Transcritical CO_2 solution in tropcial climates

The first installation of a transcritical CO_2 system in a new 7,000 m²/75,347 ft² supermarket in Mexico demonstrates that year-round tropical to subtropical climates are not a criterion for exclusion regarding supermarket refrigeration. With an adiabatic gas cooler, Güntner supplied the key technology making the use of CO_2 as refrigerant economical in hot climate zones.

The climate at the site of a new Mexican supermarket in Culiacán in the state of Sinaloa is not only tropically warm to hot all year round but is also characterised by high humidity. The average summer temperature is 36 °C/96.8 °F, and temperatures may even reach 44 °C/111.2 °F during this season. With maximum temperatures of more than 20 °C/68 °F, it can be quite warm also in the winter months. This means a refrigerating plant with the natural refrigerant CO_2 would have to operate above the critical point of CO_2 (31.1 °C/88 °F) very often. However, this operating point is not efficient and thus very uneconomical: CO_2 is in a supercritical state from a physical point of view, i.e. a mixture of gas and liquid that may well cool down in the gas cooler but does not condensate.

Thanks to the consulting provided by an experienced refrigerating plant designer who had already successfully installed and put into operation a transcritical CO_2 system in the south of the US, the Mexican operators of the supermarket chain decided to opt for the environment-friendly refrigerant CO_2 in their new supermarket in the framework of a one-year test operation. They rely on well-proven plant engineering here with a Güntner V-SHAPE Vario GFW as adiabatic gas cooler.

Overview

Business line:	Commercial Refrigeration
Application:	Supermarket Cooling
Country/Region:	Mexico, Culiacán (Sinaloa)
Fluid:	CO_2
Product:	Güntner gas cooler V-SHAPE Vario GFW

Güntner GmbH & Co. KG
Hans-Güntner-Straße 2 – 6
82256 FÜRSTENFELDBRUCK
GERMANY
www.guentner.eu

▲ The Güntner gas cooler V-SHAPE Vario GFW is equipped with the Güntner Motor Management GMM for the speed control of the EC fans and with the Güntner Hydro Management GHM that controls the water supply.

Life cycle costs and maintenance as a basis for decision

The costs and the installation of the transcritical CO_2 unit and the adiabatic Güntner V-SHAPE Vario GFW are about 30 per cent above the investment costs estimated for a direct evaporative DX system with parallel compression and ejector. Yet the operators focused on the anticipated life cycle costs (i.e. the sum of investment costs and operating costs for water and electrical power for the entire life cycle of the technology) of the refrigerating plant in their considerations and expect to achieve significant savings in terms of operating costs.

After all, a transcritical CO_2 system for the Mexican supermarket requires only two compressors with a total capacity of 5.27 kW/7 HP whereas an HFC system with the same refrigerating capacity would need three compressors with a power of 26.85 kW/36 HP in total. Following this approach, the return on investment (ROI) of the transcritical system is acceptable for the operators.

Adiabatic operation

The Güntner adiabatic gas cooler V-SHAPE Vario GFW is capable of condensing CO_2 below the ambient temperature. This increases the proportion of subcritical operating hours dramatically, and the proportion of the unfavourable transcritical operating hours is significantly reduced despite high external temperatures. The gas cooler‘s refrigerating capacity is 271 kW/925 MBTU/h.

In adiabatic operation, the difference between the dry and wet bulb temperature is about 5.6 K/22 °F so that economic operating conditions are achieved. According to present estimates (before the end of the test year), the energy consumption of the refrigerating plant with the integrated adiabatic gas cooler is about five to ten per cent below the energy consumption of a conventional DX system.

The Güntner gas cooler V-SHAPE Vario GFW is equipped with the Güntner Motor Management GMM for the speed control of the EC fans and with the Güntner Hydro Management GHM that controls the water supply. The GHM sets the optimal operating point by comparing the (current) operating costs for electricity (EC fan) with the operating costs for water.

Adiabatic humidification for increased dry cooler capacity

If air is cooled down in front of a heat exchanger without heat supply or dissipation of heat, we call this adiabatic cooling. With regard to air-cooled gas coolers, condensers and dry coolers, adiabatic air pre-cooling systems may be used with water-wetted pads attached in front of the coil. The ambient air flows along the pads, water condenses and extracts energy from the ambient air, thereby cooling it down.

The air with the lower temperature level is then passed along the heat exchanger and cools the fluid or refrigerant. Up to 80 % of the maximum possible cooling to the wet bulb temperature are achieved by adiabatic air cooling. The capacity increase of a dry cooler achieved in this way results from the increased driving temperature difference between air inlet temperature and fluid temperature (condensation, gas or glycol outlet temperature).

All in all, the refrigerating plant as a whole operates more efficiently when applying adiabatic air pre-cooling.

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GERMANY
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