Heat Pumps and Public Swimming Pools, a Perfect Match

M. Zuliani, P. Pattijn - Belgium

Public swimming pools have a very high energy consumption, due to high demands of heating and climatisation of the swimming pool hall, heating of the supply water for the pools, and hot water for showering, all resulting in a considerable demand for heat, also during the summer period.
By smart integration of different heat pump technologies in the building concept, the energy consumption of a public swimming pool can be reduced significantly.

Introduction

In the construction of the swimming pool Nekkerpool (Mechelen, Belgium) - see Figure 1- the theme of sustainability is extensively applied throughout the design, both in used materials and equipment.

By smart selection of matching heat appliances, a major part of the high heat demand of the swimming pool can be supplied by low temperature heating technologies, in particular heat pump systems.

This article describes the different heat pump technologies integrated in the concept, supplemented by available monitoring data on the operation of the heat pumps.

Heat pump concept

A major challenge during the design was to reduce the energy and water consumption of the swimming pool. The high energy demand of the swimming pool is reduced as much as possible by the use of advanced recovery of waste heat using different heat pumps:

- through integrated heat pumps in the air handling units of the swimming pool hall, heat is recovered directly from the exhaust air of the pool hall;
- via the combination of a heat exchanger and a

Figure 1. Nekkerpool inside view, showing the swimming pools with adjustable floors.

heat pump, residual heat is recovered from the shower water and waste water of the swimming pool;
- the remaining heat demand is filled to a large part by a heat pump connected with the energy roof: a solar collector, integrated in the entire roof of the swimming pool, allows to use the radiation of solar heat on the roof, through a heat pump into the HVAC system.

Other sustainable applications:
- water treatment installations are provided to reduce the consumption of fresh water while minimizing the discharge of waste water;
- in the choice of the building materials, requirements were imposed on the origin of the materials. Where possible, a sustainability certification was requested. The most visible application is the façade of the entire building with recycled ceramic tiles.

Heat pump with energy roof

The 1 300 m² roof of Nekkerpool is designed as an integrated solar collector that converts solar energy into usable heat, see Figure 2.

The principle of underfloor heating was reversed: the heat is captured from the roof in order to use it elsewhere.

The basics of the energy roof consists of a classical flat roof thermal insulation system, combining an insulating mortar and EPS (expanded polystyrene) insulation to provide a well-insulating layer. On top of this insulation layer, PE (polyethylene) tubes are placed into profile strips. Between the PE tubes an "energy mortar" is applied, smoothed out with the top side of the tubes. The finishing consists of a black water sealing coating. Through the tubes a glycol-liquid mixture flows absorbing radiation heat from the sun and then releasing it through the heat pump into the heating installation. The system also contributes to cooling of the roof, since it dissipates excess heat.

Waste water heat recovery with heat pump

Residual heat from waste water is recovered by a unit with recuperator and heat pump, that is specifically designed to heat fresh water using energy recovered from waste water. The unit is equipped with a fully automatic heat exchanger cleaning system, where, at regular intervals, cleaning pellets pass through the waste water pipework, removing dirt that adheres to the pipework walls. This ensures a clean surface and constant, high efficiency heat transfer, see Figure 3.

This is a very interesting appliance for swimming pools where waste water has to be regularly replaced by warm, fresh water and shower water also is required.

In Nekkerpool, waste heat is recovered both from waste showering water and filter backwash water, with two separate heat recovery units.

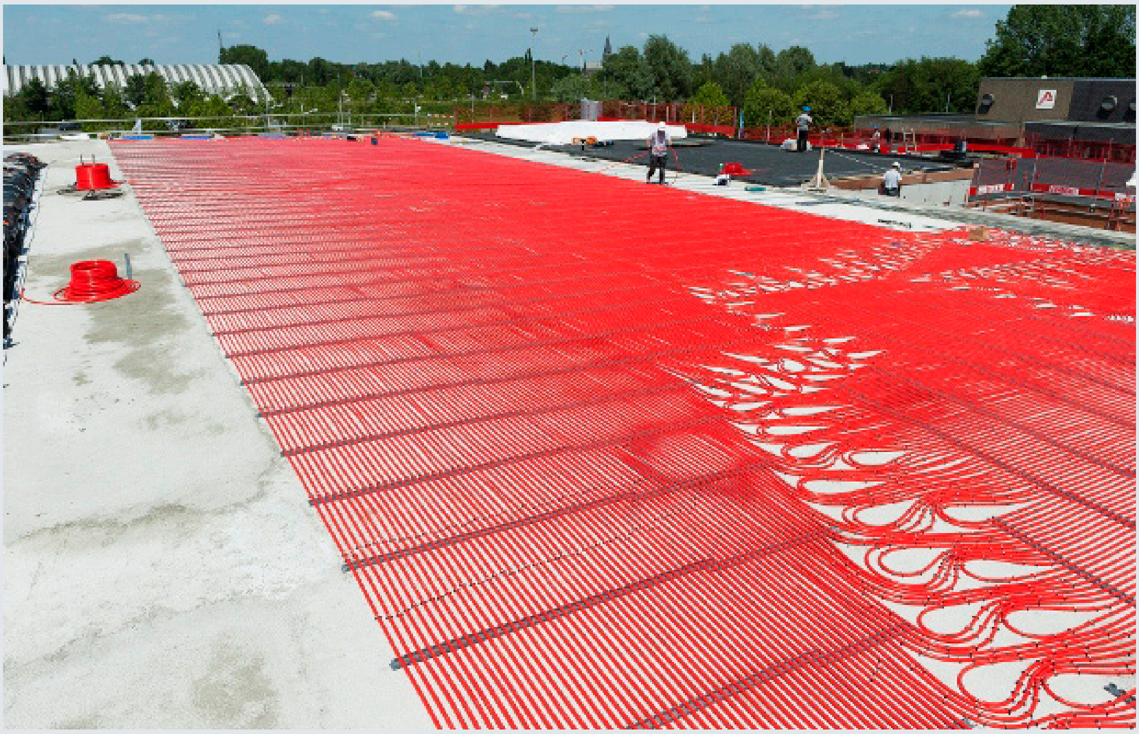

Figure 2. Build-up of the energy roof.

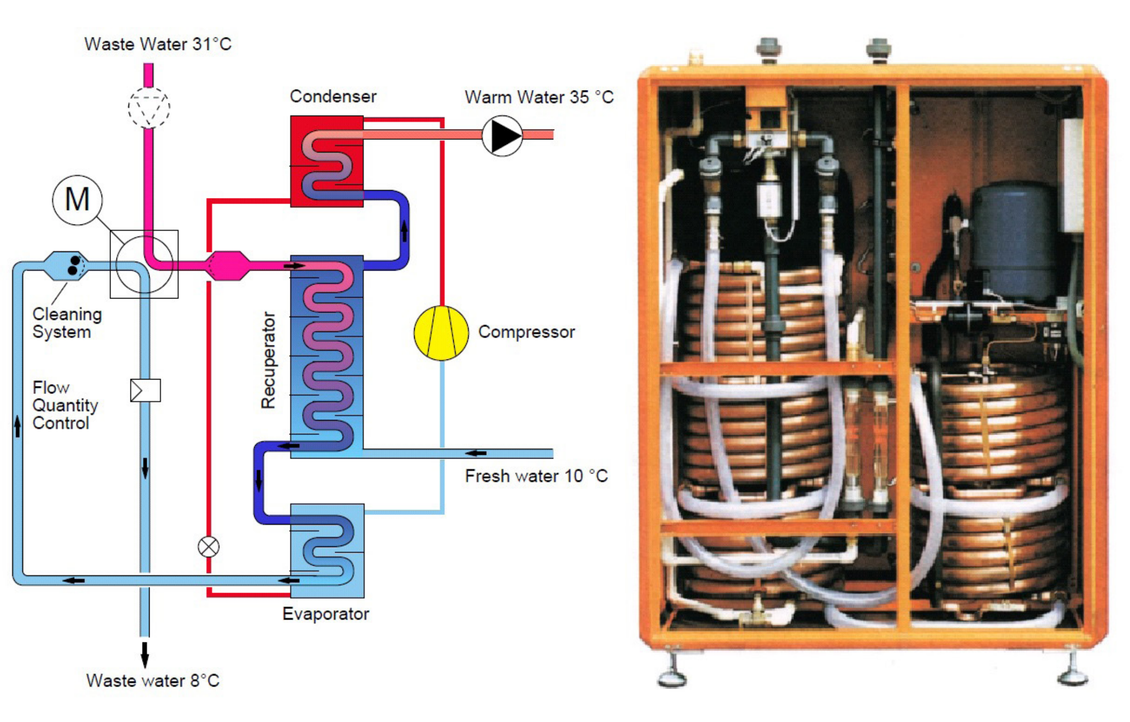

Figure 3. Waste water heat recovery unit with recuperator and heat pump.

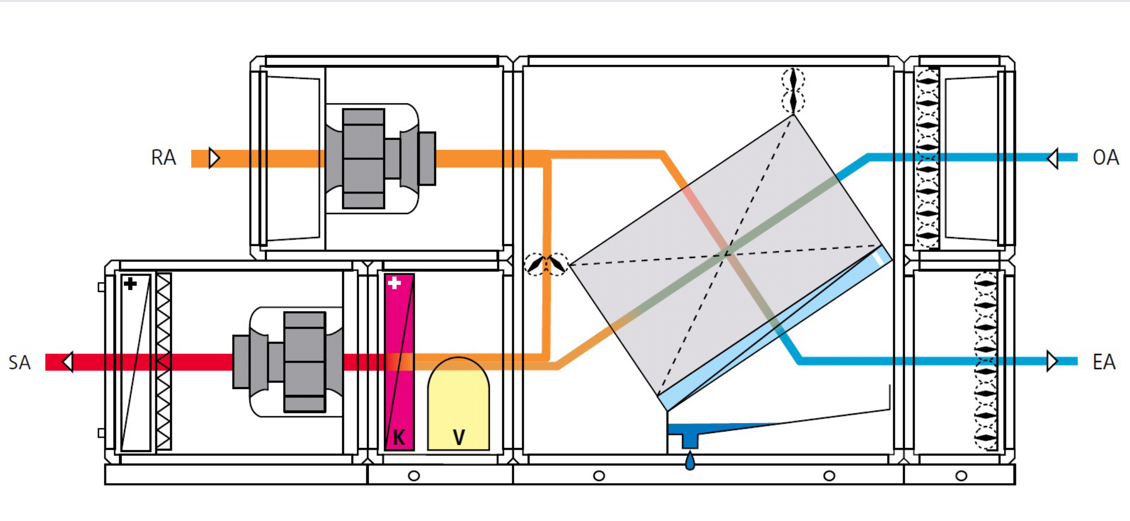

Figure 4. Air handling unit with integrated heat pump (evaporator in blue, condenser in red, compressor in yellow) for climatisation of the swimming pool hall.

Climatisation with integrated heat pump

The air handling units dehumidify, heat and ventilate the swimming pool hall, and simultaneously create good climate and protection for the used building materials. An integrated output-regulated heat pump increases the total efficiency of the system, see Figure 4.

When the swimming pool is in use, return air is cooled and dehumidified in the evaporator of the heat pump, reinforced by the upstream heat exchanger. The evaporator cools the exhaust air below its dew point, causing condensation and simultaneously recovering latent heat from the exhaust air. The outside air is

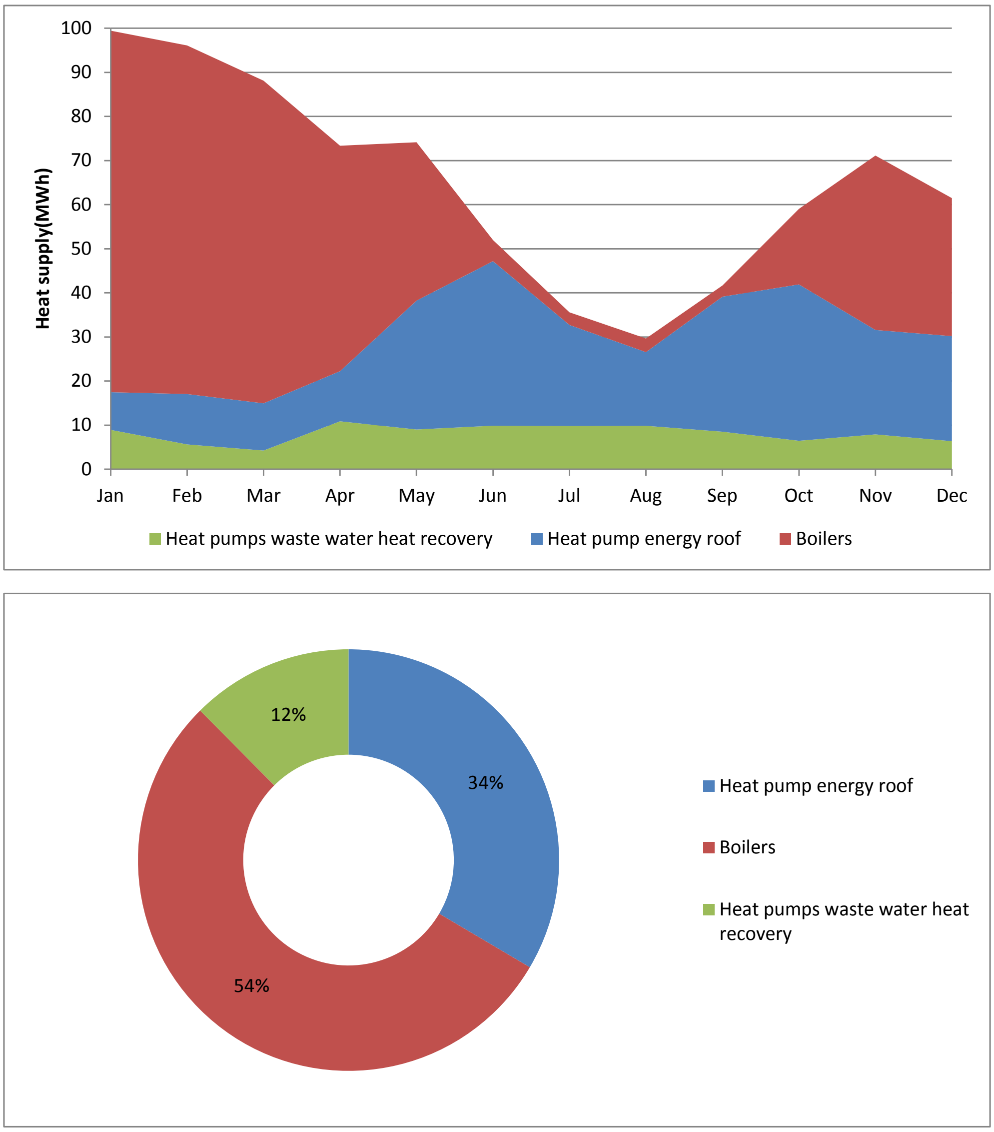

Figure 5. Monitoring data on the heat supply for Nekkerpool.

preheated in the heat exchanger, and is subsequently mixed with a proportion of untreated recirculated air, heated in the condenser of the heat pump, recovering the heat energy from the dehumidification process of the return air, and fed into the swimming pool hall as supply air.

This makes it possible to recover the latent heat, stored in the exhaust air, as sensible heat into the supply air. The energy consumed by the compressor of the heat pump system is entirely incorporated in the supply air, in the form of heat energy. For hygienic reasons, a minimum of outside air is fed into the swimming pool hall during swimming pool mode. The proportion of outside air is determined based on the current evaporation of water (and therefore the occupancy level of the swimming pool hall) and is continuously adjusted.

Monitoring data on the operation of the heat pumps

Figure 5 shows monthly heat supply data for Nekkerpool.

The graph shows that during the summer period (June – September), more than 90 % of the heat demand of the swimming pool building is supplied by the heat pump systems. The remaining is 10 % supplied by the boilers, necessary for Legionella treatment of the sanitary hot water for showering, which is not possible through the heat pumps.

Overall, the graphs show that 46 % of the total annual heat demand is supplied by the heat pumps.

There is no data available on the heat supply of the integrated heat pump in the air handling units for the swimming pool hall. Thus, we assume that more than

50 % of the total heating demand will be supplied by the heat pump systems.

Based on an integrated energy performance contract, concluded with the service company on site, plans are to further optimise the total energy performance of the swimming pool.

Conclusions

It is shown that the high energy demand of public swimming pools can be significantly reduced by smart integration of heat pump technologies for heating.

If proper attention is given to the design of matching heat appliances, over 50 % of the total heat demand of a public swimming pool can be supplied by heat pump systems.

Ing **MATTHIAS ZULIANI**
Expert Energy
Ingenium
Belgium
matthias.zuliani@ingenium.be

Ing **PEDRO PATTIJN**
Business Unit Manager Energy & Sustainability
Ingenium
Belgium
pedro.pattijn@ingenium.be