Figure 1: BUD Holland Maassluis

Replacement of refrigeration system and addition of ripening chambers by Nijssen Koeling at BUD Holland

BUD Holland has replaced the whole of its refrigeration system at its location in Maassluis with an energy-efficient refrigeration and freezer system. Six ripening chambers have also been included in the new system which uses the natural refrigerants ammonia and CO_2. Various energy-saving components were chosen in order to ensure that the investment was economically sound. The modification and expansion were carried out by Nijssen Koeling BV of Leiden.

Introduction

BUD Holland BV has been a loyal customer of Nijssen Koeling BV for many years. The original refrigeration system which used the chemical refrigerant R22 was supplied by Nijssen in 1994. The system was also expanded at a later date. Since then, Nijssen has also looked after the maintenance of the whole system.

When BUD Holland wanted to expand the system by adding a number of ripening chambers for exotic products such as avocados and papayas, the possibility of replacing the whole system was considered. Attention was focussed on environmentally-friendly refrigerants on account of the fact that, since 2010, it is no longer permissible to use the existing refrigerant R22 for construction and expansion projects due to the resulting increase in greenhouse gases.

It was decided that a central refrigeration system would be used for the refrigeration cells, one freezer cell and the six ripening chambers. Ammonia was chosen as the primary refrigerant and CO_2 as the secondary refrigerant.

This design was used to create an energy-efficient and environmentally-friendly system. Both ammonia and CO_2 are natural refrigerants that do not contribute towards the CO_2 emissions released into the atmosphere. The very high thermodynamic efficiency of both ammonia and CO_2 made it possible to create a system with a low energy consumption.

The use of natural refrigerants and energy-saving components also yielded financial benefits in the form of an EIA contribution.

Phased construction

As the project involved replacing and expanding an existing system, it had to be carried out in phases to keep the interruption of operations to a minimum.

During the first phase, the new ammonia/CO_2 machine room was built and structural work was carried out for the new refrigeration cell and six ripening chambers.

After the commissioning of the central ammonia/CO_2 system, the refrigeration cells were modified one by one and connected to the new system. Finally, the existing Freon freezer system was removed and the freezer cell was connected to the central system by means of a CO_2 cascade system.

Summary

The plan to expand the complex by adding ripening chambers for exotic products gave BUD Holland the incentive to replace the refrigeration and freezer system too. In December 2012, Nijssen Koeling BV of Leiden supplied new systems relying on natural refrigerants. An environmentally-friendly system was created by using ammonia and CO_2 as refrigerants. By using these refrigerants and various energy-saving components, considerable energy savings have been made, despite an increase in the refrigeration capacity. Optimum safety is guaranteed for products and people because ammonia only circulates in the machine room and the condensers set up outside. CO_2 circulates as the refrigerant in the refrigerated rooms while a water/glycol mixture is used in the ripening chambers. This choice enables the temperature in the ripening chambers to be controlled with maximum precision using the **Ripeningmaster®** software package from Nijssen.

Primary ammonia system

The system is designed in such a way that the ammonia content remains restricted to the components in the machine room and the condensers set up outside.

The cold in the primary circuit is generated by four screw-type compressors manufactured by Bitzer. These have a total refrigerating capacity of 722 kW with an evaporating temperature of -8°C. By installing an economiser for the systems, a high COP value of 4.07 can be achieved. This has enabled **the compressor output to be improved** by more than seven per cent.

In addition, one of the compressors is designed with a frequency regulator which permits continuously variable speed regulation. Compared with a conventional stepped compressor controller, this system has yielded energy savings of a further five per cent in terms of the total compressor energy.

The heat emitted from the system is removed by means of two air-cooled condensers. The condensers are designed with fans with Hy-blade impellers. The **optimum aerodynamic characteristics** and the continuously variable speed regulation enable maximum efficiency to be achieved. During full-load operation, the power consumption of the condenser fans is only 14 Watts/kW$_{(nom)}$.

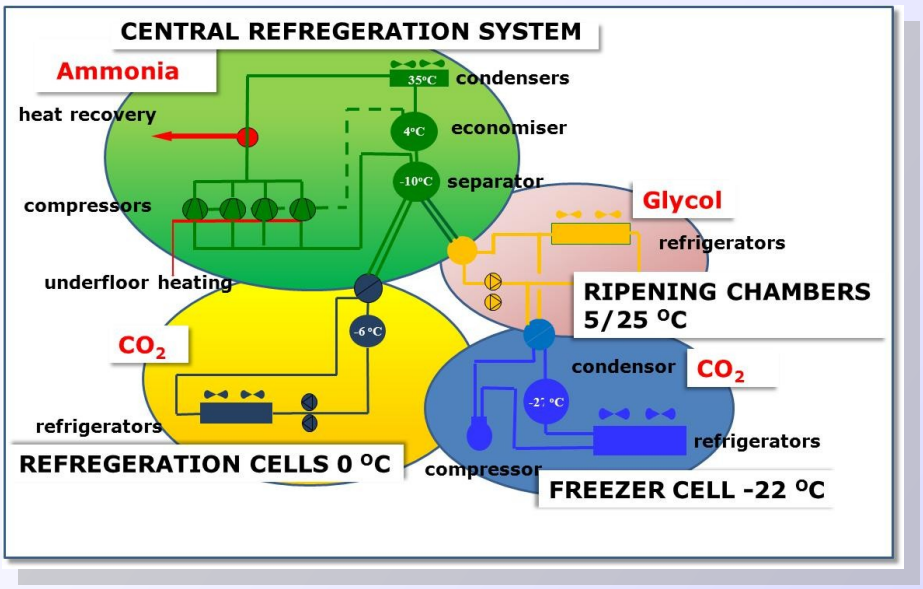

Figure 2: Schematic diagram of the refrigeration/freezer system

The condensers are designed with stainless steel tubes and fins made of seawater-resistant aluminium to ensure a long service life.

Two cascade refrigerators are connected to the ammonia circuit. One refrigerator with a capacity of 560 kW supplies the refrigeration for the refrigeration cells via the secondary CO_2 circuit. In the second refrigerator, a water/glycol mixture is cooled to a temperature of approximately -6°C. The ripening chambers are connected to the water/glycol circuit. Using water/glycol means that the temperature in the ripening chambers can be controlled with a high level of precision which is important in order to guarantee the quality of the exotic products to be ripened. The condenser for the CO_2 freezer system is also installed within the water/glycol circuit.

Figure 3: Ammoniaseparator

Ripening chambers

Six ripening chambers were supplied for ripening exotic products such as avocados, papayas, mangos and physalis, Nijssen Koeling BV took care of both the structural works for these as well as the installation of the chambers and the technical facilities.

The temperature of the products needs to be regulated extremely precisely and uniformly in order for these products to ripen evenly. In order to achieve this, the chambers have been designed with a tarp system. The **electrically operated tarp cover** ensures that the conditioned air is sucked through the stacks of products. The covers are fitted with an **inspection window** in order to allow the products to be inspected.

Nijssen developed special refrigerators for ripening chambers to facilitate the uniform conditioning of products. The equipment these use includes **contra-rotating fans** with an extra-high external pressure output. The fans can be continuously controlled by means of a frequency regulator.

During both the storage phase and the ripening period, the desired room temperature is achieved by cooling or heating the air. A **continuously controlled mixing system** has been installed for this purpose, with each room having its own control valve and mixing pump. Sensors have been installed to control both the air temperature and the product temperature.

For various products, controlling the relative humidity is extremely important. Each of the ripening chambers has therefore been fitted with a humidifier and an air dryer. Finally, each chamber has its own ventilation system for controlling the supply of outside air.

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An ethylene gassing system has been installed to allow ripening of the products to be regulated. The sophisticated **Ripeningmaster®** control program developed by Nijssen facilitates **fully automatic control of the refrigeration, heating, moisture regulation and gassing systems.** The software makes it possible to set up a ripening programme for each individual product so that optimum product quality is guaranteed.

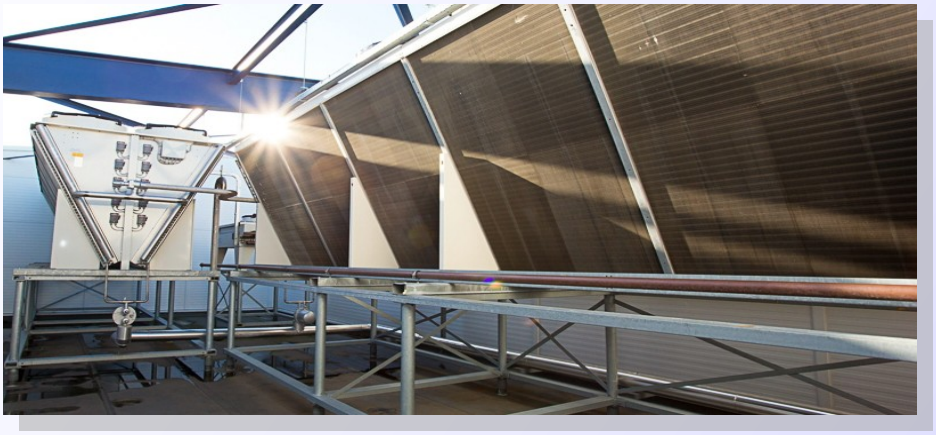

Figure 4: V-shape condenser

Refrigeration cells and shipping

The existing refrigeration cells had to be modified in order to enable CO_2 to be used as a refrigerant. Once the central system had been put into operation and the main pipelines had been installed, the modification of the refrigeration cells could start. Refrigerators and pipework were disassembled and removed. Then the cells were fitted with CO_2 refrigerators, new pipes and control equipment.

The customer specified that operations were to be interrupted as little as possible. Therefore it was essential to draw up a strict work schedule and to consult with the customer.

Nijssen also provided the structural components required for a new refrigeration cell which included insulation panels and an insulated refrigeration cell door.

Ginger cell

A special cell has been built for storing ginger. Because of the special storage conditions for ginger, there is an extra high air flow rate within the cell.
A heating element has been installed for drying the products. Heat from the system which is available free of charge is used for this purpose.

Freezer cell

In the old situation, there was a freezer cell which had a separate freezer system based on the refrigerant Freon. During the entire renovation, a **cascade CO_2 freezer system** was installed and connected to the primary ammonia system.

By using a CO_2 cascade system, a total COP of 2.00 can be realised for the freezer system. This represents an improvement in efficiency of more than 25% compared with the old Freon system.

An additional benefit gained from the connection to the central system is that there is no need to install an additional condenser on the roof, which also means savings on construction costs.

Heat recovery

The system contains various energy-saving components including a heat recovery system. Heat emitted during refrigeration and freezing is used to defrost the refrigerators, amongst other things. A heat recovery condenser connected to a heat buffer is used to extract the heat. In addition, the heat emitted from the oil cooling system for the compressors is collected in the buffer tank. The buffer tank contains a mixture of hot water and glycol. The hot water/glycol circuit is connected to the refrigerators via a pipe system. The refrigerators have a separate defrosting circuit. The refrigerator in the freezer cell is also fitted with a suction cap and defrost socks. These ensure efficient defrosting where as little as possible of the heat used for defrosting is released into the refrigerating chamber.

Compared with the original electrical defrosting system used for the refrigerators, this system yields considerable energy savings as the heat used for defrosting comes free of charge.

The free heat from the refrigerating system is also used to heat the ripening chambers. All the heat needed for this can be recovered from the system; there is no need for additional heating.

Figure 4: Ripening chambers

Energy-efficient control

Coolmaster® program

The whole system is managed and controlled using the Nijssen **Coolmaster®** control program. This control system for refrigerators was developed in-house by Nijssen. This software provides an **energy-efficient method for controlling** the system.

This control system includes the **Nijssen Power Saving©** system which controls the components in the system in such a way that the highest possible evaporating pressure and the lowest possible condensation pressure are achieved. It has been shown that the optimisation of evaporating and condensation pressure can yield savings of up to 15% on energy consumption. Naturally, all this is carried out under conditions that guarantee optimum product quality.

Project details for BUD Holland:

- 14 refrigeration cell 0 °C : 2,410 m^2
- 6 ripening chambers +5/+25 °C : 115 m^2
- 1 freezer cell -22 °C : 72 pallets
- 2 shipping rooms 12°C : 3,400 m^2
- Total refrigeration capacity : 722 kW with an outside temperature of 25°C
- Total freezing capacity : 28.5 kW
- System design : ammonia/CO_2/water-glycol cascade

Ripeningmaster® program

The Nijssen **Ripeningmaster®** control program is used for the ripening chambers. This software can be used to pre-program a conditioning programme for each individual ripening chamber, for a period ranging from one day to several weeks. The user can set and store a programme that he has chosen himself for each product that is stored and ripened.

The control system ensures that **temperature changes between the storage period and the ripening period are achieved uniformly** at a rate that guarantees the best results for the product. Together, the ripener's specialist product knowledge and the optimum control made possible by the system ensure perfect quality at the end of the storage and ripening process.

The following components have been used to contribute to an energy-efficient and sustainable system design:

- Ammonia screw-type compressors in the primary circuit;
- One of the compressors is designed with a frequency regulator;
- An economiser for increasing compressor efficiency;
- Energy-efficient condensers with a low temperature difference of 10 K;
- Condensers fitted with speed-controlled fans with an extra low power consumption of 14 Watts/kW;
- Heat recovery for heating the ripening chambers;
- The use of heat from the oil coolers for the underfloor heating system;
- Each condenser is fitted with a separate high-pressure float;
- Refrigerators with a defrost facility using residual heat;
- Fans in the ripening chambers fitted with frequency regulators;
- Energy-efficient control using the Nijssen Power Saving® system and weather-dependent condenser pressure control.

Figuur 6: Overzicht machinekamer

Energy savings

As a result of the renovation process, BUD Holland BV has gained a refrigeration, freezing and ripening system that guarantees the optimum conditioning of fresh products. In the process, the use of natural refrigerants has significantly improved the **corporate social responsibility** of BUD Holland.

Thanks to very latest system components and a sophisticated control system, this system has already yielded savings on energy costs.

Energy Investment Allowance

Thanks to its natural refrigerants and energy-efficient design, the system qualifies for an Energy Investment Allowance (EIA).

More information

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