



DATE: 04-03-2013

Subject: description of HFC DX-CO2 FX cascade unit

Commercial refrigeration system of supermarket for medium and low temperature range with refrigerant charge below 3kg: Tesco Hu took choice on solution which is not concerned by the F-gas rule thanks the small charge of HFC refrigerant. The solution ensures potential implementation on environmental friendly way even under tight and strict building criteria. The lower stage refrigerant is CO2. CO2 do not act as a brine with temperature drop but deliver latent heat thanks to the high enthalpy differences between phase changes.

We persist in flooded solution with its best efficiency while reducing refrigerant charge significantly. The one of the details of really smart gravity solution is, there is no need for any circulating pump.

What is more, a blackout of electricity doesn't risk the refrigerant charge. A big step forward in our development that refrigerant loss due to electrical blackout frequently referred as backward to CO2 systems become practically impossible by rising the design pressure as high as the low pressure side also withstand equivalent temperature of +30°C.

While the development does the operation doesn't require any special skill. The spread over can be assisted by the low implementation and operational costs which really do not exceed recent multi-compressor systems with HFC refrigerant.

On customer demand, so far site condition permit, the 3kg HFC refrigerant charge may be substituted even with the natural hydrocarbon (HC) refrigerants or though synthetic, but with low GWP index hydro-fluor olefin (HFO) refrigerant in near future.

These two potential refrigerants eliminate the limitation of high stage refrigerant charge thus more integrated solution can be developed like total heat recovery, heat pump mode, AC chiller applications.

For larger store with higher capacity needs we recommend to execute 2 MT HFC and cascade units in parallel connection to CO2 circuit. The fine capacity regulation is achieved by so called "sequence control" of the two MT units.



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Typical system parameters at store Express "C":

MT case loads: 9kW

LT case loads: 1,66kW

Typical system parameters at store Express "A":

MT case loads: 18kW

LT case loads: 4kW

Refrigerated cases: in full compliance with Tesco standard 2011-12 and delivered by the nominated suppliers

Upper stage refrigerant: HFC R404 or R407A or R410A

Upper stage compressor technology: scroll (digital)

Upper stage condenser technology: microchannel

Cascade side refrigerant: CO₂ (R744)

Design pressure (cascade side): 75bar or 60bar

Design pressure (LT suction): 60bar or 30bar

LT compressor technology: reciprocating, with frequency driver

Enclosure!

Benefits:

- *system out of F-gas rule*
- *continuous improvement - new development on refrigerants can be incorporated (lower GWP, higher COP new refrigerants)*
- *flexible adaptation to available space*
- *no need for engineroom or any ground area – increased retail area*
- *very well balanced operation no fluctuation on high stage side compressor capacity can be observed (even loads and no swinging of suction pressure)*
- *system contain Tesco approved components only (HFC compr.: Copeland digital scroll; controllers, valves: Danfoss)*
- *continuity in environmental-friendly progress*
- *available in retrofit and conversion of existing HFC systems*

Concerns:

- *sophisticated or over-engineered solution (NO; the great work is it in simplicity. Over the intellectual properties and sharing the special know-how in cascade side refrigerant distribution the system can be reproduced effectively.)*
- *flooded solution requires large vessels and space (NO; thanks to the special know-how in cascade side refrigerant distribution system; components hold up extreme small place)*

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- *CO2 solutions are not reliable (NO; the system reflect high level of resilience thanks to PS 75bar exceeding surrounding temperature as +30°C and contain less moving element than the standard HFC solution)*
- *CO2 solutions are less efficient at high ambient (NO; the solution is as efficient as the upper stage refrigerant selected)*
- *gravity flooding restrict adaptation to building design (NO; the required liquid head is not larger than the height of the case itself, only the free draining must be maintained between cascade HEX and positions)*
- *later refit or extension is difficult: (NO; the existing system can be extended by additional units and the basic system configuration deliver sufficient reserve in capacity – ca. up to 35kW)*
- *high implementation and installation costs: (NO; cost at the same rate of standard HFC systems, pipework from standard blacksteel)*
- *high maintenance costs: (NO; service do not require any special skill, system contain less components than standard HFC solution)*
- *cascade solution impose lower equivalent suction pressure (NO: either pressure losses on cascade side tends to zero, additionally you can gain on flooded expansion (see enclosed “flooded vs. dry”) and the losses on cascade heat exchangers with the “nearly zero super-heat expansion” design are comparable or even better to pressure losses over liquid line, suction line and manifold and discharge line of extensive HFC multicompressor system)*

The significant benchmark to other environment friendly refrigeration solution are the competitive price, the lower energy consumption with no matter what outside condition concerned and the fact it can be adopted to current and severe installation condition quite easily.

Larger unit with extreme small amount of ammonia refrigerant (some 10kg!) and light construction for 100kW capacity is also under development. It could play potential role also in your business since the todays' roof mounted packs at your hypers should be imperatively scheduled for replacement - to some long term but cost effective solution would be desired. Wherever the condition of the current R404A packs allow the cascade unit can also be fitted in the roof unit while retrofitting the cases for CO2 and conversion of packs to refrigerant with lower GWP.

Pls., note, however, the great work is it in simplicity but servant imitation of design image can lead to serious malfunction in operation.

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