Opteon™

Medium temperature refrigeration systems using R-454C

Chemours™

zimmermann
kälte- und klimatechnik

Practical experience of an installer company with A2L refrigerants

Baxter is a globally operating company in the pharmaceutical and medical technology sectors. Consequently, the logistics and storage requirements for the high-quality products are high. Due to their age, the existing low temperature systems were already replaced in 2021. The old units, which until then had been operated with the refrigerant R-404A, were to be replaced by an efficient and environmentally-friendly alternative. The decision was made in favor of three units (one of them redundant) with the refrigerant R-454C including heat recovery. The existing redundant unit and emergency power supply ensure operation even in the event of a fault. The verdict after around two years could not have been more positive.
The units run smoothly and reliably. (https://www.kka-online.info/artikel/kka_Medizin-Produkte_mit_A2L-Kaeltemittel_gekuehlt-3673622.html)
This unit concept should now also be implemented in the existing medium temperature refrigeration warehouses.

After careful consideration, the A2L refrigerant R-454C was chosen here as well, mainly for the following reasons: Firstly, the experience with the A2L refrigerant when replacing the low temperature units. The idea of being able to operate all units with the same refrigerant also makes long-term support easier. In addition, the GWP of 148 is just below the expected limit of 150.

These considerations were discussed at length long before the current amendment to the F-Gas Regulation. In the end, this long-term solution was chosen. Short-term alternatives might have appeared cheaper, but only at first glance. Strangely, many colleagues have lost sight of the refrigerant topic over the last two years. But ignoring it is not getting our industry anywhere. We need to act now and use low-GWP refrigerants, think about waste heat recovery where possible and practical, and integrate this into the unit concepts. We can certainly have different opinions about ways and means, but changing nothing at all will not help us combat the climate catastrophe. Every reduction in greenhouse gases helps. Efficient systems not only help operators reduce emissions and costs, they also make it possible to help protect the climate.

Local conditions

Thanks to forward planning, the on-site logistics team was able to clear the affected storage areas on time. This made it possible to perform the installation work at normal room temperatures. However, one of the challenges was the ceiling height of around 8 meter.

Textile hoses were attached to the evaporators to ensure that the air and temperature distribution was as balanced as possible. The affected employees in the warehouse will also benefit from the low air speeds.

To facilitate service work in the future, the electronic expansion valves and additional sight glasses were installed on the ceilings of the cold storage cells. This makes access during operation much easier.

The condensers were installed on the outer wall right next to the compressor machine room. Another plus point is that this wall is located on the northern side of the building, which means that the condensing temperature can be kept within reasonable ranges even at high outside temperatures.

All compressors, receivers and control cabinets were brought into the machine room to make servicing easier, as all important components are within sight and easy to reach. Previously, some of the units had been installed outdoors. Although this initially an easier installation, it was necessary to cover a distance of several hundred meter with two staircases to get from the switch box to the compressor. Troubleshooting quickly turns into a sporting challenge.

Danfoss Regler, System Manager, Integration of IQ module and input modules

The AK-CC55 controllers have proven their worth in practice as cooling point and overheating controllers in the low temperature units, which is why there was no question of using them for the new medium temperature refrigeration units. Operation via the additional Bluetooth display is really comfortable and intuitive. There is no need for laborious reading of parameter lists and instructions, which at least partially offsets the additional price.

Another reason for selection was the desired remote access. With medical products, speed of response in the event of a fault plays an important role, which is why a view of the units from the service office is a precondition for customer-oriented work.

With the Danfoss System Manager, it was also possible to integrate components from other manufacturers into the Modbus network (after a few rounds of discussions). Knut Schlicht from Danfoss was very helpful during the initial setup. The operating status of the compressor can thus be queried via the Bitzer IQ module. Input modules, e.g. for external messages, are also integrated.

In our case, the System Manager sends an email, e.g. the response of the installed gas warning device, to saved recipients. Such comprehensive links not only help us to resolve faults quickly, but may also be an important building block in the long term when dealing with a shortage of skilled workers.

A2L refrigerants

Of course, the potential dangers were also taken into consideration when selecting the refrigerant. It is well known that A2L refrigerants can be flammable under certain circumstances. But with R-454C in particular, the potential hazards are quite manageable:

- slow burning velocity (FSR = 1.6 cm/s)
- high required ignition energy (300-1000 mJ)
- small flammability range of 7.3 % (flammability range LFL 15 - UFL 7.7 [% by volume in air])

(Source: Chemours presentation 2023)

The situation is improving if the room volumes are large enough. The conditions in the shipping warehouse at Baxter are correspondingly spacious. The limit values were only exceeded in the machinery room. This is why a gas sensor was installed there, which triggers an alarm in the event of a leak and automatically starts up the ATEX exhaust ventilation system.

The handling of R-454C barely differs from the (previous) safety refrigerants. In the air conditioning sector, the handling of A2L refrigerants has become almost part of everyday life, and employees are familiar with the safety measures and how to implement them. This means that the work barely differs from classic refrigeration technology. Materials, pressure level and mechanical tools do not change.

In terms of the refrigerant, Dominic Düing from Chemours was a helpful and open-minded contact. Understandably, the concept of flammability is worrying for many people, which can certainly be alleviated with good consulting. A risk assessment should always be carried out, also to ensure that potential hazards, such as those related to routine, are not neglected.

Challenges

During planning discussions, Jochen Tohol, the on-site technical manager, made the justified request to avoid start-up current peaks as far as possible. Not only do these peaks place a strain on the existing emergency power generator but they really stand out on the bill from the energy provider. Frequency converters were therefore not only planned for the new compressors, but also retrofitted to the existing low temperature units. This not only eliminates the high starting currents, but also helps to operate the units more efficiently.

Looking back, the biggest challenge turned out to be planning the control cabinet, as many eventualities had to be taken into consideration. Accommodating all the rooms with redundancy, emergency power operation, frequency converters, local safety measures and notifications, automatic switchover in the event of a fault, etc. in one control cabinet was not easy, also for reasons of space. Here too it is important to take enough time to plan the units and layouts. Lutz Riedel from Frigotechnik Nuremberg was involved in the refrigeration planning from the very beginning and also patiently implemented all the adjustments.

The commissioning itself was the tried and trusted classic refrigeration method with a leak test, function test and data recording. The service office can now take a quick look at current operating data without having to jump into the car. To be honest, it's a great feeling and makes you want more.

Technical data

Refrigerant **R-454C**
Cooling capacity per evaporator **14 kW**

Evaporation temperature **-4°C**
Room target temperature **+4°C**

2 individual units, each with
- 1 compressor, capacity-regulated
- 1 evaporator with EEV

1 redundant unit with
- 1 compressor, capacity-regulated
- 3 evaporators with EEV

Chemours™

zimmermann
kälte- und klimatechnik