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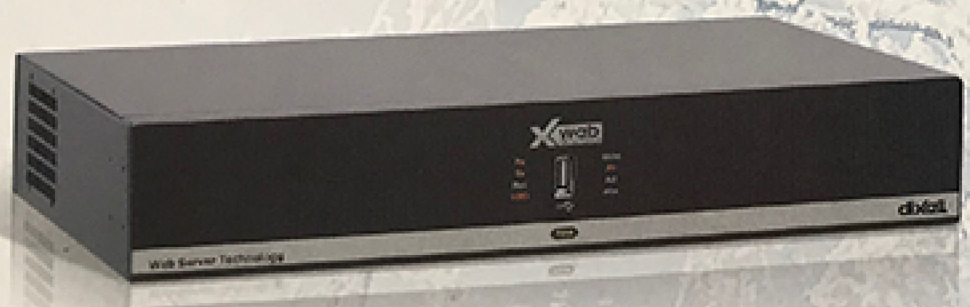

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SYSTEMS

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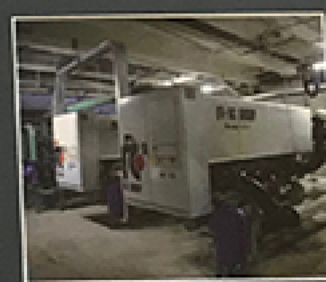
The air conditioning systems were designed with the objective limited energy consumption and centre management. Interestingly, it incorporates an ice bank to support the refrigeration system



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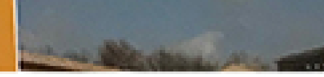
Haribo sweets cooled by the sun

Solar air conditioning is a new



by MICHELE RUGGERI

The air conditioning systems at the new Postal Mechanization Centre in Bologna (Italy) were designed with the objective limited energy consumption and centre management. Interestingly, it incorporates an ice bank to support the refrigeration system

The Ice Bank at the Bologna Post Centre

The CMP (the Postal Mechanization Centre) building in Bologna is located in an area of 132,400 sq.m, 80,000 sq.m of which has been allocated to the mechanization centre. It comprises two sets of parallel buildings that differ in height and size, linked by a tunnel.

The renovations have aimed primarily to preserve the existing building, in particular upgrading the obsolete technology of the systems to meet new company needs and compliance with the law, in addition to ensuring the integrity and efficiency of the systems themselves. One of the first things that needed to be done was to adapt the rooms housing the large mechanization machinery.

SPECIFIC NEEDS AT THE COMPLEX

The CMP buildings house the following activities and rooms:

- offices and similar;
- manual and mechanized working zones; these areas are allocated for processing mail and consist of large areas housing a number of mechanized systems and a small number of operators running the machines;
- technology stations; these are areas designated as control centres for mechanized plants and video coding mail to house computers, electronic equipment and personnel;
- loading and unloading areas and hubs; these are areas where sectional doors are opened continually thereby creating extensive contact with the outside;
- locker rooms and bathrooms;
- connections; these are areas connecting the various designated areas and comprise for the most part of corridors and areas for additional services, canteens etc.

Heating and conditioning

Heating and conditioning systems are designed with the objective of limiting energy consumption and centre management, whilst respecting the needs for comfort for personnel and the functional parameters of mechanized system. The systems were designed for remote control systems to streamline management costs (see box on page 13 and 14).

DESCRIPTION AND CRITERIA FOR THE SELECTED SYSTEMS

The mechanical and electrical systems and building works have been renovated at the Postal Mechanization Centre in via Zanardi 30, Bologna. We describe the renovation works on the mechanical systems in the basement, and ground, first and second floors and the roof.

The work areas are:

- thermal power station for the production of heating liquid for winter conditioning and heating;
- refrigeration system and closed cycle regeneration system for condenser liquid;

Figure 1 - Detail of the refrigeration system

Figure 2 - Ice storage area

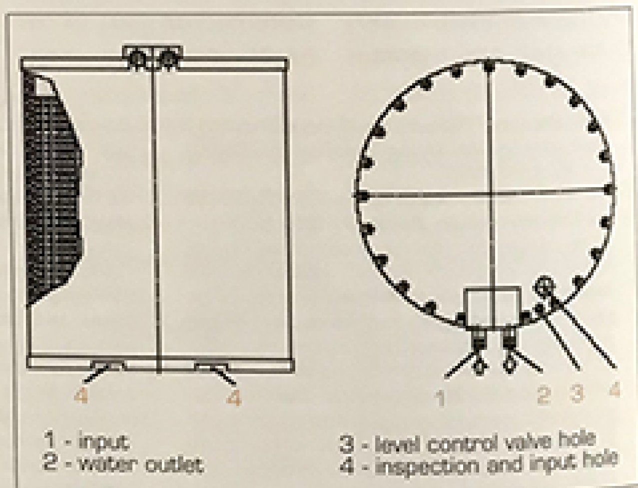


Figure 3 - Practical diagram of ice maker

Figure 4 - View of plate exchanger area

Figure 5 - Electropump circulation area

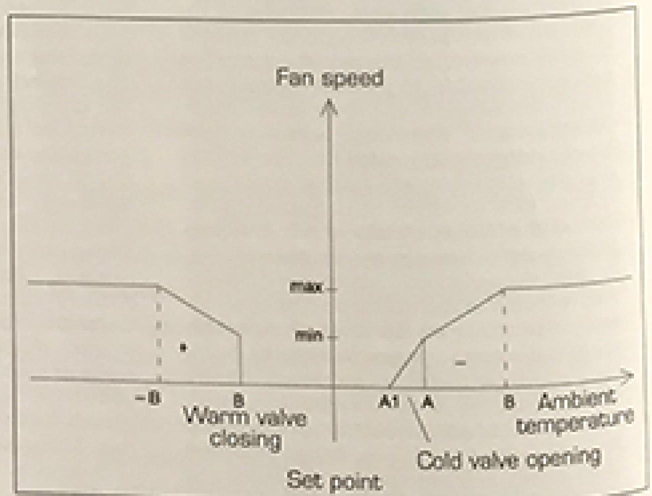


Figure 6 - Diagram indicating ATU regulation

- refrigerator energy accumulator (the "ice bank");
- distribution network for horizontal ring hot and cold liquids in the basement and vertical mounted columns for hot and cold liquids feeding the terminals;
- summer-winter conditioning systems for industrial areas on the ground and first floors;
- summer-winter conditioning systems for the office and similar areas on the ground floor;
- heat-ventilation and heating systems for transit areas, locker rooms and bathrooms; hygiene and sanitary systems for bathrooms.

Design decisions and general description of the works

Heat generation: the thermal power station

The old boilers have been disposed of, the rooms that housed them have been improved and brought up to code, and new equipment has been installed, all in compliance with current legislation (Italian Ministerial Decree of 12/04/96). The new boilers are condensing type, fitted with temperature regulation for outflow liquid in function of the external conditions.

A "waterfall" type regulation system has been installed in order to adapt the thermal power to the system's effective load, to manage the number of generators in operation.

A primary circuit uses a special, low head electropump for the circulation, via the boiler, of the liquid in the outflow collector to the return collectors.

The combustion product monitoring and analysis apparatus, to standard, controls continuously and automatically the equipment's performance.

The acid condensation produced by the boilers is collected and analysed. Where necessary, it is neutralized with corrective substances before being discharged into the sewage system.

The decision to adopt condensing type boilers is attributable to the fact that they provide:

- greater performance, by recovering latent heat contained in the discharge fumes;
- loss reduction, again thanks to using heat at a lower temperature.

It all adds up to good energy savings and even reduces pollution.

The design and installation of the condensing type boilers anticipated legislation introduced by the Italian Legislative Decree no. 192 on energy saving.

Cold generation: refrigeration system and cooling towers

New refrigerator groups have been installed with water condensation regenerated in cooling towers for the production of refrigerator liquids, needed for summer conditioning systems. An "ice bank" completes the refrigeration system.

The new groups are connected alternatively to a cold accumulation system (night time operation at T = -6°C) and direct generation, with the option of disposing of the stored cold (daytime operation at T = +7 ÷ +8°C). The liquid in the primary circuit can be frozen and is suited to the production of ice; it is indeed constituted of a mixture of water and propylene glycol with a freezing point inferior to -18°C. The terminals are fed by a plate exchanger with large exchange surfaces.

With this system, the energy produced by the refrigerators is "degraded" but at the same time use of glycol liquid in the secondary circuit is avoided, resulting in notable savings in the cost of purchasing glycol as well as in its disposal (every 10 years).

There are therefore two circuits: the primary circuit with glycol blend, the secondary circuit with water. The circulation of liquid between the various apparatus in the system and the terminals is guaranteed by centrifugal electropumps, ideal for the characteristics of the liquid and circuit.

The regeneration system comprises cooling towers and includes a make-

Heating and conditioning

EXTERNAL CLIMATE CONDITIONS

The external climate conditions for the premises in question are indicated in the Italian Presidential Decree no. 412/93 with successive modifications, and UNI standard 10349 "Heating and cooling buildings - climate data".

INTERNAL CLIMATE CONDITIONS

Winter

- Offices, general work areas, cafeterias, conference halls, meeting rooms etc.
  Ti = 20°C rH = 45-55%
- Bathrooms
  Ti = 20°C rH = not controlled

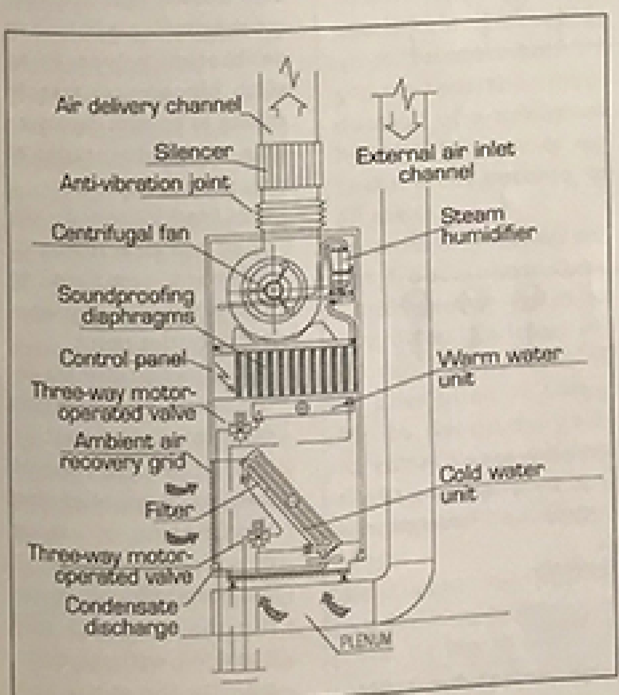


Figure 7 - Diagram of vertical ATU

>> continued from page 13

- Halls, corridors, transit areas
  Ti = 20°C rH = not controlled

Summer

- Offices, general work areas, meeting rooms, conference halls, etc.
  Ti = 26+/-1°C rH = 45-55%
- Halls, corridors and bathrooms;
  Ti = not controlled rH = not controlled
- Large rooms for manual and mechanized mail rooms
  Ti = 28°C rH = 45-55%
- Rooms containing electrical equipment (control rooms, processing rooms, inverter rooms etc).
  Ti ≤ 40°C rH = not controlled.

ENDOGENOUS LOADS

Endogenous loads in consideration are:

- thermal equivalent of mechanical work generated by the postal sorting machinery in compliance with the electrical input of the machinery located in the various departments as declared by the manufacturer. 2500 kW
- coincidence coefficient during operations 70%
- thermal equivalent of the people present (sensible heat) 100 W/person
- thermal equivalent of the people present (latent heat) 50 W/person
- lighting in large areas 50 W/m^2
- lighting in offices and similar 10 W/m^2

EXCHANGING AND REPLACING AIR IN THE ROOMS

Minimal air exchange volumes for the rooms to standard are:

- Offices, work places generally
  1.5 vol.amb./h or 39 m^3/h per person
- Meeting rooms, conference halls, cafeterias
  25 m^3/h person
- Bathrooms and powder rooms
  10-15 vol. minimum (exchange also ensured by the expulsion of primary air from the system)

CROWDING

The crowding values considered were:

- Offices and work places generally
  5 m^2/person (max 10 m^2/person)
- Large mechanized rooms
  20 m^2/person
- Cafeterias, meeting rooms
  2-2.5 m^2/person
- Conference Halls
  1.5-2 m^2/person

LIQUID TEMPERATURES

Temperatures, production and distribution of the hot and cold liquids produced by operating machinery are:

Thermal systems

Heating system:

- hot water for use directly in the winter heating and conditioning systems:
  - into the boiler (according to external conditions) T = 45÷50°C
  - corresponding outflow T = 55÷60°C
  - into the user terminals T = 55÷60°C
  - corresponding outflow T = 45÷50°C

Refrigerator systems

	In temp.	Return temp.
- Daily production by the refrigerator unit	7°C	12°C
- Night time production by the refrigerator unit (for the ice bank)	-6°C	-1°C
- External air treatment conditioner sets	7°C	12°C
- Process and fan coil conditioner sets	10°C	15°C

up water purification system, which decalcifies and treats the water with an injection of anti fouling, corrosion and algae liquid.

Semi-hermetic compressors with screws as opposed to pistons were chosen, as they allow a continuous flow of refrigerant gas; the system uses R407-C gas.

With the cooling towers, the condensing temperature of the refrigerant gas remains stable even in the worst external climate conditions and the units consume less electricity (about 25-30% compared to air condensing units).

Refrigerant energy accumulation system

Each unit of the ice accumulation system comprises a cylindrical container with an internal spiral tube heat exchanger and delivery/return collectors connecting to the system.

In our case, in the daytime we will use the refrigerator unit functioning normally in parallel with the accumulation system, whilst producing ice in the night time.

The basic concept that draws on the advantages of this cooling system is to generate energy by night, to collect it in special tanks, to then provide the power needed for refrigeration by day.

This produces a "thermal flywheel" to be used in parallel to the units or replacing the same where necessary (momentary interruptions) for maintenance.

Power utilities have introduced the time-of-use metering system, rekindling interest in refrigeration systems with cold accumulation, particularly for civil and industrial summer air conditioning systems.

This rate system involves rates for the amount and price of the electricity provided that can differ greatly according to the season (winter/summer) and the various times of the day, closely correlated with the network supply.

Using electricity in the night time, when the general load on the distribution network is modest, is very attractive in terms of cost compared to peak daytime hours, when generating systems and the distribution network are overburdened.

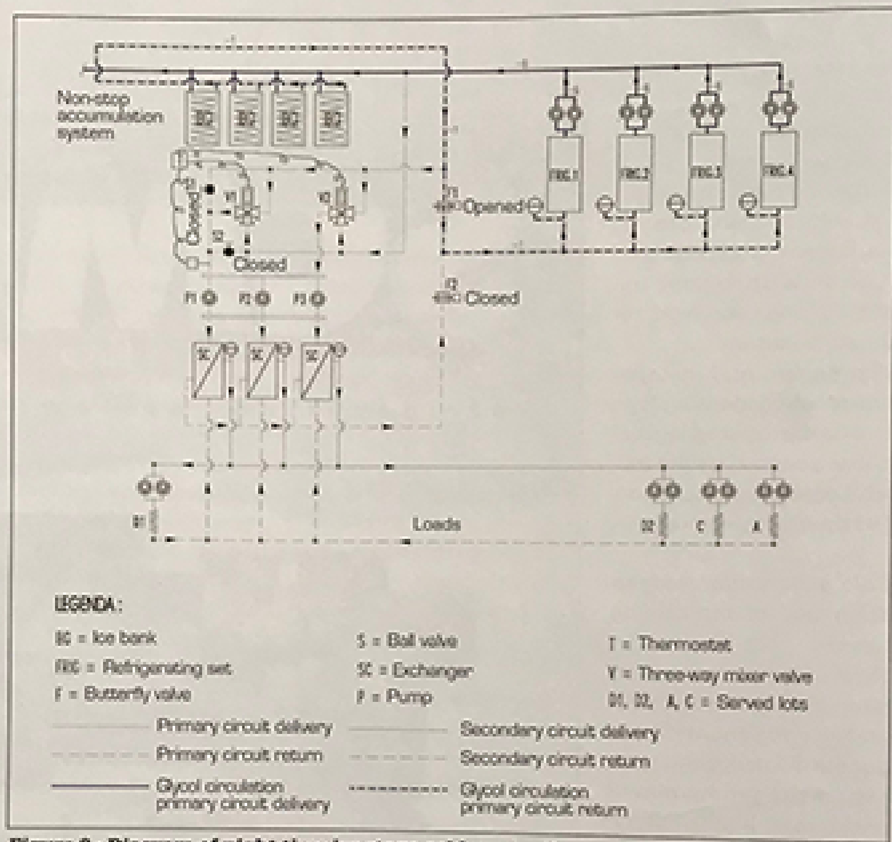


Figure 8 - Diagram of night time ice stage cold production system

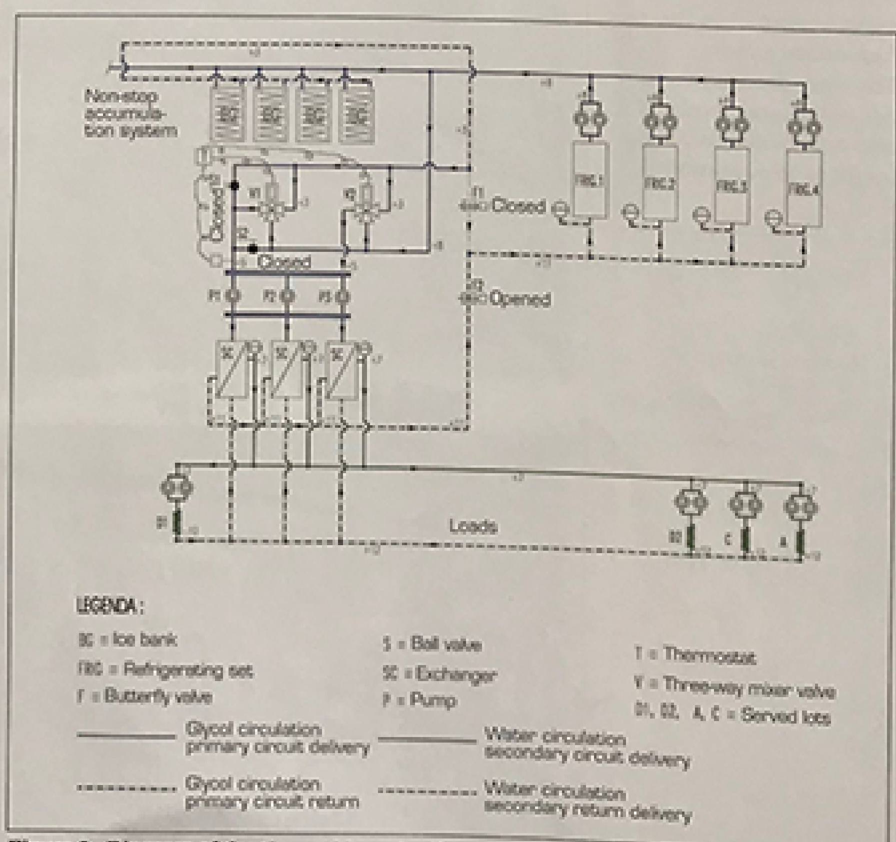


Figure 9 - Diagram of daytime cold production system using night time accumulation and direct unit production contemporarily

Hot and cold secondary liquid ring distribution network

Three horizontal hot and refrigerant liquid distribution rings run from the thermal and refrigerant subsystem in the basement to various applications associated with the three factory sections of the building. The rings are sized for "space saturation" in order to supply the greatest energy needed for the area in question.

Vertical switch-off points supply the equipment situated on the storeys which have sectional access points for future changes and additions.

The access points on the return circuit are balancing calibration valves, fitted with piezometer attachments to control capacity.

The main advantages of ring distribution are:

- low load losses, so low they are practically irrelevant, compared to the whole for any electrical outlet point.
- great versatility for integrating new columns or lateral distribution ducts that may become necessary for changing destination of use or new heating needs;
- the possibility of providing maintenance and changes without interrupting the entire system.

Conditioning systems: large-scale mechanized rooms

It was decided to adopt "all-air" systems with variable capacity for the areas, with a vertical treatment unit situated on the floor or on a technology bridge. The treated air is distributed through channelling and delivered at a number of highly inductive distribution points.

The air is recovered through a special grille placed on the machine shell. Each conditioner comes complete with external air intake and ambiance thermo-hygrometric conditioning.

The capacity of the fans is partially variable in function of charge: this happens by reducing the motor's rpm, via an inverter that decreases charge from 100% to 50-60%.

A temperature sensor positioned on the recovery channels commands the fan speed in sequence and the three-way valve that manages the "hot" or "cold" according to the season.

On reaching the minimum fan speed, in fact, it will continue to operate and the liquid flow will be changed.

The adjustment trend therefore follows the diagram shown in figure 6.

Each ATU (air treatment unit) comes with microprocessor to drive and control the various treatments.

Remote control via a dedicated card is optional for monitoring the system centrally.

The section of ATU is shown in figure 7.

The large-volume areas feature internal thermal charges as they contain machinery (for postal sorting) that produces a significantly high quantity of heat.

This leads to variations in charges from area to area within the rooms themselves.

An all-air system was chosen over a zoned type unit, for the following reasons:

- architectural-structural: to reduce to a minimum the intrusive impact of the work, as apart from the zones occupied by the ATU, the overall dimensions of the channelling are inferior to central zoned systems, which also require recovery channels;
- economical: reducing the number of conduits has direct consequences on installation savings;
- energy: thanks to the possibility of having precise control over the various parameters that we are interested in and that may vary inside the large mechanized rooms, as mentioned above, energy saving is possible, as the effective power to the area is adapted.

Conditioning systems: offices, meeting rooms and equivalent

Primary air and four tube fan coil systems are used in these areas.

The fan coil system is integrated by air recovery systems to ensure a suitable microclimate for personnel comprising an exchange for breathing sufficiently oxygenated air, adequate relative humidity and ideal comfort. The decision to use a mixed system of this kind, as far as well-being and energy are concerned, is widely justified for several reasons:

- it is able to control the temperature of a number of spaces no matter what the load, between the summer and winter maximums;
- ensures relative humidity control within a particular interval of time, for any hygrometric condition and for any conditions of crowding up to the maximum;
- guarantees the introduction of a minimum hourly quantity of air taken from outside to all areas.

The most interesting aspect from an economic and energy point of view, using a primary air and fan coil system, is the possibility of being able to condition various zones depending on whether personnel are present, slashing wasted energy.

Additional extraction from smoking rooms is required by law in order to guarantee a supplementary air exchange flow.

Bathrooms, locker rooms and equivalent

Bathrooms are located in a number of areas.

The bathrooms contain:

- heating systems with radiators or fan coils (hot only);
- extraction and expulsion systems taking spoilt air outdoors;
- hygiene-sanitary systems.

Sanitary hot water for bathrooms for the disabled, sinks, showers and bidets is produced locally by electrical boiler.

There are heating only bodies in these rooms, as they are ventilated (although only partially) through grills on the door, that enable air extraction to adjoining conditioned areas by suction.

A central hot water production system serving the entire building was certainly a costly and large option, especially for the low demand due to the type of work carried out in these areas.

This guided the decision to install local electrical boilers in each bathroom block. //

by Michele Ruggeri engineer

ice bank

MAIN APPARATUS SUPPLIER COMPANIES

- Refrigerator unit Clivet - Rc Group
- Ice bank Rc Group
- Plate exchangers Alfa Laval
- Cooling towers Evapco
- Boilers Thermital
- Electropumps Grundfos
- Conditioners Rc Group - Uniflair - Zoppellaro
- Fan-coil Clivet
- Water/glycol purification Cillichemie
- Regulators Siemens - Carel