Evaluation and optimize control of energy processes in indoor swimming pools – HVAC system management

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1. Abstract

The Indoor Swimming Pool (ISP) because of the high energy consumption, represent an interesting attraction for the conservation of energy.

Control strategies adapted to the reality of each building is a way to reduce energy consumption.

This paper presents control strategies, to be implemented in an ISP Home Automation System, to control the HVAC system, in order to minimize the energy consumption of the building.

Key words: Building Performance, Energy Management, Home Automation, Indoor Swimming Pools, Optimization control.

2. Introduction

The increase of the number of sport complexes with ISP, with an intensive use of users and employee, appeared the necessity to effectuate the evaluation and control of the indoor environment in order to minimize the energy consumptions, recommended for the measures propose for the directive 2006/32/EC of the Commission of the European Communities and lay 79/2006[1]. In these directive all buildings most be energetic classified using de Energetic Efficiency Index (EEI)

In the study case we have an EEI of 95.7 keg/m^2.year, in 2006[2]. The Fig. 1 represents de distribution of consumption per primary energy.

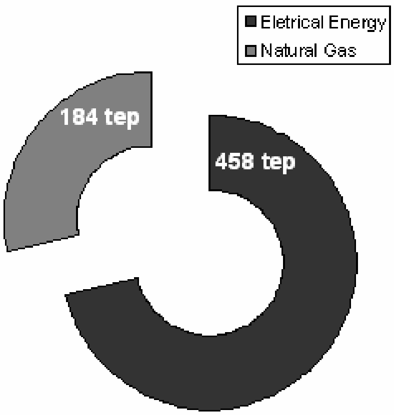

Fig. 1. Primary energy distribution

We can identify five processes, in ISP, that represents 95% of energy consumption: HVAC System, Pumping system, Water heating for bath, Lighting, Pool water treatment.

In this work we present an approach to a control strategy, with and without pool cover at night, which reduces significantly de energy consumption.

3. Technical Work Preparation

A. Study case

The sports complex of Eurostadium consists of 2 indoor swimming pools. An Olympic pool and learning and rehabilitation pool with of 25 meters.

In the Olympic pool the water is at an average temperature of 27ºC. Humidity conditions have the following values: air temperature between 28ºC and 29ºC, relative humidity between 50% and 55%.

The smaller pool the average temperature is 29ºC to 30 ºC. Humidity conditions have the following values: air temperature 30°C, relative humidity of 60%.

The Eurostadium is managed by a Home Automation System using programmable logical controllers.

B. Control Strategy – HVAC System

The strategies of control based on the variation of environmental variables in the night, and meet two distinct criteria: wet bulb temperature, the dew point temperature. For each of the criteria was made two simulations, resulting in four strategies control (CS-1, CS-2 CS-3 and CS-4).

The simulations were made using the software ESP-r[1].

For the simulation we considered three major losses in process:

- Losses to environment, quantified by

[1] The ESP-r is an integrated modeling tool for the simulation of the thermal, visual and acoustic performance of buildings and the assessment of the energy use and gaseous emissions associated with the environmental control systems and constructional materials.

simulation, the energy that is matched by the HVAC system, using thermal energy produced by natural gas boiler.

- Losses associated with the reduction of latent load of the building, quantified by simulation, which will be done with the HVAC system using electricity.
- Losses associated with energy heating water that is brought in to compensate for that was evaporated, and calculated according to the amount of water evaporated in each of the simulations.

The control strategies will be implemented, in the Home Automation System, using the methods of the standard IEC 61131-3[3].

C. Pool Cover simulation

Evaporation is the largest source of loss of pools; recent studies indicate that the pool cover could save between 10 and 30% of energy consumption [4]. Combining the coverage of the water with an appropriate strategy of control still further reduces the energy consumption further, in this context were considered two strategies of control:

- CS-5 – with pool cover and normal HVAC control at night.
- CS-6 – with pool cover and without HVAC control at night.

D. Results

The quantification of savings is presented in Table I, based on the EEI of the building under study. The first line represents the real consumption occurred in 2006.

TABLE I – CONSUMPTION OF ENERGY AND EEI

	Electrical Energy (tep)	**Natural Gas (tep)**	**EEI**
Real	427,0	203,0	95,7
CS-1	414,8	179,8	90,3
CS-2	416,2	176,8	90,0
CS-3	405,4	169,1	87,2
CS-4	423,0	163,6	89,1
CS-5	383,9	201,0	88,8
CS-6	381,1	142,6	79,5

4. Conclusion

Using the most appropriate control strategy, in conjunction with pool cover at night, we have a reduction of energy consumption to 106 tep per year.

The future work will combine the controls strategies to minimize the energy consumption and ensure the comfort conditions.

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