Tuna frozen by Güntner heat exchangers in CO_2-NH_3 cascade

A new cold storage facility in General Santos, the Philippines, deep-freezes and stores tuna with a modern CO_2-NH_3 cascade refrigeration system. Güntner not only equipped the logistics rooms with CUBIC Vario CO_2 direct evaporators but also supplied ECOSS evaporative condensers for the dissipation of the excess heat from the NH_3 refrigeration cycle.

Skipjack tuna, yellowfin tuna, bigeye tuna – big saltwater fish are stored in the new cold rooms. Products arrive at the facility either as whole fish in fish bins or as vacuum-packed tuna loins ready for canning at automated canning facilities located in export markets.

The facility equipped with a refrigeration system engineered and installed by plant contractor Omnico Engineering currently has six small and three large cold rooms, each 8 m in height. The total logisitcs area is 84 x 66 meters and is divided into freezing rooms of 6 x 324 m² (each accommodating 500 metric tons) and 3 x 648 m² (1,000 metric tons each). The temperature of all LT rooms is constantly at -25 °C. The separate rooms for grading fish and for the transport of goods within the storage are maintained at +10 °C. In a worst-case scenario, the goods are delivered at -10 °C.

“There were four main requirements that had to be met”, says Bjarne Waldstrom, Managing Director at Omnico Engineering. “These were:

1. Loading of 250 metric tons of tuna fish or tuna loins per day in any of the nine cold rooms. The product temperature at loading can be as high as -10 °C. Cooling to -18 °C core temperature must be achieved within 24 hours.
2. Energy efficiency.
3. No ammonia evaporators or piping are allowed inside or above the cold rooms, anterooms and processing rooms due to risk of product contamination in the event of ammonia gas leaks. The ammonia charge shall be small and restricted to the plant room and the condenser areas only.
4. Refrigeration by means of a centralized heavy-duty refrigeration system equipped with fully automatic control system with SCADA system interface (Supervisory Control and Data Acquisition) for system monitoring and control in real-time, data logging and power usage recording”.

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

▲ NH_3 and CO_2 compressors in the machine room.

▲ Control panel for controlling the compressors in the machine room.

▲ Two Güntner ECOSS evaporative condensers dissipate the waste heat of the NH_3 compressors into the ambient air.

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

"By installing a skid packaged CO_2-NH_3 cascade refrigeration system, we achieved just that, and it was a pleasure working with all parties throughout the project development", says Waldstrom.

In the Philippines alone Omnico Engineering has designed and installed systems for three other plants since 2013 and currently has one system under installation. All systems supplied come with ASME-approved pressure vessels and UL-listed electric panels and keypads.

Waldstrom continues: "We often hear people say that top quality equipment isn't needed in remote areas or developing countries. I utterly disagree with this statement – it is precisely because you are in areas with lower skill set of operators and engineers that you need properly engineered systems and top quality equipment. Nonetheless, one of our most important tasks is to conduct comprehensive hands-on and scheduled classroom training for our customers' operators and technical staff.

During start-up and commissioning of the plant in General Santos, we did three weeks of hands-on training of four technicians and classroom training for a full day for more than twenty of the customer's staff members. We don't leave until the customer's staff can run the plant and do the period maintenance on their own".

Similar LT equipment for different use

CO_2-NH_3 cascade refrigeration systems are ideal for a variety of low and medium temperature applications where high energy efficiency is called for and ammonia near products and production staff is unwanted. Some of the applications for which CO_2-NH_3 cascade refrigeration systems are already widespread include the freezing of food products using IQF, blast and contact freezers. Today, this is the preferred method for freeze-drying that requires temperatures around -50 °C, and it is becoming increasingly popular for refrigerated warehouses and distribution centres.

"Recently, we have experienced a surge in inquiries for CO_2-NH_3 cascade systems. Also, we are often contacted by end users and contractors who want to know more about the technology and its pros and cons", says Waldstrom.

In addition to the four transportation aisles, there is one room for grading fish. The supply air of this room and that of the loading area is characterised by a comparatively high heat input as they are labour-intensive areas and as the warm fresh air from outside cannot be fully prevented from entering at the entries and exits. Therefore, the cooling capacity of the air coolers is increased by a factor of 2.5 compared to other separate rooms.

Fish grading rooms and anterooms are maintained at +10 °C by means of CO_2 circulating in the pipe between the Güntner air units and the CO_2 liquid receiver in the plant room. CO_2 leads to an improvement in energy efficiency over brines (e.g. propylene glycol) where there is no change of phase.

The facility will be expanded from the current cold storage capacity of 6,000 metric tons to 10,000 metric tons at a later stage. Refrigeration system and piping are prepared for it – the expansion can be carried out without shutting down the plant.

Two-stage CO_2-NH_3 cascade

Two NH_3 compressors (T_0 -4.8 °C/T_c +36 °C) provide the cooling needed for condensing the CO_2 from the low temperature side, and the cooling capacity needed for anterooms and processing rooms. NH_3 compressor #1 runs as „fixed" compressor and provides the base load (1,170 rpm). Compressor #2 is frequency-controlled (750 – 1,500 rpm) and is taking care of load variations. COP at full load is 4.39 for both compressors, but higher at partial load conditions for the frequency-controlled compressor, particularly in the 20 – 60 % capacity range where it most frequently operates. The same compressor configuration is applied for the CO_2 circuit of the system, where two compressors (T_0 -32.0 °C/T_c -1.0 °C) provide the cooling needed for the cold rooms.

▲ Güntner DUAL Vario air coolers, type CPDHN, provide the required cold for the anterooms.

▲ An LT cold room for 1,000 metric tons/1,102 short tons cooled by two Güntner CUBIC Vario CPGHN evaporators mounted at both ends of the room, blowing face to face.

A high pressure heat exchanger connects the NH_3 and the CO_2 cycle. This heat exchanger has two functions: Due to the consistent heat transfer, it serves as condenser for the CO_2 cycle and as flooded evaporator for the NH_3 cycle.

Two Güntner S-ECOSS 850 evaporative condensers dissipate the waste heat of the NH_3 compressors to the ambient air. What's more, the compressors are equipped with a cylinder head cooling. In addition, each condenser has a small built-in split coil for the closed water cooling circuit for the top and side jackets of the NH_3 compressors.

The Güntner S-ECOSS 850 are made from stainless steel and reach a total condensing capacity of 1,214 kW at 36 °C condensing temperature and 28 °C wet bulb temperature, which is also the peak wet bulb temperature at the installation site.

Güntner CO_2 direct evaporator

Two Güntner air coolers CUBIC Vario, type S-CPGHN 065.2I/210-BHL/18P.E, with 44 kW each provide the required cooling for three large cold rooms and each one Güntner air cooler CUBIC Vario, type S-CPGHN 065.2I/310-BHL/18P.E, made from stainless steel with a capacity of 66 kW is installed in the six small cold rooms. The evaporating temperature of the CO_2 refrigerant is -31 °C. The fans are made from aluminium. Defrosting for each of the twelve cold rooms takes place using warm brine.

In addition to the warm brine defrost circuit at +30 °C, the Güntner CPGHN coolers are equipped with a fan ring heater, a thermally decoupled tray as well as an insulated air intake hood to retain the defrost heat and thereby optimize the defrost efficiency and minimize the heat transfer to the cold room space during defrosting.

Located below the ceiling in anterooms are the Güntner air coolers DUAL CPDHN with different power levels (21.7 kW, 31.7 kW, 43.2 kW, 52.8 kW). The evaporating temperature of the recirculated CO_2 refrigerant is 0 °C.

The twelve Güntner air coolers in the -25 °C cold rooms with an evaporating temperature of -31 °C are supplied with CO_2 by the refrigerating installation via pump operation. The liquid receiver is located in the plant room.

Warm brine circuit for defrosting

A warm glycol solution (50 % propylene glycol) defrosts the CO_2 direct evaporators. For this defrost process, the warm brine is pumped to the tubing inside the coil in parallel to the separate circuit in tray. Each circuit is controlled by a motorized valve with spring return. First, the valve between the glycol circuit and the tray is energized during defrost cycles. Two units of the storage can be defrosted at the same time.

The hot gas of the NH_3 compressors serves as heat source for the warm brine; the heat of the compressors is transferred to the brine via a plate heat exchanger. The 21.2 °C cold brine heats up to 30 °C during this process and, at the same time, the warm hot gas from the NH_3 refrigeration cycle condenses inside the plate heat exchanger and is led via a high pressure float valve to NH_3 surge drum for the CO_2 condensers.

Plant control

The plant can run in automatic as well as in manual mode. The four microprocessor control panels of the compressor as well as all plant instrumentation such as pressure and temperature transmitters, liquid level transmitter and low- and high-pressure safety valves, are linked to the master control panel. Temperature set points can be adjusted for each room individually and defrosts can be done in manual or following a pre-set schedule. Power usage monitoring and recording is also standard.

As an extra feature, Omnico also supplied PC interface with password-protected Internet access for remote monitoring and control. With this installed, the customer can log on to the system from anywhere and see how the system is running in real time or check recorded data. Moreover, Omnico Engineering can log on to troubleshoot and guide local operators as needed.

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

Overview

Business line:	Industrial Refrigeration & Commercial Refrigeration
Branch:	Food industry Storage and logistics
Application:	Food processing Cooling of foodstuffs Order-picking warehouse Freezing room Fish processing Distribution centre/logistics centre
Country/city:	Philippines / General Santos
Fluid:	NH_3/CO_2, water/glycol mixture
Food category/ refrigerated goods:	Fish
Products:	Güntner evaporative condenser ECOSS 850 Güntner air cooler CUBIC Vario, Typ CPGHN Güntner air cooler CUBIC Vario, Typ CPDHN

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

Member of Güntner Group

G_REF_089_V2_DE