District Cooling Network in Paris

Ice Storage Unit Improves Efficiency of District Cooling Network

The district cooling system at Climespace in Paris has been well accepted. Meanwhile, the demand is higher than the cooling capacity. Climespace is concessionaire of the City of Paris, and with its 57 km long cooling network the company supplies about 400 customers with an equivalent climatized area of some 4 million square metres. In order to guarantee the cooling supply at peak times and to level off the use of electricity, two ice storage units of Fafco S.A., Biel/Switzerland, with an overall cooling capacity of about 20,000 kWh were installed at the refrigeration plant Opera/Galfa at the beginning of the year 2000. After 5 years of excellent results, at the beginning of 2006, a further 4 Fafco ice storage units with an overall cooling capacity of about 30,000 kWh were installed in the refrigeration plant »Les Halles«. In addition to the mechanical cooling capacity of 44 MW the ice storage units supply a further 13 MW to the city cooling network.

Wolfgang Schmid,
Journalist for Building Services,
Munich/Germany

District Cooling

District cooling is setting a trend. All over Europe networks are being improved and feasibility studies on new cooling networks prepared. The classic district cooling cities are Paris, Stockholm, Oslo, Helsinki, Amsterdam and Barcelona, but recently cities in Austria (Vienna, Linz) and in Germany (Munich, Gera) have been building up new district cooling networks. Experts predict a similar development for district cooling as for district heating at the beginning of the 1970s.

District Cooling in Paris

In 1992, Climespace started as concessionaire of the City of Paris with building up a city network, which today includes 5 cross-linked refrigeration plants with a mechanical cooling capacity of 170 MW. After initial skepsis shown by property owners and managers towards district cooling the trend is definitely towards a district cooling connection in the City of Paris.

More Economy and Reliability

Whilst in other European countries factors like minimizing cooling agents, efficiency improvement of the cooling process and the use of waste heat for cooling play an important role when deciding for district cooling, additional reasons are decisive for a connection to the district cooling network in Paris, for example:

Figure 1. *Ten turbo chillers supply roughly 44 MW cooling capacity. Two of these work with Glycol as cooling agent for loading the ice storage units.*
Photo: Margot Dertinger-Schmid

• permits for air-conditioning plants of more than 500 kW electric power; application approvals can take up to 2 years,
• quasi prohibition for wet cooling towers in the city area due to the danger of an outbreak of the legionnaires' disease; the space required for dry cooling towers is greater and often not available
• new planning regulations according to which the »roofs of Paris« are cultural assets and should therefore be free of technical constructions like air-conditioning units, cooling and recooling plants; approval for renewals of plants or parts of plants is hardly ever granted.

Apart from the amended official basic regulations economic reasons also speak for a district cooling connection. Some of the arguments are:
• simple connection of subsequently climatized old buildings, as there is often no space for air-conditioning plants/recooling units,
• fewer or less qualified personnel for building management required,
• no maintenance costs for chillers and installations, no costs for regularly required legionnaires' disease tests in the cooling tower water,
• calculable costs for cooling independent of further official stipulations (safe investment),
• more space available due to smaller plant area, recooling units on the roof are no longer necessary (visual gain),
• improvement of reliability, even at extremely high outside temperatures,
• low electrical power peaks as cooling plants are omitted,
• no further investments required for renewing the refrigeration plants; financial reserves no longer necessary.

Numerous publications on the subject district cooling confirm the following points:
• more efficient use of cooling agent,
• less danger of cooling agent leakage due to professional management; refrigeration is concentrated at only a few places instead of operating many single chillers,
• higher energy efficiency (COP coefficient of performance) which means less CO_2 emissions,
• improved utilization of chillers and possibly COP optimized operation,
• use of waste heat from co-generation for driving absorption-type chillers,
• less warming up of building environment as no recooling equipment is required.

Higher Output and Less Power Peaks

In the course of modernizing its first district refrigeration plant »Les Halles« in Paris built in 1978 and induced by the rising demand for district cooling in Paris Climespace raised the output of mechanical cooling units by means of ice storage units. In the meantime, the district refrigeration plant integrated in the »Les Halles« complex is equipped with 10 turbo chillers of about 42 MW cooling capacity as well as 4 Fafco ice storage units (l = 11.8 m, w = 4.8 m, h = 3.3 m) with a total cooling capacity of about 30 MWh. The integration of the ice storage units into the hydraulic network of the cold water generator is achieved via 2 flat plate heat exchanger with 2.6 MW each. The two ice storage units are hybrid units with a very high discharge output within a short time at extremely low cold water temperatures. The high discharge output results from the simultaneous discharge via the glycol circuit and the water circuit of the ice storage unit. The air injection system integrated in the ice storage units effects an additional increase in output and guarantees an optimal constant

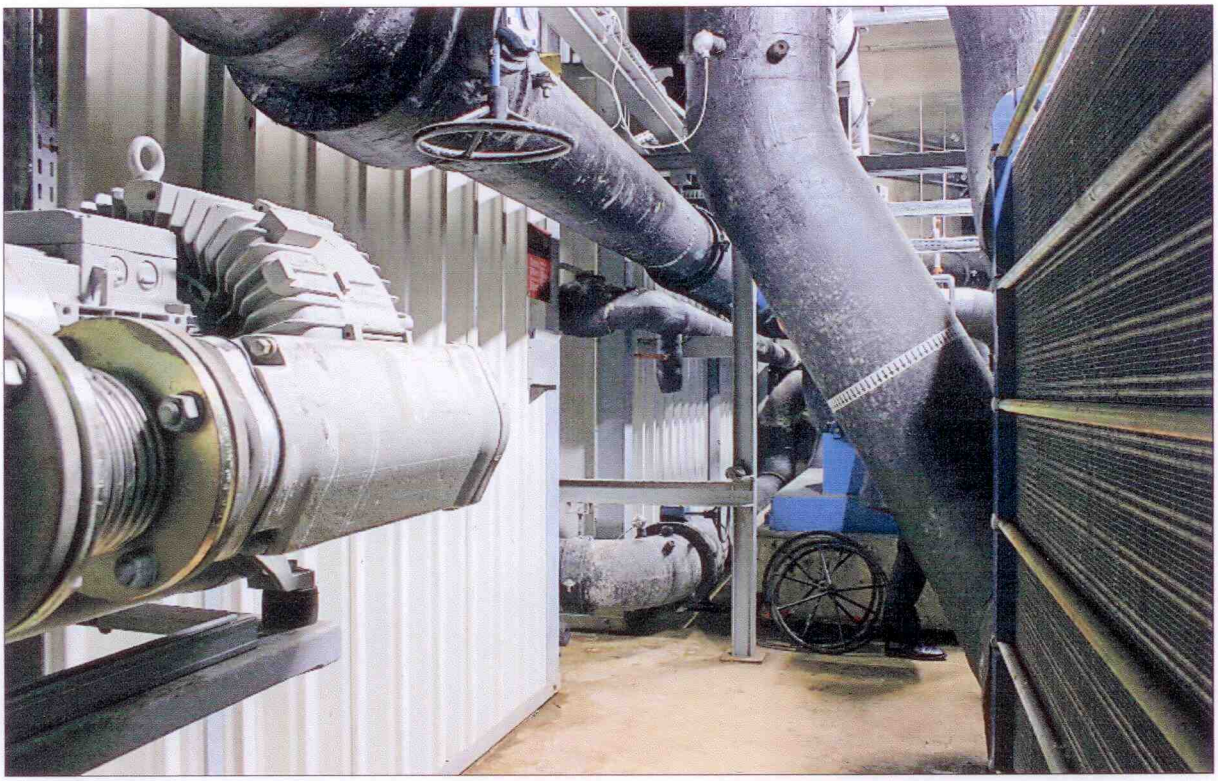

Figure 2. *Four Fafco hybrid ice storage units with an overall capacity of 30 MWh can supply about 13 MW to the district cooling system at short notice.*

Photo: Margot Dertinger-Schmid

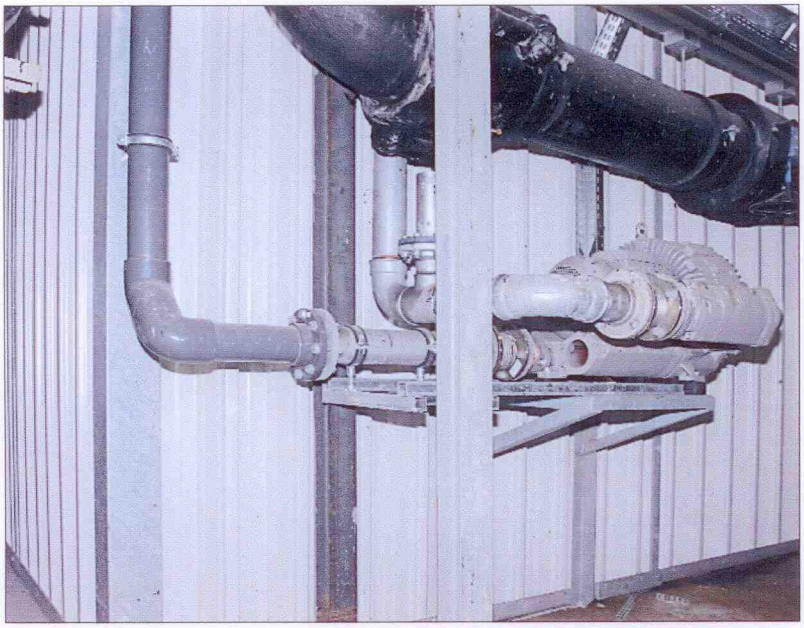

Figure 3. *By injecting air into the lower part of the ice storage unit the melting capacity is raised and the melting process more consistent.*

Photo: Margot Dertinger-Schmid

melting and flow-through of the ice block. The geometry of the ice block is thus preserved until just before the discharge time. An essential advantage of this ice storage type is the optional partmelting and part-loading without affecting the function or the efficiency of the ice storage unit.

Peak Load and Emergency Cooling

Climespace uses the ice storage unit mainly to reduce the network temperature from 4 to 2 °C and can thus transport a considerably higher load through the existing system at the same flow rate.

The ice storage units also serve as stand-by in case one of the chillers fails and also as reserve at peak load times in the district cooling network which occur mainly in the late afternoon. The usual integration of the ice storage unit into a power management system in order to reduce the electrical power requirement and thus avoid load peaks is not being practised at present due to tariff agreements with the power suppliers, this could, however, be activated any time. The integration of 4 ice storage units in the district cooling network offers various ways for strategic operations to make the district cooling network more reliable. Examples:

- Interseasonal period: Chillers operate in COP-optimized part-load operation, ice storage units fulfil load peaks,
- Extremely hot summer period: Ice storage units are fully loaded during

the night at weekends, even if the utilization of the district cooling network on Sundays amounts to only about 60 %. To compensate extremely high load peaks at the beginning of the week, as a prophylactic measure, the district cooling network is cooled down to 4 to 2 °C incorporating the hybrid ice storage units. The district cooling network – volume of water roughly 8,000 m^3 – thus becomes a cooling storage unit in itself.

• Normal summer period: The cooling requirements are fulfilled by the chillers as long as possible; the ice storage units are only set into operation if the requirements for the specific day are foreseeable. This strategy allows the loaded storage units to take over an emergency cooling function if one or several chillers should fail. Two of the chillers are constructed in such a way that they can load the ice storage units at -5 °C during the night and during the day also provide cooling at the warmer COP cold water of 2 °C. This design creates further cooling capacities.

Logistics Challenge in the City of Paris

Although the integration of the 4 Fafco hybrid ice storage units into the district refrigeration plant represented a complex engineering solution, the real challenge of the »Les Halles« project were the building site logistics. Roughly 950 m^3 of material weighing 70 tons, loaded on 13 articulated trucks, had to be transported from Biel/Switzerland to Paris/France. As trucks are restricted in the city, the equipment had to be transferred to 34 smaller trucks in the suburbs of Paris. Due to the limited space situation in the Quartier »Les Halles« as well as the limited overhead clearance of merely 1.90 m for the only approach to the assembly site, the parts of the ice storage units had to be transferred once more to car trailers in order to pass through the basement garage »Rambouteau«. About 250 trips on 60 days were necessary to install the demounted ice storage units just-in-time roughly 20 m below ground level and 12 m under the River Seine. To add to the difficulties, work stopped on Thursdays, the market day, Fridays are often half working days in Paris or even days off, so that actually only 3 working days were available.

Figure 4. *A total of 950 m^3 of material for 4 ice storage units weighing 70 tons had to be transported on 250 car trailers through a basement garage to the refrigeration plant 12 m below the River Seine.* Photo: Margot Dertinger-Schmid

Thanks to the meticulous planning of the Fafco specialists and the optimal coordination with Climespace the 4 Fafco ice storage units were delivered and installed within circa 12 weeks. From Fafco's point of view not only the technical know-how but also the logistic competence is a decisive factor when placing an order for future projects.

Prospects

Building managers in Paris and other major cities have realized that in the long run district cooling is more economic and more compatible with the environment than single building refrigeration. Even today, it is estimated that the City of Paris requires additional cooling capacities of about 50 to 100 MW. The reliable cooling supply in the extreme summers of 2003 and 2006 convinced many skeptics. The restrictive local authority measures like permits, the »free roof politics« as well as the strict hygiene investigations of wet cooling towers promote district cooling. Due to the high electrical load peaks in the summer months – and simultaneously reduced capacity at the power generating stations caused by the shortage of cooling water – the time-shifted prophylactic refrigeration at low tariff periods will become more important in future. With the help of ice storage units cooling peaks can be fulfilled and at the same time peak tariffs for electricity avoided. An important side effect of refrigeration during the night is that the outside tempera-tures are lower and thus also the recooling temperatures of the chillers. Skilful management can result in favourable COP values for ice storage loading of chillers. ■

wsm@netsurf.de

www.climespace.fr

www.fafco.ch