

Arts & Leisure Case Study

Explore-at-Bristol

A transparent tank full of plastic balls is among various intriguing sights that await visitors to the newly opened Explore-at-Bristol, an interactive science and technology centre. What makes this 'exhibit' particularly unusual is that it functions as a thermal store and forms the central element of the building's air conditioning. Control of the whole ingenious arrangement – a task involving endless energy calculations – is performed by a Trend system supplied and engineered by Concord Integrated Services Ltd of Stourbridge.

Explore-at-Bristol is part of a major urban regeneration scheme in Bristol's harbourside area. Focussing on science, nature and the arts, its purpose is to encourage people to look more closely at the world around them. Housed in a converted railway shed, Explore comprises three floors of exhibition space plus classrooms, workshops and offices.

The building's novel eutectic thermal storage system was designed by Ove Arup & Partners and provides the main source of both heating and cooling. This has allowed comfort conditions to be met without the need for boilers and chillers, which would have been more costly both to install and run.

The thousands of balls within the 7m high eutectic tank contain a calcium chloride solution that becomes solid below 27°C. The solution absorbs heat as it liquefies and emits it when solidifying – and it is on this principle that the whole system is based. To help visitors understand what is happening, the balls have been coated in a material that changes in colour in response to the phase change.

Water circulated through the tank serves as the energy transfer medium. Another water circuit, which connects to the tank circuit via a heat exchanger, supplies numerous Versatemp reverse cycle heat pumps that are scattered around the building; each is able to supply either warm or cool air. Also linked to the heat exchanger is a circuit fed by four, large, 2-stage air-to-water reverse cycle heat pumps, which are run every night (using cheap rate electricity) to recharge the tank – ie, freeze or melt the solution in the balls.

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TREND

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Though the overall concept is relatively simple, this can not be said of some of the control strategies needed to make it work. To ensure effective and efficient operation of the plant, Concord has had to devise a number of complex algorithms for the Trend control system to implement.

The decision as to whether the eutectic tank is to operate in heating or cooling mode is made by the Trend system on the basis of the time of year and outside temperature levels. However, provision has been made for manual selection of the mode if, say, a sudden change in weather conditions were forecast. Once the tank starts discharging, the system constantly monitors energy consumption. Using flow and return temperature measurements from the Versatemp circuit it continually calculates the total cooling or heating demand and compares this with its measurements of the charge remaining in the eutectic tank. Should its calculations indicate that the heating/cooling available from the tank is insufficient to meet the prevailing load for the remainder of the day, it uses the large primary heat pumps as a supplementary energy source. The number of heat pump stages it brings on is matched to the predicted shortfall. These would be switched off again if demand fell and the eutectic tank could cope unaided.

For them to operate at peak efficiency, the Versatemp units require a constant flow temperature of 27°C. To achieve this the system modulates a 3-port valve on the tank circuit to maintain a constant heat or coolth output. Varying the flow through the tank is necessary because the thermal transfer properties of the eutectic solution change as discharging progresses. Flow direction is altered according to whether the tank is charging or discharging, heating or cooling. It is controlled by the system opening and closing a set of 4 changeover valves.

The Versatemp units themselves are mostly controlled in groups; the system dictates when each group is enabled, its mode of operation and temperature setpoint. It also directly controls the two air handling units which supply tempered fresh air into the building. Each is fitted with a thermal wheel for recovering heat/coolth from the extract air. Before bringing on the Versatemps, the system attempts to satisfy heating or cooling demand using just the AHUs.

Other functions performed by the system include lighting control, monitoring of lifts and control of the motorised circuit breakers for the various exhibition stands. It is also interfaced with the building's fire detection system, which allows automatic shut-down of the Versatemps in the event of a fire.

The Trend system comprises twelve network-linked IQ intelligent controllers of various sizes. A Trend 945 graphical supervisor provides the building's facilities manager with the means to monitor conditions and plant status and adjust space temperature settings and occupancy times. A modem link enables Concord's engineers to remotely monitor the whole system.

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