Water-Loop Heat Pump Systems: Latvian Experience

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I. Introduction

Today most modern buildings in the world widely use the systems of heating, ventilation and air conditioning (HVAC) in order to create and maintain a microclimate in the rooms corresponding to the required norms. One of the most update HVAC systems is the water loop heat pump (WLHP-system).

The engineering systems of the complex „Riga Plaza", including the systems of heating, conditioning and air preparation are divided into several independent parts each of which corresponds by its characteristics to a particular functional area of the complex. The source of the heat supply of the complex is a gas boiler house. The sources of cold are twelve chillers and twelve dry cooling towers installed in the utility rooms on the roof of the building as well as on a special site next to the building of the complex.

II. Method

As the basic method for the efficiency estimation of the systems of heating, ventilation, conditioning and air handling is a method of drawing up a balance of the efficiencies of the system equipment generating and consuming heat and cold. The microclimate quality insurance was evaluated in agreement with the standards adopted in the country. The estimated temperature of the heating system is based on perennial climatologically observation data about the outdoor temperatures in a particular region of the country. The terms for the estimation of the conditioning and air handling technology are based on the climatologically data about the repetition frequency of various combinations of the outdoor air entropy, temperature and relative humidity. The estimation methods of the energy consumed in the air handling equipment depend on the combinations of various ventilation and conditioning units and their operation schemes.

III. Results

The heat efficiency of the boiler house constitutes only 4950 kW, and it was limited by the level of emissions CO_2 into the surrounding environment in the centre of Riga. At the same time, in order to satisfy the needs of the heat-generating equipment of the complex, a heat capacity of 6783 kW is required, the share of the calorifiers of the central conditioners constituting 4936 kW (73%) but the share of the WLHP-system constituting 940 kW (14%). Consequently, the capacity of the boiler house makes only 73% of the maximum demand for the heat capacity of the heating equipment of the complex. If the areas of shops and the atrium are considered separately, the capacity of the calorifiers of the central conditioners (AHU) constitutes 64% but the capacity of the WLHP-system makes only 21.5%. Hence it follows that the WLHP-system plays a secondary role in the heating system of the complex since even in the same functional area where it is used it consumes not more than 21.5% of the heat envisaged for heating the area.

The maximum designed capacity of the cold supply system of the complex (the chillers and dry cooling tower) is 18016 kW, the overwhelming part of which (13740.6 kW or 76%) pertaining to the areas of shops and the atrium. A large part of the cold supply complex is ensured by an air handling system "chiller-fancoil" the share of which constitutes 8308.8 kW or 46% of the entire cold produced. 4200 kW go to the WLHP-system, which makes less than 25% of the cold produced in the complex, and, consequently, the WLHP-system plays a secondary role in systems of the cold supply complex. Its value increases for the areas of the shops and the atrium where the WLHP-system duplicates the system "chiller-fancoil" since it ensures approximately 30% of the cold supply of this functional area. At the same time, the system "chiller-fancoil" ensures more than 50% of the cold supply of this functional area. Thus the consumption of cold in the rooms of the complex exceeds the consumption of heat more than two times. Moreover, if the consumption of heat more often is effected by calorifiers of the central conditioners (AHU), the consumption of cold generally takes place by means of the air handling systems (70%) to which the systems "chiller-fancoil" and the WLHP pertain.

IV. Conclusions

At the present time the water loop heat pump (WLHP-system) is one of the most update systems of heating and air conditioning in the rooms. It can be used both – as end equipment for air handling in the systems of central conditioning, and as an energy-efficient substitute for such other air conditioning systems as the VRV (VRF) and the "chiller-fancoil".

In the building of a shopping and entertainment complex, discussed as an example of its use, air handling in the area of shops is executed according to the scheme "chillers-AHU-fancoil" to which the WLHP is added. The main function of the WLHP-system is the function of additional cooling of the rooms in the shops during the summer period. The system "chillers-AHU-fancoil" is controlled and operated in a centralised manner, while the WLHP-system is started and controlled by the end-users. Such a scheme is applied since it is necessary to ensure independent, individual temperature regulation simultaneously in a great number of shops and offices of the complex.

It is necessary to expand the application of the WHLP-system in the HVAC in order to raise energy efficiency. The local municipalities should arouse the interest of enterprises in conducting energy monitoring and optimisation of the HVAC and the WLHP operation to achieve energy economy.

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