Geothermal Cooling System for ACC

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The need to conserve power, its high cost and undependable supply in many parts of the country has made HVAC design engineers study each new building project carefully to evaluate the possibility of maximum power savings. Latent heat storage systems and absorption chillers have both been used in many installations but Ground Water cooling systems have not found wide usage so far.

This article gives an example of a recent application of a small combined Well Water and Heat Pump air conditioning system in Thane, an industrial township only 30 kms from Mumbai.

Background

ACC, India's largest cement manufacturing company, decided to renovate and convert an existing non-airconditioned 40-year old 4-storey building, used for staff quarters into a high grade guest house for its many visitors. The total area was divided into 30 bedrooms with attached bathrooms, lobbies, corridors, etc. The total AC plant capacity worked out to 45 tons or about 150 sq ft /ton. Using a conventional central chilled water system would have entailed a high electric load that would have necessitated applying for a new electric connection from the Maharashtra State Electricity Board (MSEB), an organization that is terribly short of power in any case. Long delays and formalities and the high cost of power were the other deterrents.

Reducing the Heat Load

A study was taken up on measures to reduce the heat load and roof insulation was first on the list. A new roof was laid with brickbat coba waterproofing, screed, white China mosaic tiling, which was fully covered with PV (photo voltaic) cells, resulting in a U value of 0.21 W/cm.K. Wall insulation was then added on all sides of the bedrooms, using 25 mm glass wool on the inside covered with Gypsum board. The existing glass windows were changed to double glazed sandwich type with a U value of 2.1 W/(m^2.K) In each case several different materials were selected initially and thermal insulation software used to evaluate the best alternative. The light fittings were changed to LED type fixtures. Fresh air intake locations were changed and instead of drawing air near the fan coil units, it was drawn from a window panel facing the landscaped area where outdoor air temperature is lower because of water bodies in the surrounding area. CO_2 sensors were

About the Author

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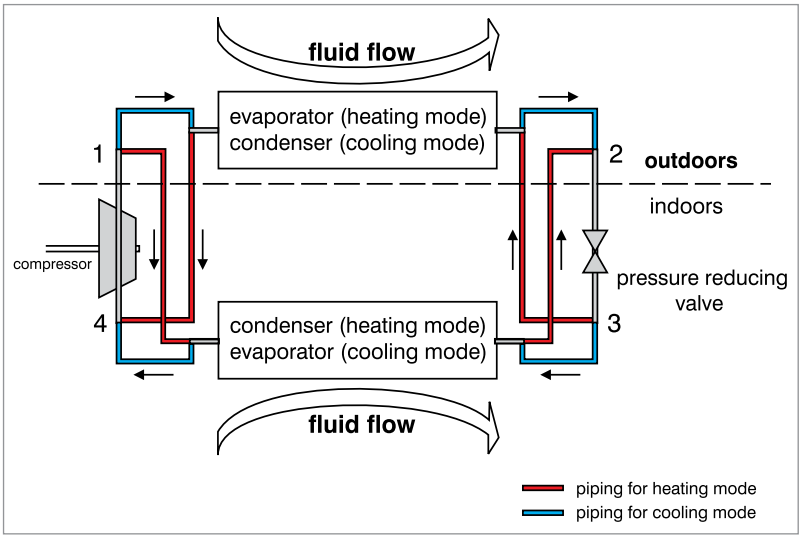

Figure 1: A typical Heat Pump

installed in the bedrooms to check the FA levels. With all these measures the final heat load was reduced to only 14 tons or 675 sq ft/ton.

Selecting the AC System

Now that the plant capacity was determined, various options were considered and a central chilled water system was selected for maximum flexibility. With the help of the ACC engineering staff, a soil investigation was carried out in the land around the guest house and it was found that an unused borewell had a water temperature in the summer months of 26°C maximum. Further cooling of this source of water to 8°C through a small capacity water-cooled packaged chiller could give us the chilled water required for the fan coil units in the guest rooms.

Figure 1 shows a schematic diagram of the chilled water circuit, condenser or cooling water circuit and the refrigerant circuit in the heat pump that functions as a chiller, using several borewells to supply cooling water to the Heat Pump water-cooled condenser as well as to the evaporator in the chilled water circuit and ultimately discharging the cooling water to other borewells in the vicinity for recharging the earth.

In the first loop at the top of *Figure 1*, the chilled water is circulating between the cooling coils inside the FCUs/AHUs inside the guest house and the evaporator of the Heat Pump with the help of a chilled water pump. This chilled water takes the heat from the guest rooms and transfers it to the low pressure liquid refrigerant in the evaporator. By absorbing this heat, the refrigerant changes its state from liquid to a vapor phase, is

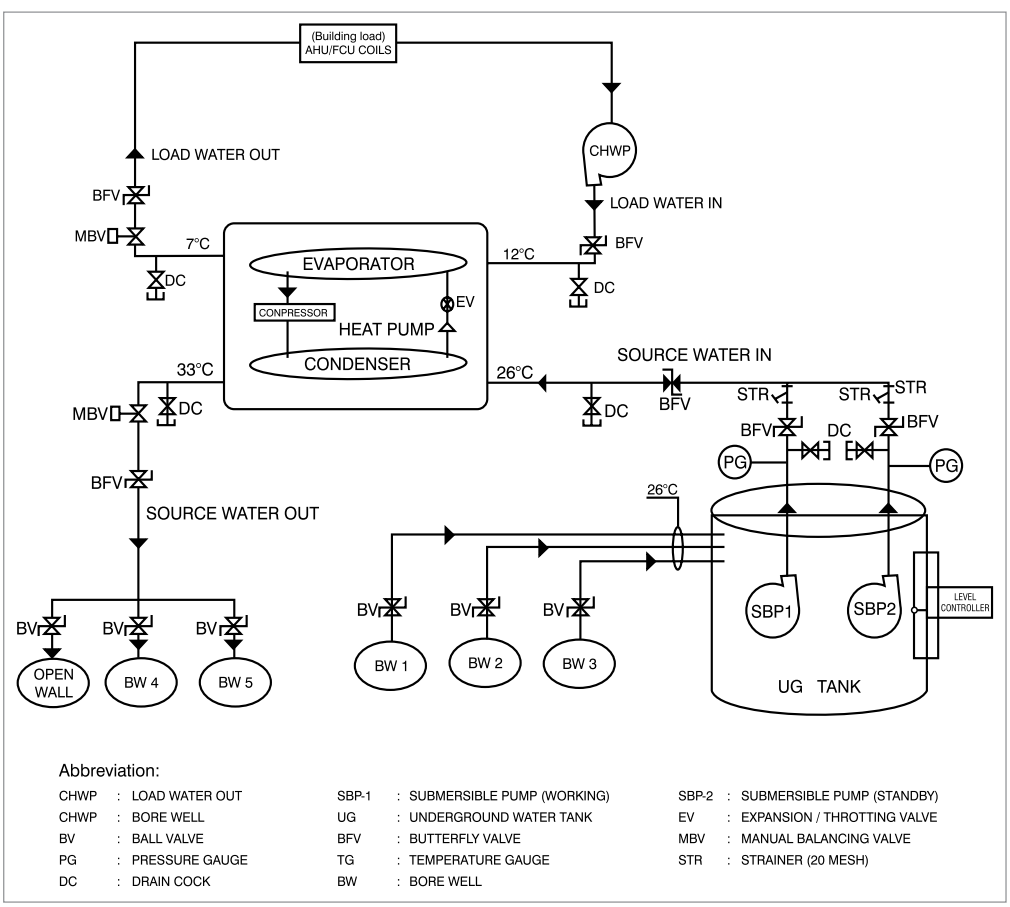

Figure 2: A schematic of the open loop Heat Pump installation

pumped by the compressor to a high pressure, enters the water-cooled condenser of the Heat Pump, where this heat is transferred to the cooling water from the borewells and the underground tank (UG).

Heat Pump in plant room

Cooling water is supplied to the UG by three borewells and submersible pumps (one working and one standby) circulate this water through the condenser of the Heat Pump as well as for make up to the expansion tank in the chilled water circuit, after which it is discharged into the ground via two borewells and one open well or it can be used for any hot water application in kitchens.

Selecting the Chiller Package or Heat Pump

Finding a reliable manufacturer for a small capacity packaged chiller among Indian companies proved to be a formidable task and it was decided to import a suitable unit from USA. The manufacturer, ClimateMaster could supply a high efficiency water-to-water Heat Pump with advanced features, quiet operation and application flexibility that could be used for chilled water for fan coils, industrial process control, potable hot water generation, radiant floor heating, snow/ice melt and other types of HVAC and industrial applications.

A built-in control panel with multiple protocol interface board is provided which allows monitoring various performance parameters at a remote computer. The choice of protocol is field selectable with the use of a simple switch.

The unit uses HFC-410A, zero ozone depletion refrigerant, making it an extremely environment-friendly option, eligible for additional LEED points because of the "green" technology points. The closest standard capacity model was 20 tons that could match our need for 14 tons and this comes with two Copeland scroll compressors in two independent refrigeration circuits. The vertical format of the unit gives it a very small foot print that can pass through standard door openings and it is therefore installed in a ground floor room inside the guest house.

Conclusion

The design of the total system has been precertified for a Platinum Rating by the Indian Green Building Council and the air conditioning plant has been in operation for close to nine months without any major problems and to the satisfaction of the users. It is hoped that such installations will become more common in the future, thereby conserving scarce energy and using the natural geothermal resources of the Earth. ❖