

Three circuits, 13.6 MW capacity, 48 t of ammonia

Güntner supplies Europe's most advanced slaughter house



Line of Business:	Industrial Refrigeration
Application:	Meat Product Cooling
Country / City:	Denmark / Horsens
Fluid:	NH ₃ , Glykol
Product:	Ceiling unit cooler GDS, Ceiling unit cooler GHS

In 2005 in Denmark the world-wide most advanced pig slaughterhouse and one of the largest in Europe went into operation. Danish Crown provides the best working conditions, the highest quality and the best technology for its showpiece. For the proportionally largest energy consumer, refrigeration technology, the planners and plant builders selected Güntner heat exchangers.

A match made in heaven: In exactly the same week, when the author himself was able to form an impression of the world-wide most advanced pig abattoir, Danish Crown, the operator, announced a new production record: 77,699 pigs were processed in one week at the beginning of October, 2006 at the Horsens' slaughtering operation. This is a daily average of around 15,500 pigs, an inconceivable number, but quite normal in Denmark.

A traditional industry

Because the smallest part of the Scandinavian Peninsula numbers world-wide among the leading nations in pig slaughtering, with a history well over 100 years old. The cooperative

company, Danish Crown (DC) was created under the economic pressures on global merchandising today. A total of approx. 22 million pigs are slaughtered by DC today (over 90 % of the Danish market share). This is equivalent to 2 % of the world's pork or just under 9 % within the EU. In the past years, DC has concentrated on the numerous locations of Danish slaughterhouses and created highly productive modern slaughtering factories. This includes the latest and most advanced slaughterhouse near the town of Horsens in Nordjütland. On the place where, in 1887, Denmark's first cooperative slaughterhouse started operation, now stands a true showpiece of pork processing in all respects. For this showpiece, three traditional operations in the inner cities of Horsens, Sundby and Hjørring were closed and the new one built in the open countryside.



View of the cutting and boning lines...

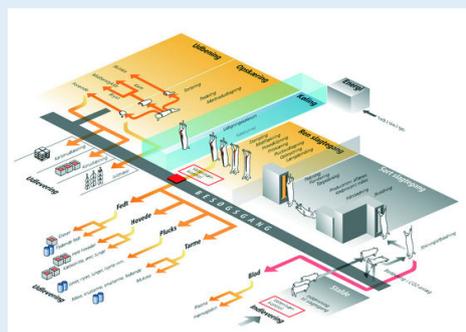
DC acts on behalf of people and animals

Even if it may sound macabre: at Danish Crown, the needs of people AND animals take center stage. And so everything is set up so that an animal's death is as stress-free as possible. The reasons behind this are animal protection, employee protection, and above all, quality. Because meat from animals slaughtered in a stress-free manner is not ridden with adrenalin and other substances and therefore maintains its quality, unchanged throughout processing and to the consumer. When forming the concept of the first new Danish slaughterhouse in the past 25 year at the gates of Horsens, the planning team of 50 engineers, architects and consultants had strict specifications from the principal that had to be filled. A simple summary of these is:

- There can be no environmental disturbance due to noise, smell or pollution.

- The employees' working conditions must meet state-of-the-art requirements and physical and psychological stress must be prevented.
- Living animals are to be handled as living creatures and not as goods.
- Great care must be taken with regard to the hygiene (DC developed its own code of practice).
- Special attention must be given to economical and energy-saving operation.

And these last two points were a real challenge for the proportionally largest energy consumer - refrigeration technology.



Slaughter layout; the refrigeration area is highlighted in blue

Slaughtering in a nutshell

But what actually happens in a slaughterhouse like Horsens? This will be briefly described here. On average, 10,000 animals arrive after a maximum transport time of 2 hours. In groups of 5 to 7 animals, they are slowly driven into a deeply situated chamber using a lift and there they are anaesthetized with CO₂ before slaughtering. The next procedure is unique so far: Each pig is exactly measured with a scanner and assigned to its later destination based on its condition and fat content.



Fans in the chill tunnel and heat exchangers

For instance, the Japanese prefer lean ham; however the Italians prefer their ham to have a higher fat content. A burned-in producer number allows each kilo to be uniquely associated with and credited to its producer. Payments are made weekly and the cooperative premiums are distributed at the end of the year. Next, the hair is singed off and the body is eviscerated. All working steps take place in a fully automated process.



Cooling down the pig carcass sides to 5 °C

The start of the cooling chain

While at this point in time, the separated body parts as well as the innards will be removed for other utilisation, the carcass sides will now need to be refrigerated. This is the start of the cooling chain which cannot be interrupted at any point. For this purpose, Horsens has two parallel chill tunnels that can be operated independently and have a capacity of 7,000 pigs per tunnel. The exposure time is 110 minutes in two temperature steps: first at -14 °C, then at -10 °C. The throughput speed is 3 to 4 m/s. Two rows of 30 fans blow cold air directly on the sides in each tunnel. This cools the average temperature from 37 °C down to approx. 7 °C. We speak of average, because the external meat temperature after just under two hours is around -2 °C and the inner flesh temperature is still approx. 25 to 30 °C.



Main piping for the NH₃

For this reason, the carcass sides continue on into the temperature equalising chamber (there are three, with a capacity of 7,000 pigs each), where they are completely cooled down to a constant 5 °C for further processing. The exposure time for this is 15 hours. Air is distributed through a 4.5 km (!) long plastic tube. One day later, the carcass sides are cut up into shoulder, loin and leg before being sent to the so-called 'T-bone area' for the final cut. This work is then half-automatic or manual which is why most of the people work in this area. The ambient temperature in the working areas is 8 to 10 °C. And before the meat is sent on its journey around the globe, it is stored in the storage rooms at 2 to 0 °C.



Fans in the chill tunnel and heat exchangers

Another dimension of cold

Chill tunnels, temperature equalisation chambers, T-bone area, storage rooms - there is an enormous cooling requirement everywhere. There are also numerous personnel and administrative rooms, kitchen, canteen, etc., where the air supply needs treatment. In 2002, the contract for the planning and construction of refrigeration and distribution was awarded to York Denmark Company which is part of the Johnson Controls Group since October, 2006.



In front of the large air coolers in one of the store rooms (from left): Sven Hougaard (Bardram Company), Flemming Sørensen (York Company) und Holger Thygesen (Güntner Company)

“For York Denmark, it is the single largest contract in the history of the company”, explained Flemming Sørensen, the responsible project manager. This came after a tough bidding phase, in which York received comprehensive support from Güntner in Denmark in order to be able to meet all the requirements. Especially with regards to the quantity, dimensioning and placement of just under 150 air coolers, a very experienced and dependable partner was required. “We really are somewhat proud that our planning was borne out in practical operation”, stated Güntner area sales manager, Holger Thygesen, “even though we were all under very high time pressure. A slaughterhouse is also an unusual project for us.”

The overall heat exchanger area, through which the air cooling reaches the cold rooms is equivalent to a gigantic area of 37,000 m² - metaphorically speaking, around five football fields! In addition, there are heat exchangers in the 26 air handling units - the air technology was planned by the Danish company, Badram – for other air conditioning needs, which cover approximately the same area again. These are used for the air conditioning in the cutting rooms and are especially responsible for making sure that the blown air is not too dry so that the meat does not dry out and so that accumulated condensate does not precipitate.



A look on to the ventilation-units on the roof

Since, for hygienic reasons, air tunnels were not allowed to be used for distribution, today there are numerous small units on the roof, exactly where the air supply is located. Produced in stainless steel and soundproof, it is not a standard design and was made to meet the DC hygiene requirements. The Güntner stainless steel/aluminium heat exchangers are up to 2.5 x 4 m large and are used to cool and heat (turned on in case of humidity) the air.

Refrigeration with NH₃



The screw-type compressors, lined up from right to left according to the temperature range -3 °C, -10 °C and -25 °C.

York meets the various temperature requirements using three refrigeration circuits with the refrigerating capacities given below, created with 12 Sabroe screw-type compressors.

- -3 °C with 6.4 MW (4 screw compressors)
- -10 °C with 3.3 MW (3 screw compressors)
- -25 °C with 3.9 MW (5 screw compressors)

The refrigerant used is ammonia. It is evaporated in NH₃ pump operation as this is the most energy-saving operating mode. After all, NH₃ is the oldest refrigerant with the most technological experience. This filled one of Danish Crown's major requirements – safe and efficient refrigeration. Today, the COP value of the refrigeration system is permanently monitored. Only in the personnel rooms is heat transported using glycol. In this case, a plate heat exchanger is used as an intermediary in the refrigerant circulation.



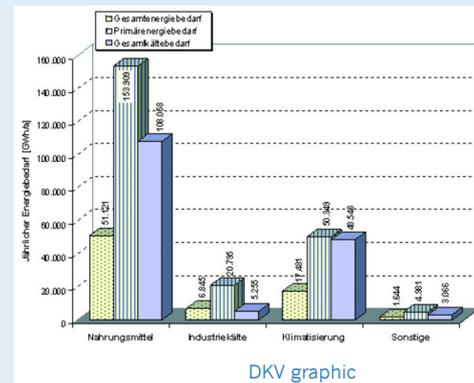
Distributing the refrigerant in the installation control valves.

The NH₃ capacity is 48 tons which is 2 tons below the limit, at which an emergency plan in the case of leakage must be set up. Of course, safety measures were taken everywhere to monitor inside rooms having refrigerant-carrying piping. The refrigerant distribution network has an overall length of 14 km and the large main entrance alone, through which the thickest ammonia pipe runs, is 500 m long. This alone was a true challenge in determining the correct dimensioning of the heat exchangers and this challenge was brilliantly mastered by York and Guntner. A total of 175 installation control valves are responsible for the distribution of the refrigerant.

Energetically optimized

“Unfortunately, we cannot use most of the waste heat”, regrets Flemming Sørensen during the tour and inspection of the three giant dry coolers with a total power of 12 MW at temperatures of 30/20 °C. “However, we do use heat recovery and we reclaim maximally 5 MW via the plate heat exchangers from the oil coolers of the screw compressors (1.2 MW), superheating the refrigerant (0.9 MW) and condensation heat (3 MW) which is then used to heat the slaughterhouse's processing water. And a 1.8 MW heat pump operates using the reclaimed heat energy.” Holger Thygesen adds: “As the largest energy consumer, refrigeration was especially challenged. Therefore, we took special care that the heat exchangers were dimensioned so that no unnecessarily low evaporation temperatures occur, yet all the requirements were filled. Because it is well-known that each unnecessary degree of evaporation temperature saves 4 to 5 % in energy and there-

fore in CO₂ emissions as well as in hard cash.” Therefore, it doesn't make any sense to save on investments if it causes run-away operating costs.



Danish Crown, the operator, recognized this early on. Therefore he entrusted his partners York and Guntner with the refrigeration technology for his showpiece – and to this day, there have been no complaints heard. And also in the case of ventilation technology, which was designed in close cooperation between Guntner and Bardram, the high hygiene standards could be met and draught-free working conditions in the cutting room could be guaranteed. For the customers and employees of Danish Crown, both are equally important.



A look into the cutting room with its associated air distribution.



Inside the ventilation unit: stainless steel heat exchangers for air treatment



Global Player on the pork scene

Danish Crown, the third largest company in Denmark (28,000 employees) is a co-operative with a democratically elected management (board of directors and representative committee) made up of members and employee representatives. Of the 18,000 members, significantly more than half are involved in the production of pigs for slaughter, of which 90 % are slaughtered in Denmark.

As the second most important pork distributor in the world (only the US company, Smithfield Foods Inc. in Norfolk, Virginia is larger) and the largest in Europe, DC is one of the true global players in the pork industry with 122 foreign sales and production operations alone. As the world's largest pork exporter, DC posted an export value of 3.4 billion EUR in the previous fiscal year. This is more than half of the overall revenue of over 6 billion EUR. The most important export markets include Germany and England, and also Japan and China.

The links in the cool chain

What's behind the cool chain, the uninterrupted circulation of low-temperature cooled food between the producer and the consumer? The annual updated VDKL (German Association of Refrigerated Warehouses) survey of all refrigeration and deep-freeze storage capacity in Germany gives us information and recorded for the year 2005 over 728 refrigerated warehouses with a volume of at least 2,000 m³. This includes operational as well as commercial refrigerated warehouses. According to the survey, the overall capacity of German refrigerated warehouses in 2005 was approx. 20 million m³. According to VDKL, there are currently over 55,000 freezer trucks and 43,000 trailers with a loading capacity of almost 1 million tons on German roads to transport cooled goods from the producers to the warehouses and to the markets.

And frozen foods have been on the increase for years. According to the German Deep-Freeze Institute, the quantity of frozen food per consumer rose in the last 10 years from 13.1 kg to 37.1 kg in 2004 and by the end of the year will further increase to over 38 kg. This is equivalent to 3.15 million tons, or put another way, a goods turnover of 10 billion. Representatives of the deep-freeze industry estimate that this trend will continue since German consumption is still far behind the USA and other European countries. Consumer surveys report similar results.

Chilling food consumes the most energy

The food sector is world-wide by far the largest sector that requires mechanically created cooling energy. According to research carried out by the FKW Hannover and ILK Dresden, in Germany in 1999, around 155,000 GWh were needed alone for the production, transport, distribution and storage (up to and including home refrigerators) of foods alone. Cooling energy accounts for a 5.9 % share of Germany's primary energy needs. 67 % of this share is used for food refrigeration; this is equivalent to a total share of approx. 4 %.

Facts about the Horsens slaughterhouse

- Area square footage: 370,000 m²
- Building area: 78,000 m²
- Employees: approx. 1400
- Construction period: August 2002 to May 2005
- Capacity: 77,000 pigs per week (expandable to 85,000)
- Total costs: 2 billion DKK or 267 million €
- Costs for refrigeration technology: 11.5 million €

Güntner heat exchangers that were used

- 1 GHS 046C/112
- 2 GHS 046D/212
- 1 GDS 051B/210
- 4 GHS 051D/112
- 1 GHS 051D/212
- 1 GHS 051D/312
- 6 GHS 051E/112
- 6 GHS 051E/210
- 1 GHS 051E/212
- 2 GHS 051E/312
- 1 GHS 066C/18
- 1 GHS 066C/210



- 1 GHS 066C/212
- 2 GDS 066C/312
- 2 GHS 071D/312
- 1 GHS 071E/112
- 1 GHS 071E/212
- 1 GHS 071E/312
- 4 GHS 081D/210
- 4 GHS 081D/212
- 4 GHS 081E/212
- 4 GHS 081E/312
- 2 S-GHS050G/314
- 21 S-GHS071D/312
- 8 S-8/10/13,7/2000
- 24 N-14-24-12
- 20 N-5-21-11
- 16 N-5-20-11