Tekloth experts Stefan Bollman (project planning and sales) and Christoph Holtschlag (project planning and software development), Michael Holländer (Building Automation, Beckhoff Rhein/Ruhr office), and Marco Möllenbeck (refrigeration technology planning, development and sales, Tekloth) in front of the control cabinets for the compound CO_2 refrigeration systems (from left to right).

PC-based control runs compound CO_2 refrigeration system, eliminating the need for regular defrosting

Commercial meat freezers: Easy implementation of sophisticated controls

Tekloth GmbH in Bocholt, Germany, has designed an innovative compound CO_2 refrigeration system that operates without the cumbersome intermediate defrosting stage as required by other commercial meat freezing systems currently available on the market. PC-based control technology made it easy and convenient to implement the expertise required for the special configuration and control functions of the system despite the high degree of complexity involved in the application.

Tekloth, a specialist for technical building systems, used PC-based technology to develop the complete control system for a compound CO_2 refrigeration system as supplied by Fischer Kälte-Klima in Essen, Germany. The installation is used as a cooling unit for a deep freezer for smoked and cured pork. After the meat has been smoked, it is shock-frozen at a temperature of -18 °C (0 °F) or colder. Because the meat is still warm (30 to 40 °C) when it enters the system, a large amount of moisture is introduced into the process, which collects on the evaporator and is then frozen. As a result, conventional systems must be defrosted in regular intervals.

Since defrosting requires a lot of energy, Tekloth completely redesigned the compound refrigeration system to be more efficient. Marco Möllenbeck, who works in planning, development and sales at Tekloth, explains: "Due to a special system design and corresponding control functions, our solution does not require regular defrosting like conventional installations. What makes it special is a switching valve that allows changeover from regular cooling (RC) to deep-freezing (DF) operation. Since traditional installations would require two separate systems for this, our design delivers clear benefits in terms of lower investment costs as well as reduced power consumption."

Two operating modes combined in a single system
With the switching valve, the system can be operated for regular cooling in the so-called transcritical range or as a booster with DF and RC compressors in the transcritical range. This kind of switchover function requires many control processes that standard systems cannot support. Christoph Holtschlag, who

works in planning and software development at Tekloth, explains: "By switching operating modes, the system initially cools and dehumidifies at an evaporation temperature of approximately -6 °C (21 °F). The elevated RC evaporation temperature keeps frost on the evaporator to a minimum. When the room temperature reaches 4 °C (39 °F), the system switches to the RC-DF booster mode."

During this process, the RC mode initially stops, and a circulation defrosting mode starts. The RC mode provides energy-optimized cooling in the regular cooling temperature range while dehumidifying most of the product surface – all with minimal freezing of the heat exchanger in the evaporator. After the circulation defrosting stage and switching to RC-DF booster mode, the chamber and the product are cooled to -18 °C (0 °F). Depending on the product quantity and the time it stays in the chamber after the target temperature has been reached, the need for intermediate defrosting may be completely eliminated, according to Holtschlag.

PC-based control as an open and flexible control platform
Stefan Bollmann, who works in project planning and sales at Tekloth, believes there are many good reasons for implementing the complex sequence control with PC-based control technology: "We benefit from the ability of Beckhoff control technology to meet industrial requirements in all our projects. In addition, the systems' modular structure and open programming environment make them very flexible and enable an exceptional degree of innovation. As a result, we were able to program the sophisticated controls for this compound refrigeration system ourselves, which allowed us to maintain total control of the

The valve that switches the compound CO_2 refrigeration system from normal cooling to deep-freeze operation.
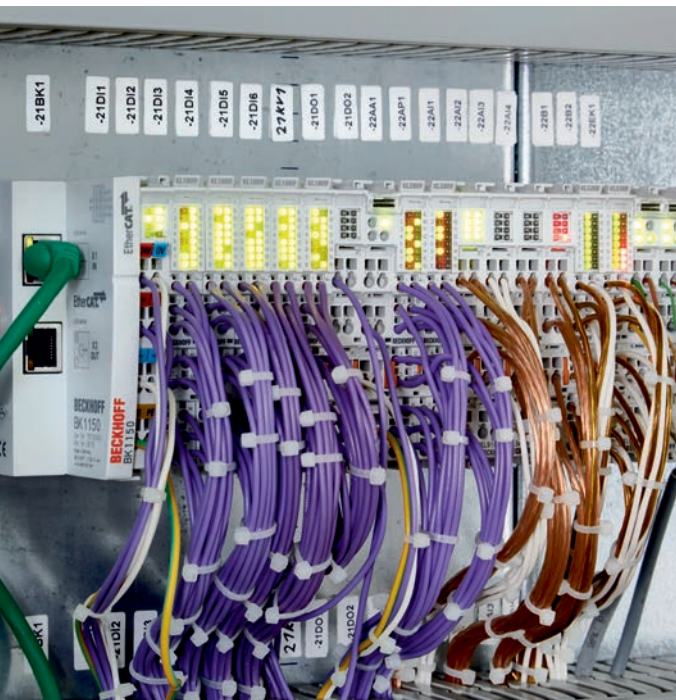
machine software. In addition, system changes and modifications in response to customer requests can be implemented quickly and easily."

Another benefit is the consistent use of PC-based control technology across platforms as Christoph Holtschlag explains: "Whether we build heating, cooling, ventilation or building automation systems with individual or centralized controls, we can implement all open-loop and closed-loop control requirements with Beckhoff hardware and software. This kind of universal applicability allows us to employ our software modules in all areas. The system's openness and its support for a wide range of bus systems used in buildings is another contributing factor." There are also financial benefits, he adds: "Common control systems for HVAC systems are fairly complex and demanding. The Beckhoff platform offers everything we need to keep our processes in-house, implement them efficiently, and deliver added value to the customer compared to standard offerings on the market. This absolutely applies to the compound refrigeration system, because no standard refrigeration controller provides this switching capability from regular cooling to deep-freeze mode."

Optimized closed-loop process control

A Beckhoff CP2716 multi-touch Panel PC with a 15.6-inch screen serves as the operator interface hardware for automation, data recording and visualization tasks. The modular I/O system is custom-configured with digital and analog Bus Terminals that collect data from all sensors and actuators as well as control-relevant values. The control system integrates components such as PT1000 sensors, high-, medium- and low-pressure sensors, temperature sensors and CO_2 sensors.

It also handles operation feedback from the various units as well as target and actual values and closed-loop control values.

The system acquires over 150 data points, with value changes in one-minute intervals, to provide a complete image of the process status. If a malfunction occurs, data changes are registered in one-second intervals and can be buffered at this high resolution for up to one hour. As a result, says Holtschlag, the process is under total control. "The flexible and easy-to-use implementation with PC-based control was critical to ensure our ability to accumulate the necessary knowledge in-house and advance our refrigeration technology. We conducted a lot of electrical and software engineering to reflect the refrigeration process in our control technology and map it with many new features compared to standard refrigeration systems. Making this possible were the many additional features available with PC-based control technology, such as graphical user interfaces, data trend mapping, fault signal logs, and email notifications. Features like these enable us to implement individual customer requirements in the best possible manner," Holtschlag sums up.

Further information:
www.tekloth.de
www.beckhoff.com/building

The advantages of PC-based control are also apparent in the custom-configurable modular I/O system.

The system layout represented on the Beckhoff CP2716 15.6-inch multi-touch Panel PC illustrates the high complexity of the application.