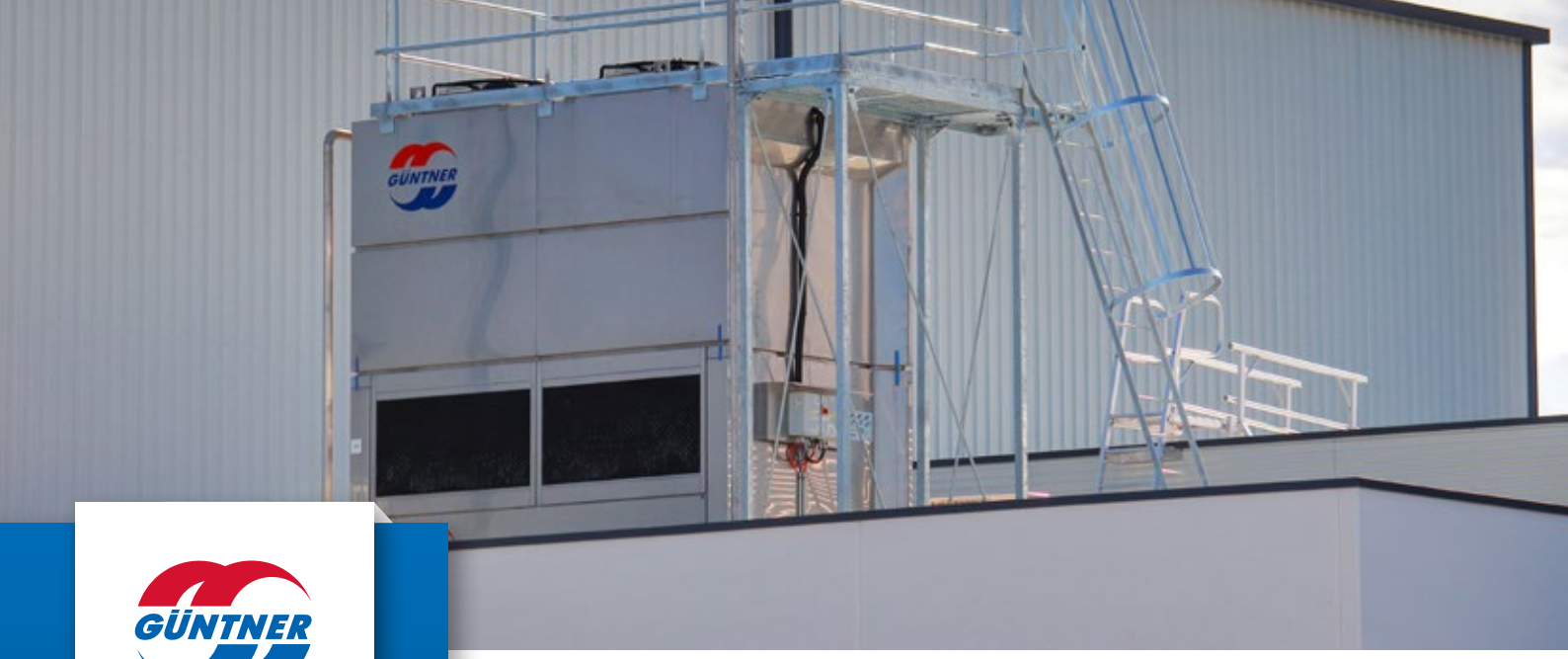

Storing tuna at low temperatures with CO_2/NH_3 cascade

A new energy-efficient low-temperature storage facility deep-freezes and stores tuna with a modern NH_3/CO_2 cascade refrigeration system. Every day, around 2,250 metric tons/2,480 short tons of tuna fish or tuna loins can be stored in the LT storage rooms. Güntner equipped the logistics rooms with CO_2 evaporators – the cubic CPGHN and the dual discharge CPDHN – that are operated via pumps, and the excess heat from the NH_3 refrigeration cycle is dissipated via Güntner ECOSS evaporative condensers.

Skipjack tuna, yellowfin tuna, bigeye tuna – big saltwater fish are stored in the new LT cold rooms in General Santos which is known as the Tuna Capital of the Philippines. The modern plant meets the operator's four main demands with regard to capacity, energy efficiency, safety and plant engineering:

1) The capacity of the facility is as large as to deep-freeze 250 metric tons/275.5 short tons of tuna fish or tune loins per day in any of the nine LT cold rooms. The product is supplied for storage at temperatures of down to -10 °C/14 °F. But it is mandatory that the fish achieve a core temperature of -18 °C/-0.4 °F within 24 hours.

2) An energy-efficient solution was essential – the eco-friendly refrigerants NH_3 and CO_2 therefore were the operator's first choice.

▲ Philippines

Overview

Business line:	Industrial Refrigeration
Application:	Logistics / fish product cooling
Country/Region:	Philippines / General Santos
Fluid:	NH_3 /CO_2, water/glycol mixture
Product:	Güntner evaporative condenser ECOSS 850
	Güntner air cooler CUBIC Vario, type CPGHN
	Güntner air cooler CUBIC Vario, type CPDHN

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▲ 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.

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3) Ammonia evaporators or pipings are not installed inside or above the LT storage rooms, anterooms and the processing room due to risk of product contamination – a precautionary measure in the event of ammonia gas leaks. The ammonia charge is small and restricted to the machine room and outdoor condenser areas only.

4) Refrigeration takes place by means of a centralized heavy duty refrigeration system equipped with a fully automatic control system.

The tuna fish facility is designed and equipped with the refrigeration system by plant contractor Omnico Engineering.

Nine LT storage rooms

The total logistics area amounts to 84 x 66 x 8 m/276 x 217 x 26.2 ft and is divided into 6 large freezing rooms (324 m^2/3,488 ft^2 each with a capacity of 500 metric tons/551 short tons per room) and 3 small LT rooms (648 m^2/6,975 ft^2 each with a capacity of 1,000 metric tons/1,102 short tons per room). The products arrive at the facility either as whole fish in fish bins or as vacuum-wrapped tuna loins ready for canning at automated canning facilities located in export markets. As the products are destined for export markets, the state-of-the-art facility is internationally accredited by several institutions and states: USFDA, OU, CFIA, Earth Island Institute Dolphin Safe, HACCP, BRC, IFS, EU and IDC.

All low-temperature (LT) storage rooms are cooled down to a constant -25 °C/-13 °F. The separate processing room for grading fish and the four transportation aisles in the storage are maintained at +10 °C/50 °F.

Two-stage NH_3/CO_2 cascade

The installed NH_3/CO_2 cascade refrigeration system is ideal for a variety of low and medium temperature applications where high energy efficiency is demanded and ammonia next to products and production staff is unwanted.

Two NH_3 compressors (T_0 -4.8 °C/22.8 °F and T_c +36 °C/96.8 °F) provide the cooling needed for condensing the CO_2 on the low temperature side and the cooling capacity required for the anterooms and the fish processing room. One NH_3 compressor runs as „fixed“ compressor and provides the base load at a constant speed of 1,170 rpm. The second compressor is frequency-controlled (750 – 1,500 rpm) and adapts to load variations. The COP at full load is 4.39 for both compressors, but higher at partial load operation of the frequency-controlled compressor, particularly in the 20 – 60 % capacity range in which it most frequently operates. The same compressor configuration is applied for the CO_2 cycle where two compressors (T_0 -32 °C/-25.6 °F and T_c -1 °C/30.2 °F) provide the cooling for the LT rooms.

Two Güntner ECOSS 850 evaporative condensers dissipate the waste heat of the NH_3 compressors into the ambient air. What‘s more, the cylinder gaskets are cooled via a control valve. In addition, the variable design of the Güntner evaporative condenser allows for housing a multiple circuit coil for the closed water cooling circuit of the NH_3 compressors.

The Güntner evaporative condensers ECOSS 850 are made of stainless steel. The full stainless steel construction of the condensers for extremely high corrosion resistance and a long life suits perfectly to the project location near the coast. Furthermore, the savings regarding chemical water treatment as well as power and water consumption and the easy installation offered by the Güntner ECOSS series were decisive.

This is why Güntner stainless steel condensers were selected instead of conventional galv. steel condensers. The Güntner units reach a total condensing capacity of 1,214 kW/4,142,168 BTU/h at a condensing temperature of 36 °C/96.8 °F and a wet bulb temperature of 28 °C/82.4 °F which is also the peak wet bulb temperature of the ambient atmosphere at the installation site.

▲ 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 sturdy heat exchanger connects the low pressure NH_3 circuit and the high-pressure CO_2 cycle. This heat exchanger has two functions: It serves as condenser for the CO_2 cycle and as flooded evaporator for the NH_3 cycle.

Güntner CO_2 pump operation evaporator

Two Güntner air coolers CUBIC Vario (type CPGHN 065.2I/210-BHL/18P.E with 44 kW/150,128 BTU/h each) provide the required cooling for each of the three large LT storage rooms. One Güntner air cooler CUBIC Vario (type CPGHN 065.2I/310-BHL/18P.E made of stainless steel with a capacity of 66 kW/225,192 BTU/h)is installed in each of the six small LT cold rooms. The fans of the air coolers are made of aluminium. The evaporating temperature of the CO_2 refrigerant adds up to -31 °C/-23.8 °F

The refrigerant for the twelve Güntner CO_2 air coolers in the -25 °C/-13 °F LT rooms with an evaporating temperature of -31 °C/-23.8 °F is supplied in flooded operation. The pump accumulator unit is situated in the machine room.

The Güntner CPGHN CUBIC air coolers are equipped with a fan ring heater, a thermally decoupled tray as well as an insulated inlet hood to retain the defrost heat so as to optimize the defrost efficiency and to minimize the heat transfer to the LT room space during defrosting. Their cooler design provides an excellent air distribution and an even temperature pattern over the whole LT storage rooms with minimal energy consumption.

To ensure a convenient working environment for the workers in the anterooms and the processing room, Güntner air coolers DUAL CPDHN with low noise level, less draught and anticondensation design were selected. The Güntner air coolers with four different power levels (21.7 kW/74,040 BTU/h, 31.7 kW/108,160 BTU/h, 43.2 kW/147,398 BTU/h, 52.8 kW/180,154 BTU/h) are located below the ceiling. The fish grading rooms and anterooms are maintained at +10 °C/50 °F with pumped liquid CO_2 with an evaporating temperature at 0 °C/32 °F. This liquid CO_2 is taken from the CO_2 liquid receiver on the high-pressure side of the CO_2 cycle via a separate recirculation pump. The return pipe of these evaporators is connected with the gas side of the liquid receiver. Compared with procedures using conventional brines (e.g. propylene glycol) where there is no change of phase, this tubing for CO_2 improves the energy efficiency.

The level of heat input into the fish grading rooms and the picking and truck docking room is comparatively high as these areas are labour-intensive and as the warm fresh air from outside cannot be fully prevented from entering at entries/exits. Therefore, the cooling capacity of the air coolers is increased by a factor of 2.5 compared to other separate rooms.

Warm brine circuit for defrosting

A +30 °C/86 °F glycol solution (50 % propylene glycol) defrosts the Güntner CO_2 pump operation evaporator CUBIC Vario air coolers installed in each of the nine LT rooms. The glycol defrosting takes place in a separate circuit so that also a defrost piping is installed in the heat exchanger coil in addition to the refrigerant piping. The defrost piping is also passed through the drip plate. Each circuit is controlled by a motorized valve with spring return. For the defrost process, the glycol circuit valve to the tray opens first so that the tray is pre-heated. Only then the fluid passes through the coil.

The set-up allows for defrosting two units of the storage at the same time. The hot gas of the NH_3 compressors serves as heat source to heat the warm brine; the heat of the compressors is transferred to the brine via a plate heat exchanger. The 21.2 °C/70.2 °F cold brine heats up to 30 °C/86 °F 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 conveyed, via a high-pressure float valve, to the NH_3 receiver which feeds the CO_2 condensers.

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Automatic and manual plant control

The plant can be run in automatic as well as in manual mode. The four control panels for controlling the compressors and the measuring and control equipment such as pressure and temperature transmitters, liquid level transmitters and float switches are connected to the master control panel. Temperature setpoints can be adjusted for each room individually and defrosting can either take place manually or follow a preset control.

The monitoring and recording of power consumption is also a standard feature. But Omnico also supplied a computer interface with password-protected Internet access for remote monitoring and control purposes. With these installed, the operator can log in to the system from anywhere via Internet and check the system operation in real time or based on recorded data. Omnico Engineering can also log in for troubleshooting and for instructing local operators if required.

Hands-on training for staff

To ensure smooth operation from the very beginning, the technicians of the cold storage facility had received an intensive three-week training from Omnico during start-up and commissioning. Furthermore, classroom training was provided for a full day for more than twenty of the operator's staff members because the plant contractor Omnico wants to be absolutely sure that the operator's staff can run the plant and carry out periodic maintenance works on their own. "This and a properly engineered system with top-quality equipment is of high importance in areas with a lower skill set of the operators," Bjarne Waldstrom, Managing Director at Omnico Engineering, explained.

The facility will be expanded from the current cold storage capacity of 6,000 metric tons/6,612 short tons to 10,000/11,020 in the future. The refrigeration system and the piping can then be expanded without interrupting production.

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