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Path of optimized engineering of HVAC systems

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Abstract

This publication is considered the most promising path leading to the creation of energy-efficient engineering solutions for various buildings. This path begins with the first design calculations. The foundation for creating cost-effective heating and ventilation systems is carried out at the stage of forming the heat and mass balances of the premises as building components. Besides drawing the heat and mass balances must be closely connected with the study of the geometric parameters of premises and the thermal performance of the building envelope. In this paper a special way of heat load computing of heating and ventilation systems is considered. It is shown that considered method allows refining the calculations of heat losses of the building. The application of the proposed method to determine the transmission heat losses with the elemental approach is considered. The calculating method of ventilation heat losses with different variations of accounting the infiltration component is shown. Way of the joint account of heat energy consumption factors in a single mathematical apparatus is presented. The method of optimizing of heat loads during extreme operating conditions is reviewed. The paper shows further way application of accurate method in the design of buildings and the results of calculations. Some conclusions is suggested as a conclusion of this article.

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Keywords: Heat losses ; Heat gains ; Extreme mode ; Matrix method ; Building energy simulation ; Levelling peak loads

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1. Trends

We all live in a world of consumption. Satisfaction of the basest human needs throughout elevated to the national idea, to the indication of educational level, of the life's quality of the countries. The development of «comfortable» component of this life is caused by the development of the fuel and energy sector of the country in all cases. But, of course, hot summers, cold winters, difficult climatological conditions in different cities and towns around the world, pollutions, human need to clean air breathe and limits of the ability of human thermoregulation - all of those things cause the high humanistic role of the engineering systems.

In the HVAC-world and in the world of science as a whole there are similar trends. The artificial separation of markets with their own normative database is a macro-economic process, which clearly confirms the real motives. People have no interest in the supranational development of the planet. There is only gradual abolition of the concept of durability. However, buildings are not commercial products; buildings are first of all homes. Difficult climatological characteristics of China and Russia [1] allow feeling it fully.

At the same time, the «appetite» of the people in terms of comfort are also growing. There are more stringent requirements for the optimal indoor climate parameters: air temperature, averaged surface temperature in the premises, relative humidity, air mobility, composition of the air by gas impurities. This also leads to a complication of the engineering systems that create a microclimate. This always leads to an increase of the energy costs.

2. Path of optimization

To maintain the ability to develop, we have to adapt. This can be realized with help of the multivariate selection of types of engineering systems based on logic circuits and the collaboration of engineering systems and their operation modes.

Path of optimization is based on improving the accuracy of the calculation part of the design of engineering systems. Firstly, it is a detailed collection of dataset for the heat and mass balances. Of course, when you are dealing with the exact calculation, you should reduce the number of data reference points. What is the minimum of required reference points? It is extreme situation in warm and cold seasons, and as well as a set of characteristic situations (2-4 modes) of the intermediate periods. The proposed solution is a consideration of such balances in the system and by the hour, but only for a number of typical situations (the extreme days). All the necessary data to determine the power of different HVACR- equipment will be identified. There will also be clearly delineated range of parameters changes that will assess of the cooperation of these HVACR- systems.

The specified path is also the logical choice of engineering systems, the selection of the types of systems. On the path of optimization this choice takes place simultaneously with the construction of heat and mass balances. Of course, the main factor is the appointment of premises. So, it is working with space-planning decisions. This is also local improvement of structural solutions. However, already in the first stages of the design is necessary to assess the impact of the collaboration of heating, ventilation and air-conditioning systems too. Therefore, we need to take these data into account in balances compiling. In addition, at this stage we must decide on the implementation of passive energy-saving measures. It is exhaust air heat recovery (calculated payback period of such an event even with the discount in most cases has a real effect). It is heat and «cold» accumulation (such event always leads lower capital costs). Lastly, this path is the detailed design of elements of engineering systems (ducts, pipes, diffusers, radiators) with the technical and economic optimization. All of these measures is a labour-intensive activity to designers. However, what the result you can get!

Finally, control algorithms of engineering systems should be formed during the first year of exploitation phase of the building. New-born building on the first year of life is in need of assistance from «the parents». Like humans and animals. Also, in this case it guaranteed economical registration of all real specificity of the building and its life. In this case, a deviation from the use of hourly climate data is justified.

3. Compilation of the heat and mass balances

The main components of these balances are the heat losses and gains, flows of supply and exhaust air.

In terms of heat losses, there are: