

FAFCO Ice Storage. Just ingenious.



FAFCO
Ice Storage Systems

ICE STORAGE — THE SMART ALTERNATIVE

Cooling requirements in a building can vary considerably over a 24 hour period and from season to season. Whilst little or no cooling may be required at night or in winter, substantial peaks of consumption will occur during the day in summer. A conventional cooling installation must be sized to meet these peaks resulting in a chiller plant much too large for most other times. This leads to poor plant utilisation and a low overall operating efficiency resulting in high cooling production costs. In addition, higher capital investment may also be needed.

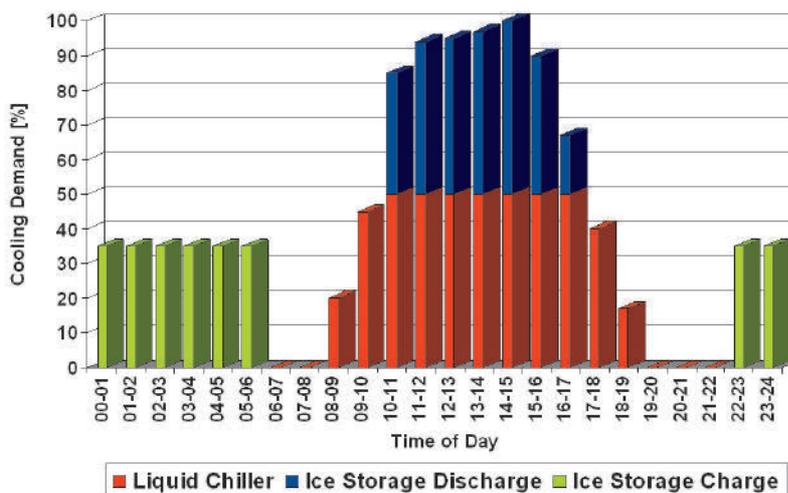
With the use of an ice store, cold energy can be produced at night usually at a lower cost. During the daytime this energy can be redistributed to the cooling system as required. In periods of high demand direct cooling

production peaks can be avoided and chiller capacity can be reduced by 50% or more. In addition, the ice store only can be used during period of low demand avoiding operation of the chiller plant altogether! Plant utilisation is greatly improved and, with better control of cooling output, production costs can be lowered even further.

The simplicity of the system structure, the simple operating principle and the low maintenance requirement

means that today the use of ice storage systems represents a cost effective alternative to conventional refrigeration provision methods. The refrigeration provided by ice storage systems substitutes refrigeration machine cooling at given times and therefore enables the cost effective operation of refrigeration plants. Ice storage systems can contribute to the green building aspects as they provide efficient use of energy and natural resources and furthermore allow reduction of greenhouse gas emissions.

Typical Load Profile in A/C Applications



THE RIGHT PRICE FOR COOLING

Buildings with widely varying cooling needs such as shopping malls, hospitals, hotels, exhibitions, office buildings together with some industrial processes will in particular benefit from cold energy storage. Ice storage will in such cases be more economical in operation than a conventional system. In addition, substantial savings in connection charges may be available. The greater the peak demand, the higher the pay-back achieved.

Compared with a conventional installation, FAFCO Ice Storage units allow many system components in addition to the chiller itself to be reduced by up to 50% in size, Heat rejection capacity whether by air-cooled condensers or cooling towers will be down-sized as will the electrical supply and its associated switch gear and transformer capacity often saving space in critical areas. Capital cost savings will be higher than expected!

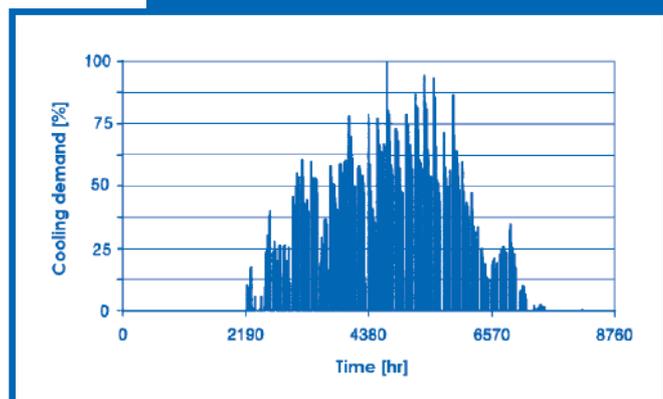
Cooling production peaks can be avoided with the use of an ice storage. High demand is met with cooling from both the chiller and the ice store which has been charged using lower cost electricity from the off-peak tariff. FAFCO Ice Storage units are durable for a long life and require little maintenance. Amortisation of their cost is rapid – increasing the benefit of savings achieved.

In most air conditioning systems part-load operation and on-off cycling of the chillers occur through-out the day. This is the reason why most air conditioning systems operate with their highest efficiency less than 50 or in some case even less than 25% of their operating time. In combination with the ice storage system, the chiller runs at full load, hence peak efficiency, almost all the time. Ice storage eliminates the inefficient cycling of chillers during part-load operation.

In combination with ice storage chillers can operate during the night with around 20°C lower condensing temperatures. This improves the energy efficiency of the cooling system compared to systems without ice storage operating only during the day.



FAFCO Ice Storage type UW
Total storage capacity 2,000 kW-hr

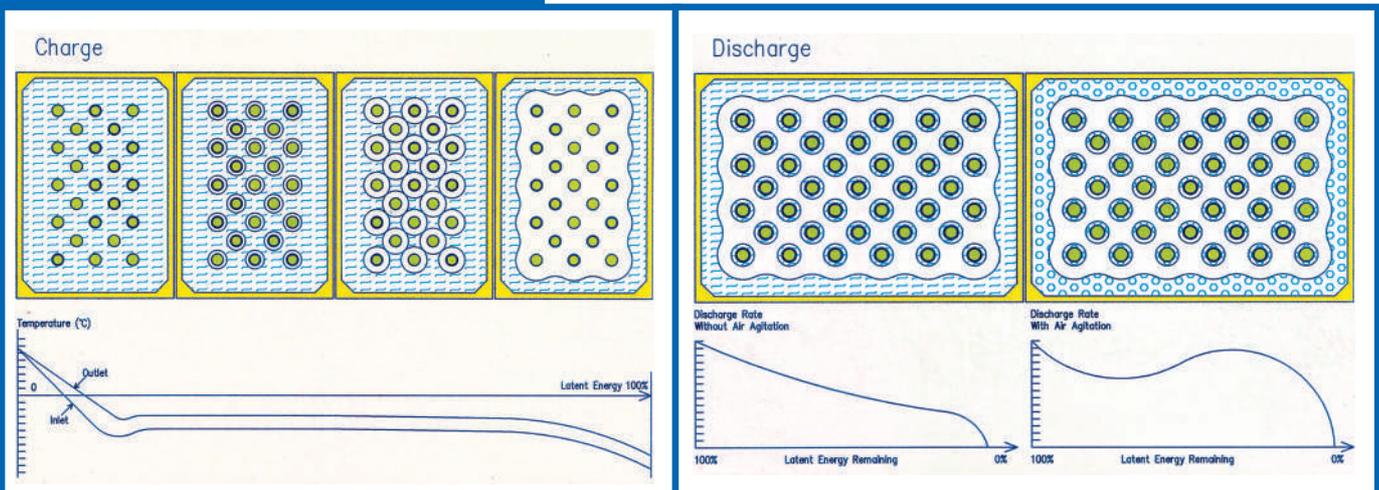


Annual hours of full-load and part-load operation

FAFCO ICE STORAGE CHARGE AND DISCHARGE OPERATION

During the charging process, that is to say the freezing of the water to become ice, brine at a temperature of approximately -5°C is fed through the heat exchanger which is situated in the water filled vessel. The ice builds up around the tubes and by the end of the process has formed a solid block of ice, hence the designation ice bank storage unit.

Ice formation during charging in FAFCO systems is perfectly uniform due to reversed return piping arrangement and a very particular heat exchanger design including an orifice device. A perfect ice block is formed at the end of the charging period. There is no necessity to discharge such kind of ice banks frequently. Recharging is easily possible at any time, absolutely no limitations in charging and discharging schedule occur.



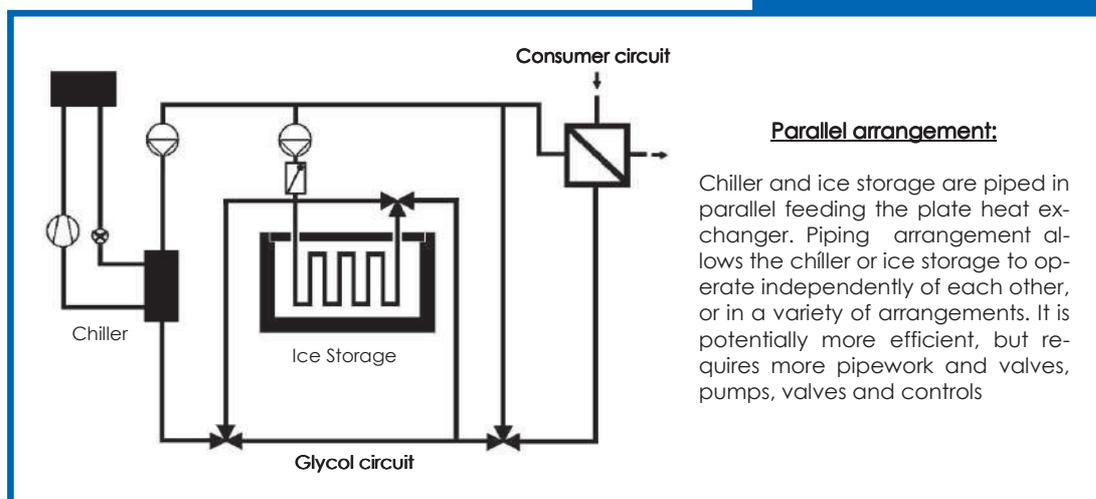
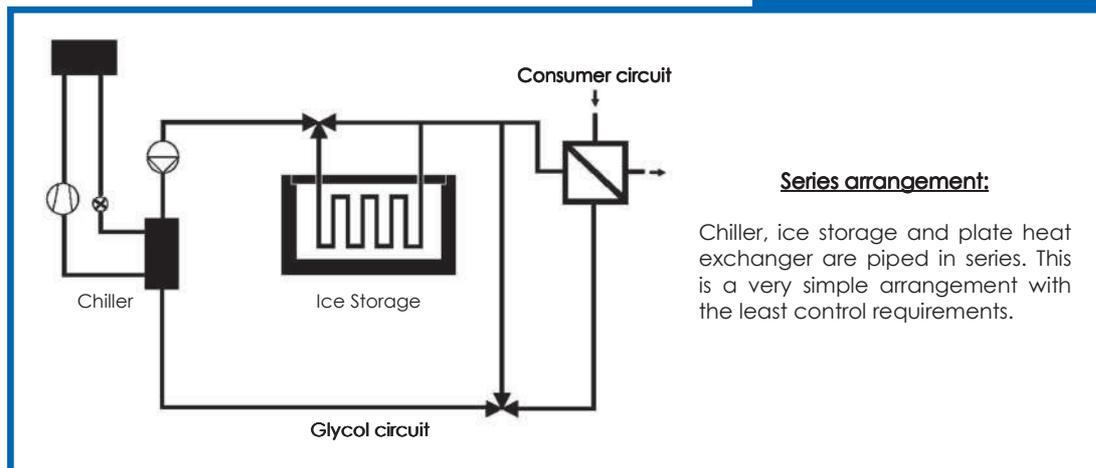
When the ice is melting, that is to say when discharging, the warm brine is fed through the heat exchanger again and the ice around the tubes melts first. As the brine is always fed through the heat exchanger system the formation of an ice block allows very compact design of the FAFCO Ice Storage systems. The tank volume can be significantly reduced compared to competitor's systems.

The discharge performance is highest when the storage unit is full and decreases as the load level reduces, that is to say the amount of ice. Today the achievable discharge temperatures with the air injection with air blower even when the storage unit is almost empty is around $+2-3^{\circ}\text{C}$. Air agitation in FAFCO Ice Storage systems is only an option.

ICE STORAGE SCHEMATICS

FAFCO Ice Storage systems can be incorporated into almost any system using liquid as the cold energy heat transfer fluid. Generally, there are two piping arrangements commonly used: series and parallel arrangement. The names reflect the relative position of chiller and ice bank. Due to the use of glycol as a heat transfer fluid a plate heat exchanger normally separates the cooling circuit from the building load circuit.

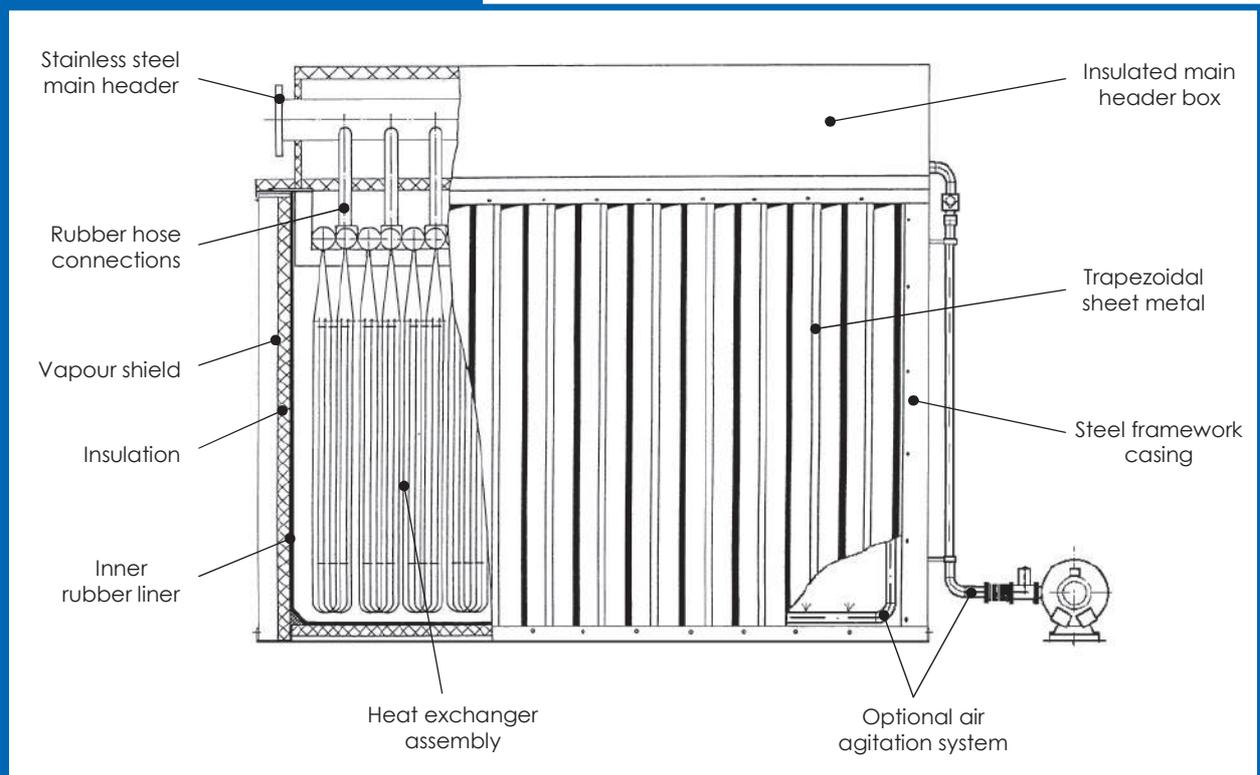
The operating modes during daytime and nighttime are adjusted by appropriate valves. During charging operation — which normally takes place in the night — the heat transfer fluid leaves the chiller at a temperature of -5°C and flows through the ice storage heat exchanger system. The daytime cooling load is met by chiller, ice bank or a combination of the two



ICE STORAGE — STEEL CASING CONSTRUCTION

A rectangular tank with internal insulation and a completely water tight inner liner enclosing a unique heat exchanger assembly make up a FAFCO Ice Storage unit. The tank is filled with water, cooling is stored as latent energy within the ice.

The heat exchanger assembly consists of individual heat exchanger modules made of specially formulated stabilized polypropylene tubing. The heat exchanger assembly is suspended within the ice/water tank. The unique FAFCO modular design with a huge number of small plastic tubes arranged in parallel provides a very extensive heat exchange surface of $0.43\text{m}^2/\text{kW-hr}$ with high transfer rates under all operating conditions. Uniform distribution of the heat transfer fluid is achieved by means of a series of calibrated openings within the collector construction. This method of construction also means that hydraulic pressure losses are low even when flow rates are high.



Optional air agitation greatly improves the cooling discharge rate as required in some installations. FAFCO can supply a special air injection system for this purpose as an option on all its ice banks.

FAFCO ICE STORAGE MADE TO MEASURE

FAFCO Ice Storage systems offer a made to measure solution for most cooling requirement and for practically any size of building. 24 standard models are available with latent cooling capacities ranging from 258 to 9,800 kW-hr but all other size units can be supplied for particular applications and plant room dimensions.

Because of their method of construction and the modular nature of the heat exchanger assemblies, FAFCO Ice Storage units can be supplied in component form. All component items can be passed through a single doorway for assembly at the ice bank's final location - an ideal solution for both new and refurbishment projects. Practically, there are no limitations in ice storage sizes. Any size can be supplied and assembled on site. Ice storage systems which are assembled on site have enormous advantages with regard to flexibility in the use of space. The less units are installed in the cooling system, the easier it is to balance the flow of the system.

The use of several heat exchanger modules affords the best reserve and allows for easy repair in the unlikely event of a defective module. Here plastic tube heat exchangers have an evident advantage. No special openings and lifting devices would be required. Ceiling height could be minimized as plastic heat exchangers can be bent and replaced easily. Due to their weight they can be carried by hand without any problems.

FAFCO Ice Storage systems can be installed internal or external to the building where necessary.

FAFCO engineers can provide estimates of saving which will result from the use of ice storage as part of its customer service. This includes also full expert advice on all aspects of ice storage and the application of FAFCO equipment.



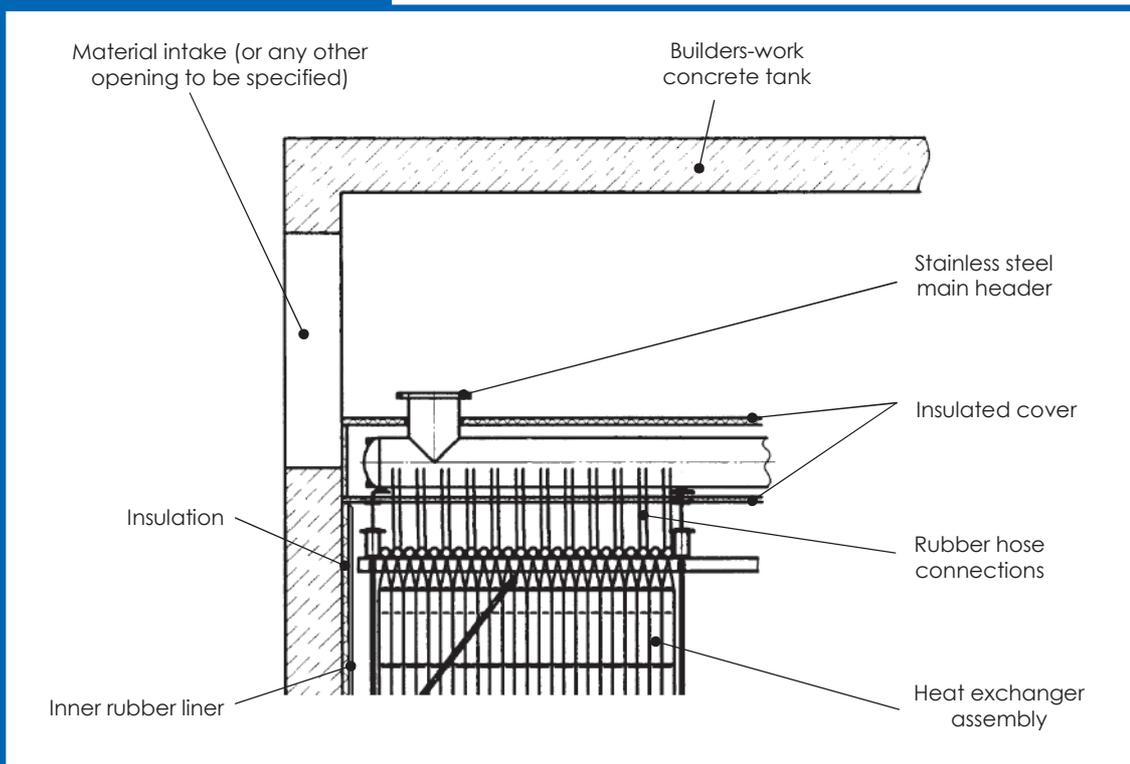
Site assembly of a FAFCO type UW Ice Storage
Total storage capacity 6,600 kW-hr



EMMI Cheese & Milk factory Emmen/Switzerland
Total storage capacity 5,500 kW-hr

FAFCO ICE STORAGE IN BUILDERS-WORK CONCRETE TANKS

As an alternative to their conventional units, FAFCO can supply ice storage systems assembled within builders-work concrete tanks. This solution provides an exceptionally solid construction and is particularly suited to large projects. Generally they require less floor area and can be easily integrated into the building structure. Irregular plan areas can be accommodated - almost any size and shape is possible!



FAFCO Ice Storage
in builders-work concrete tanks

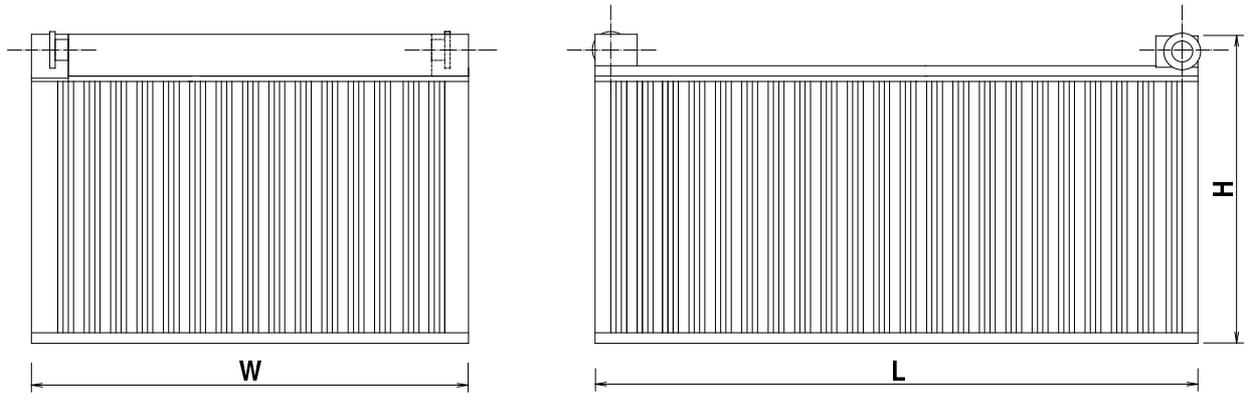


Technocentre Renault, Paris/France
Total storage capacity 75,000 kW-hr



TECHNICAL DATA

Selected FAFCO Ice Storage types



Ice storage Type: UW...	Latent capacity kW-hr	Length L mm	Width W mm	Height H mm	Flange NP 10 NW	Shipping weight kg	Operating weight kg	
155/	1/10	258	1,870	2,240	2,150	100	1,030	5,610
	2/10	516	3,245	2,240	2,150	100	1,460	10,090
	3/10	774	4,620	2,240	2,150	100	1,900	14,580
	4/10	1,032	5,995	2,240	2,150	125	2,360	19,110
	5/10	1,290	7,370	2,240	2,150	125	2,790	23,600
	6/10	1,548	8,745	2,240	2,150	125	3,230	28,090
	7/10	1,806	10,120	2,240	2,150	125	3,670	32,580
	8/10	2,064	11,495	2,240	2,150	125	4,100	37,060
200/	1/10	339	1,870	2,240	2,630	100	1,150	7,010
	2/10	678	3,245	2,240	2,630	100	1,640	12,700
	3/10	1,017	4,620	2,240	2,630	125	2,140	18,430
	4/10	1,365	5,995	2,240	2,630	125	2,640	24,140
	5/10	1,695	7,370	2,240	2,630	125	3,130	29,830
	6/10	2,034	8,745	2,240	2,630	125	3,620	35,520
	7/10	2,373	10,120	2,240	2,655	150	4,130	41,270
	8/10	2,712	11,495	2,240	2,655	150	4,620	46,970
312/	5/11	2,973	7,580	2,580	3,980	150	4,860	51,090
	6/11	3,567	9,080	2,580	3,980	150	5,630	61,630
	7/11	3,567	10,330	2,580	3,980	150	6,310	70,410
	8/11	4,757	11,830	2,580	3,980	200	7,110	81,050
	5/21	5,676	7,580	4,330	3,980	200	7,020	91,870
	6/21	6,811	9,080	4,330	3,980	200	8,100	110,820
	7/21	7,946	10,330	4,330	4,180	250	9,150	126,840
	8/21	9,802	11,830	4,330	4,180	250	10,220	145,790

Any other size can be supplied! All data subject to technical revision!

FAFCO ICE STORAGE ADVANTAGES

Since its foundation more than 20 years ago, FAFCO S.A. has been active in the field of ice storage systems. More than 1,200 ice storage systems all over the world prove the high reputation of the company. The company is highly specialized in the production of different types of ice storage systems. In the field of air conditioning and in industrial applications, FAFCO can be described as one of the world market leaders on ice storage systems. Large and well known enterprises all over the world trust in the quality of their products and in the competence of the staff. The major advantages of FAFCO Ice Storage systems are:

- Very high storage density because of ice block formation.
- Use of plastic tube heat exchangers increases heat transfer surface and minimizes ice thickness on the tubes. Thus, operating costs are preferable compared to other systems.
- Recharging possible at any time, absolutely no limitations in charging and discharging schedule.
- Simple integration of ice storage unit and brine chiller into the cooling system due to the use of a closed piping system.
- No corrosion due to the use of plastic and EPDM material of major components as well as stainless steel header piping.
- Easy repair and replacement of single heat exchangers if necessary
- Very low glycol content.
- Extremely low pressure drop.
- Internal or external location.
- Ice storage units in steel or concrete tanks.
- Supply in knocked-down form for site assembly.
- No limitations in tank dimensions due to modular design. Every size of tank can be supplied.
- Quasi maintenance-free ice storage system.
- Simple and accurate measurement of storage capacity 0-100 %.
- Turn-key assembly of large storage tanks.
- High level of customer service by FAFCO specialists and local agents/representatives.

FAFCO REFERENCES

With its sound know-how and world wide experience gained from a large number of demanding projects, FAFCO implements tailor-made ice banks throughout the world for successful companies which make no compromises in terms of quality, operating costs and the environment.



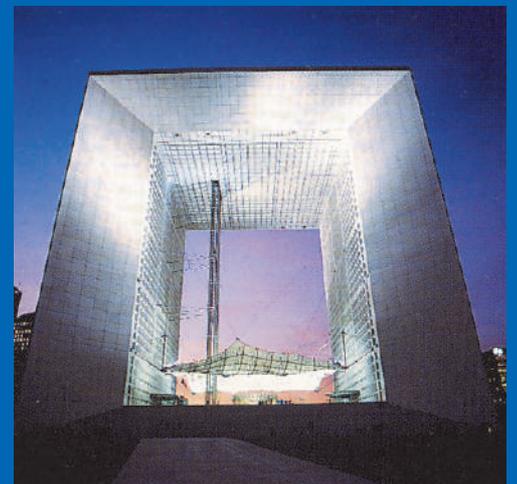
New Exhibition Munich/Germany
Total storage capacity 150,000 kW-hr



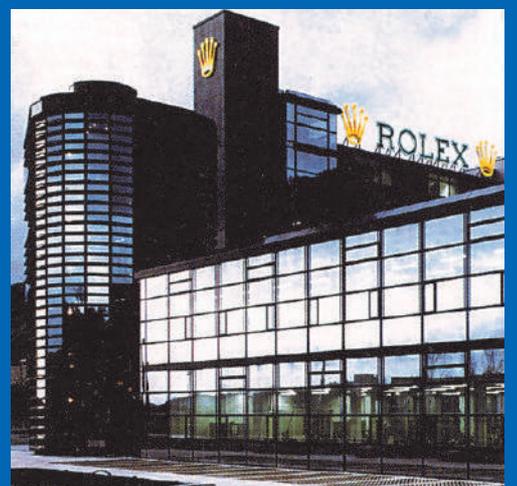
International Airport Geneva/Switzerland
Total storage capacity 17,700 kW-hr



New Exhibition Stuttgart/Germany,
Total storage capacity 56,000 kW-hr



La Défense Offices Paris/France,
Total storage capacity 100,000 kW-hr



Rolex factory Biel/Switzerland,
Total storage capacity 1,750 kW-hr

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