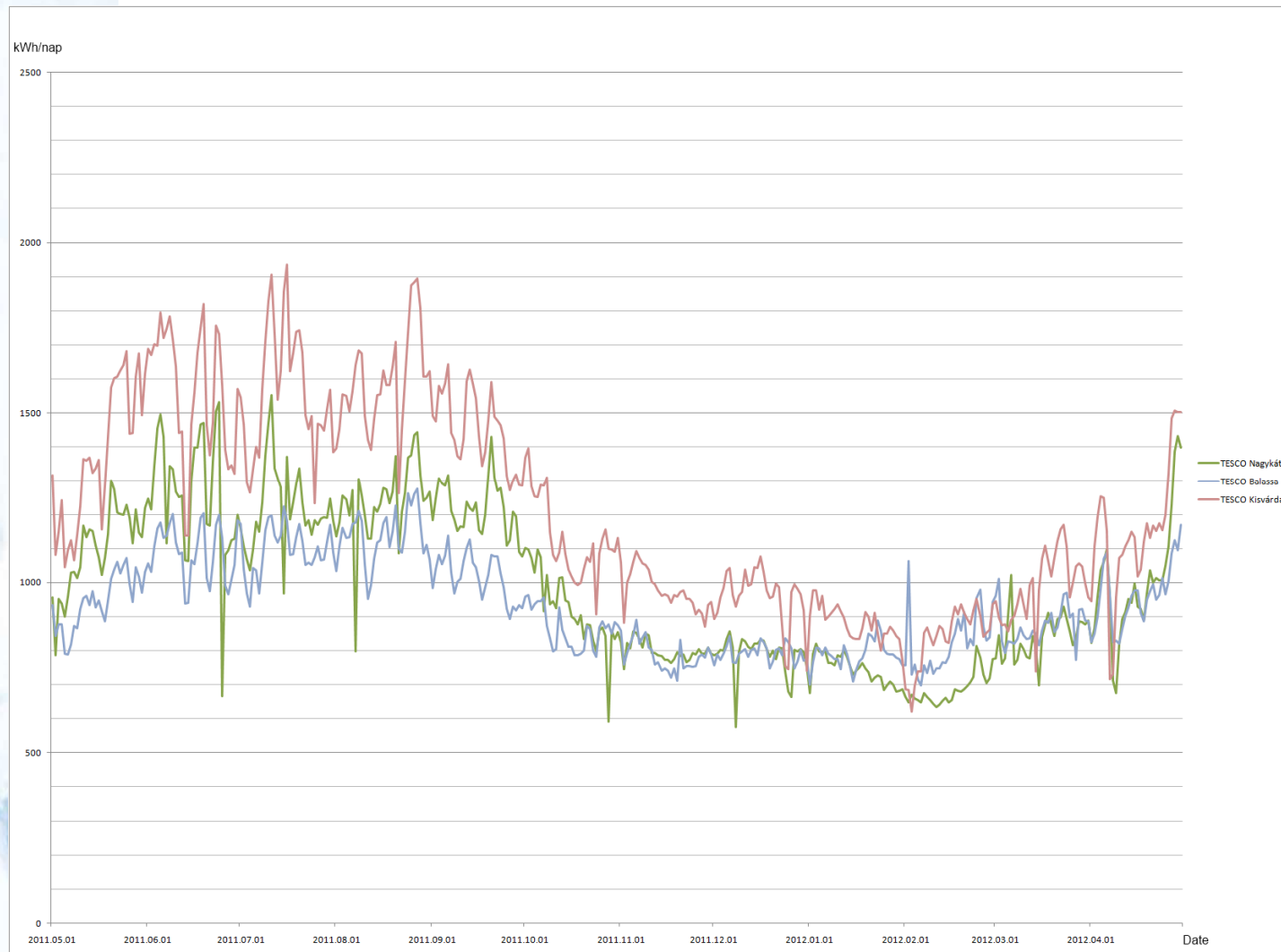
- Considering the above named ambiguity the following comparison includes Tesco supermarkets where the similarities are quite close as a consequence of that Tesco had introduced a strict standard for the refrigeration facilities.
- All supermarket we have a contract for servicing are supplied with the same remote monitoring systems with data logging, with continuously gathering data of energy consumption.

The table and diagram shows the energy consumption for a 12 months period of three supermarket at Tesco. All of them belongs to the standardized, so called 3k size, means 3000 m<sup>2</sup> sales areal.

- Color codes
- Red  
Locality: Kisvárdá  
Plant with R404A refrigerant, air cooled
- Green  
Locality: Nagykáta,  
Plant: CO2 booster
- Blue  
Locality: Balassagyarmat  
Plant: NH3/CO2 cascade



# Evaluation



## Evaluation

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Red  
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- Table of comparison

Shop	Type of plant	Consumption in 12 month	Proportions
Tesco 3k Kisvárda	R404A	441731kWh	100%
Tesco 3k Nagykáta	CO2 Booster	360978 kWh	82%
Tesco 3k Balassagyarmat	NH3/CO2 cascade	340847 kWh	77%

## Evaluation

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- Both the cascade and the booster systems incorporate heat recovery equipment but it is difficult to take into the make up of the energy balance therefore we omitted it.
- The saving in relation to the R404A system belongs mainly
  - to the use of the evaporative condenser instead of air-cooled one,
  - to the improved thermodynamic properties of NH<sub>3</sub> and
  - to the higher evaporating temperature as a result of the flooded evaporation.
- Because of that uncertainty we will not book us to the values shown, but we want to refer to the positive energy saving trend, as the use of natural refrigerants offers.

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**THANKS YOU FOR YOUR  
ATTENTION**