Vapor Quality Control

Energy and environmentally friendly cooling solution

PRODUCED BY

Photo credit: Scantec Refrigeration

LOW CHARGE AMMONIA SYSTEMS

WITH REDUCED REGULATORY BURDENS

One of the most significant benefits of using Vapor Quality is to measure and detect liquid in the evaporator output, in addtion to the sensor's ability to replace superheat control in DX systems. Less ammonia is required to achieve the same level of performance, resulting in a safer, more efficient and sustainable operation. Another key benefit of the Vapor Quality sensor technology is the reduced energy consumption. This results in lower operating costs and reduced carbon emissions, making Vapor Quality an environmentally friendly and cost-effective solution.

Charge is reduced by at least 75 %

In some countries, the regulatory burden is a challenge if the charge is above a certain level.

- USA 5 tons
- Germany 3 tons
- France 150 kg

The DX ammonia systems typically have less than a quarter of the charge used in pump-circulated ammonia systems. This inventory reduction applies to systems using hot gas for defrosting.

REDUCED GLOBAL WARMING IMPACT

Given the impact that some refrigerants have on global warming, is it essential to consider the environmental impact when selecting a refrigerant. By choosing a more environmentally friendly refrigerant, we can significantly reduce our impact on the environment.

- Ammonia is a natural refrigerant without global warming impact.
- Ammonia is a natural refrigerant with high energy efficiency.
- Systems based on synthetic refrigerant (HFC) have a considerable impact.

CASE STORIES ON LOW CHARGE

- Colmac Coil has several case stories showing a reduction from 3.9 to 0.9 kg/kW (30 to 7 lbs/TR).
- A 64,000 m3 (2,260,00 ft3) cold store project developed by Scantec Refrigeration has a charge of only 385 kg.
- If a chiller design is used, the charge can be reduced below 0.1 kg/kW. This is demonstrated on the Ecodesign chiller we have in-house and which is described on our webpage.

ENERGY EFFICIENCY

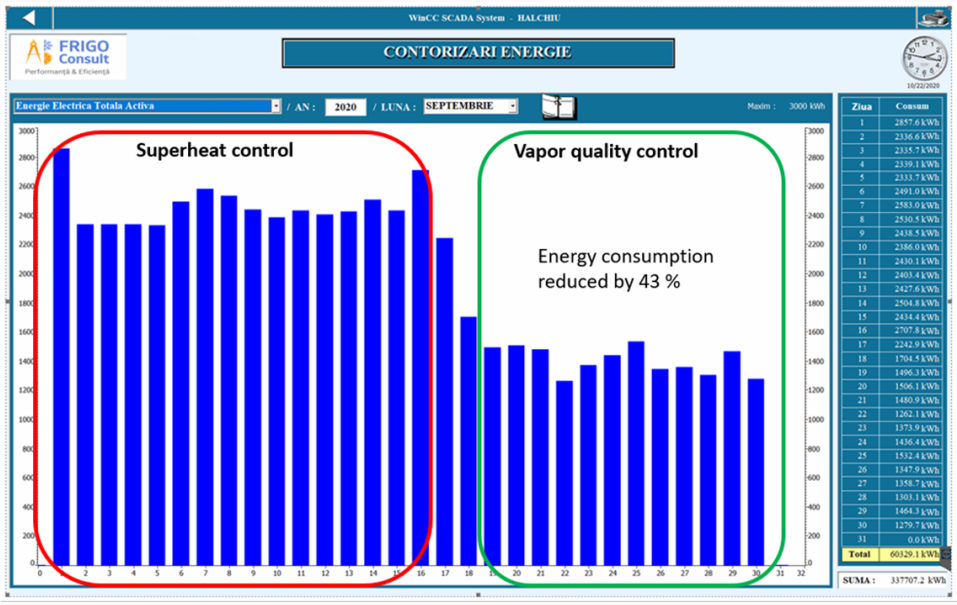
When using Vapor Quality in a DX system, is it possible to achieve a high level of cooling power, energy efficiency and reduction of operation costs, which will help the development of more sustainable and efficient refrigeration systems, paving the way for a greener future.

- 40 % reduced energy consumption can be achieved by replacing super heat control with Vapor Quality control
- 46 % improvement of SEPR* for an ammonia DX chiller when operating with Vapor Quality control
- 70 % reduced energy consumption for cold store replacing a DX system using synthetic refrigerant into DX ammonia with Vapor Quality control
- 10 to 25 % energy reduction when replacing a pump circulated ammonia system with DX ammonia with Vapor Quality control

*Seasonal Energy Performance Ratio

HB Products

40 % REDUCED ENERGY CONSUMPTION – THE HALCIU PLANT



- The bar graph shows the daily energy consumption of the Halchiu plant in Romania.
- Vapor Quality control, replaced superheat control in September 2020.
- The total energy consumption for the refrigeration system was reduced by 43%.

COP IMPROVEMENT ON DX CHILLER

46% improvement in SEPR was obtained by replacing the conventional control operating with superheat with a control based on vapor quality control. The system is a 100-kW chiller operating with R717 using direct expansion. The test was made on Hochschule Karlsruhe as a bachelor and master project.

Most chillers and heat pumps constructed as direct expansion plants use conventional control based on the temperature and pressure of the gas leaving the evaporator. An alternative to the conventional approach is to use a vapor quality sensor, which can measure the content of the liquid in the gas leaving the evaporator. When controlling the expansion valve based on the vapor quality, superheat can be eliminated and the heat transfer improved, which improves the COP.

For unique plants, it is difficult to compare the different control methods, but at Hochschule Karlsruhe, they have built and tested a chiller with the two different control systems. The chiller can be operated with both control systems and it is easy to switch between the two systems and measure the difference.

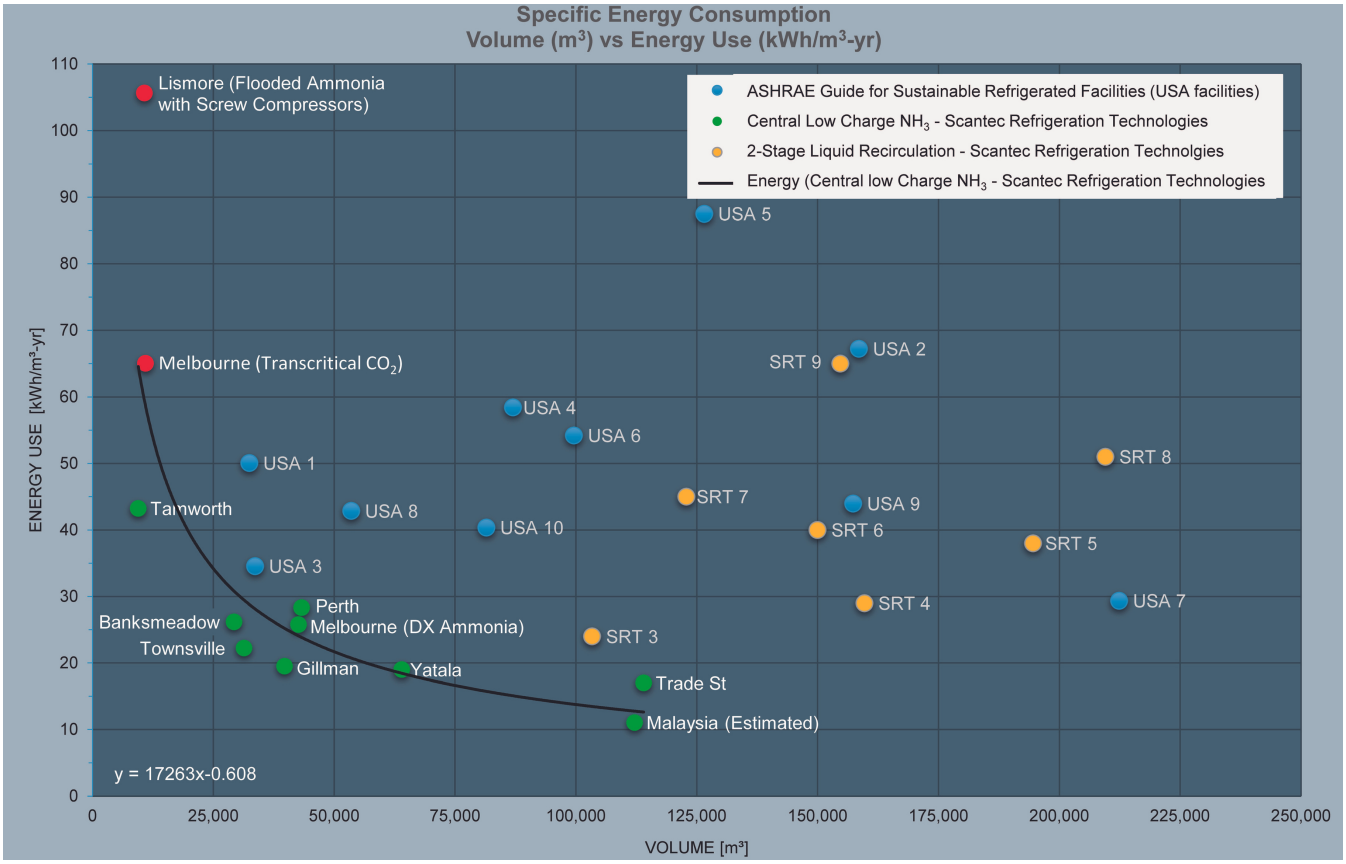
Fulfils the latest EU Ecodesign guidelines

•21% COP improvement at full load
•51% COP improvement at part load
• 46 % reduction of the Seasonal Energy Performance Ratio

The DX chiller:
•100 kW ammonia chiller 7/12°C
•4 kg ammonia charge
•Tested at Hochschule Karlsruhe, Germany
•Designed by Fischer Kälte, Germany

REDUCED ENERGY CONSUMPTION FOR COLD STORES

- The specific energy consumption (SEC) for refrigerated warehouses is usually recorded as annual energy consumption [kWh/a] divided by refrigerated volume of the warehouse [m3].
- On the graph annual energy consumption per cubic meter is plotted versus the volume.
- The green dots are DX ammonia systems using Vapor Quality Control.
- The yellow and blue dots are typical pump circulated systems using ammonia.
- Typically the energy consumption of the pump circulated systems are 1.4 to 8 times larger than the DX ammonia system



- 70% energy reduction compared to HFC DX systems delivered by Scantec Refrigeration
- Specific energy consumption (SEC) values below 20 kWh/m3/year
- Documented by several projects done by Scantec Refrigeration Technologies

ECONOMIC & ENVIRONMENTAL BENEFITS

- Reduced energy consumption has an economic benefit. The typical simple payback period is 3-6 years when replacing an industry standard HFC based system. The payback period depends on unit electricity cost

- Less required maintanace cost due to a less complex system. The vessels are smaller, no pumps are required for circulation, liquid management issues are eliminated..

The environmental benefits is split in two:

- Reduced CO2 emission coming from the lower energy consumption.

- Global warming is impacted by the refrigerant if lost. Ammonia has no global warming impact if the charge is lost. For HFC plants the impact is considerable

Data for 20,000 m3 cold store	HFC refrigerant flooded single stage	DX ammonia with Vapor Quality Control
SEC*	80	20
Annual energy consumption	1600 MWh	400 MWh
Annual CO2 emission EU average	457 tons	114 tons
Electricity cost based on EU average	192,000 €	48,000 €
CO2 impact for the charge**	4782 tons	0

* SEC is Specific Energy Consumption defined as the annual energy consumption measured in kWh per cubic meter cold store per year ** calculated based on a charge of 1200 kg R404a with a GWP of 3985

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Reference list..... LEARN MORE