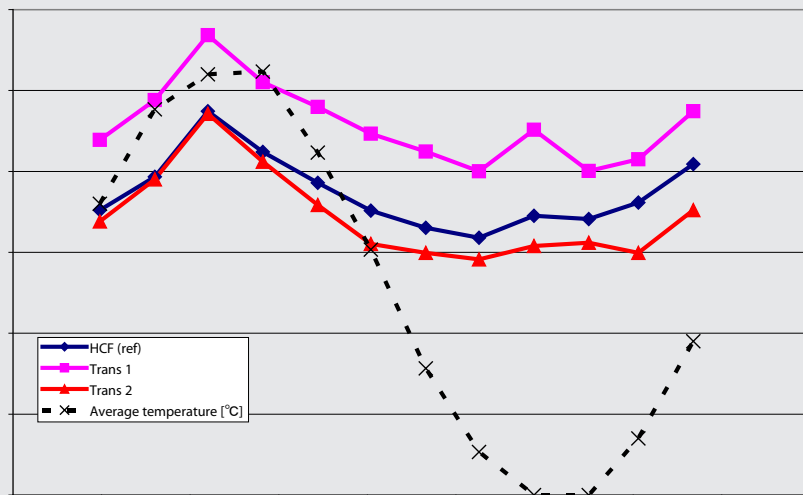


Save Energy in your Supermarket with a CO₂ Refrigeration system

Benchmarking energy optimised HFC stores with transcritical CO₂ booster systems



The Danish Supermarket Chain, Fakta – owned by Coop Denmark has experienced significant energy savings with their second generation transcritical booster system.

Fakta saves 10% energy by applying a CO₂ system compared to HFC systems.

Fakta

Fakta has continuously worked on lowering their energy consumption for the past 15 years, first on their HFC scroll packs and later on transcritical packs. As a result of this Fakta are now installing their second generation transcritical packs where part load has been optimized. Fakta and the remote monitoring centre AK Centralen has been collecting data from the systems for more than 15 years, where they started optimizing the HFC pack with low energy consumption and temperature quality as main targets.

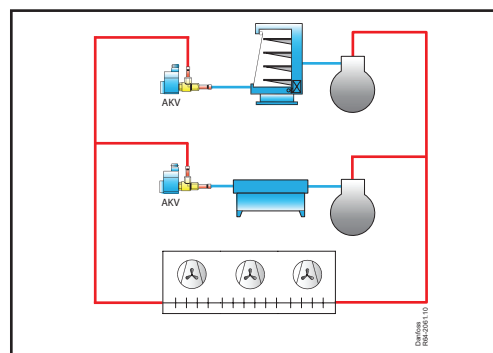
The Fakta chain has 378 stores in operation where 61 of them are transcritical. Fakta was one of the first movers to change to CO₂ and the first generation of transcritical systems were installed in 2007. The aim for 2011 is to install more than 40 systems which are relatively small with 9 kW on LT and 28 kW on MT.

Today all systems are produced in batches of 5 packs as they are standardised with the same configuration regarding capacity. The installation can be different but cabinets, pack and gascooler, are always the same arrangement. This makes Fakta a very good reference for energy studies.

System design:

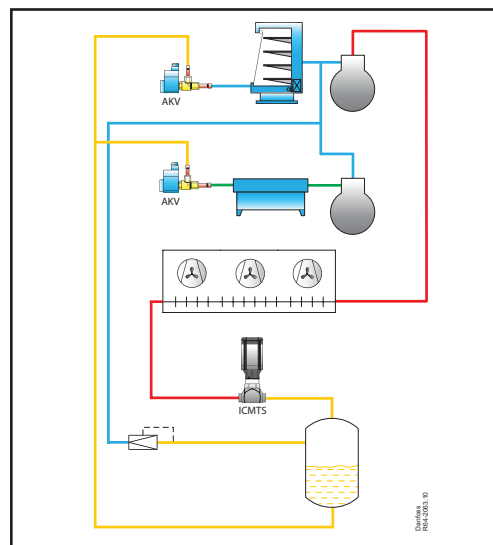
HFC system

- Parallel R404a system with very good load adaptation
- Controlled by ADAP-KOOL® pack controller and AKC 114A case controllers with electronic expansion valve type AKV
- 148 systems in operation
- 10 selected for the study.



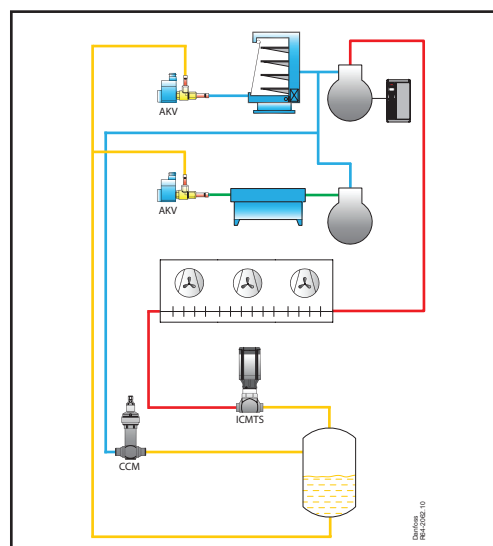
Transcritical 1st generation system

- Booster system with gas by pass.
- 2 compressors for MT (33/67%) and 2 for LT (33/67%)
- Mechanical gas by pass valve
- Controlled by ADAP-KOOL® pack controller, EKC 326 controlling ICMTS high pressure valve, and AK-CC 750 case controllers with electronic expansion valve type AKV
- 32 systems in operation
- First10 selected for the study.



Transcritical 2nd generation system

- Booster system with gas by pass
- 2 compressors, one with AKD inverter for MT and 2 compressors without inverter for LT
- Controlled by ADAP-KOOL® pack controller, EKC 326A controlling ICMTS high pressure valve and CCM stepper gas by pass valve, and AK-CC 750 case controllers with electronic expansion valve type AKV
- 10 systems in operation May 2010 and 29 in December 2010
- First 10 selected for the study.



- HP High Pressure
- HP Receiver Pressure
- LP Suction Pressure MT
- LP Suction Pressure LT

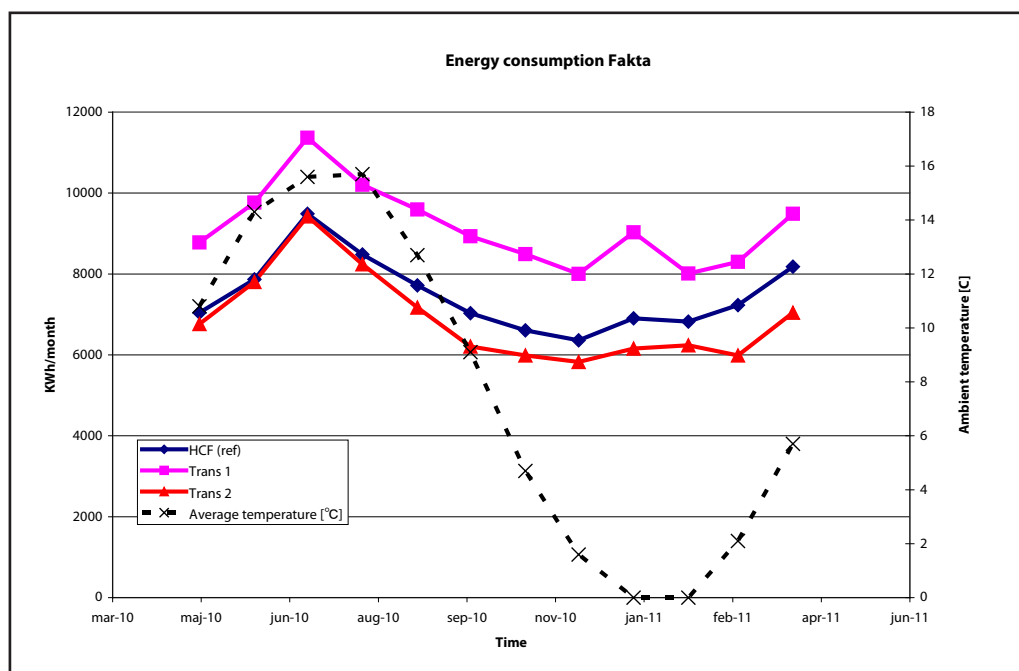
Selection criteria for energy study

For the installation to be included in the data material the following criteria had to be fulfilled:

- More than 4 months of operation since commissioning
- Equivalent size and opening hours

10 installations have been selected from each system. The stores are identical on most parameters, but the installation will of course be different regarding length of pipes and number of bends. The maximum pressure drop in the pipe work is still the same for all systems regardless of refrigerant and installation.

Results



The energy data in this study is collected from May 2010 to April 2011. The plot shows energy consumption per month for the 3 different systems (HFC, Trans 1 and Trans 2) and the average ambient temperature for the month.

Application Engineer Kenneth B. Madsen from Danfoss explains "Our measurements indicates approximately 10% energy savings in Denmark when comparing the 2nd generation transcritical CO₂ system with the HFC system - with the lowest energy consumption in the cold months" and further "The results also show a technology improvement since 2007 where the first generation transcritical system was installed.

Conclusion

The results show that the 2nd generation transcritical systems in Fakta consume approximately 10% less energy than the HFC packs installed until 2007. Energy simulations indicate that the energy consumption in Denmark should be approx 10% lower than HFC systems which are very much in line with the test results.

The difference in energy consumption between the 1st and 2nd generation CO₂ transcritical systems can be explained by improved part load capabilities and smooth control of gas bypass as well as availability of components in smaller sizes to be able to better match the capacity also for smaller systems. And a new CO₂ injection algorithm in AK-CC 750.

