PROJEKTOVANJE SISTEMA KLIMATIZACIJE SPORTSKE DVORANE¹

DESIGNING THE AIR CONDITIONING SYSTEM OF A SPORTS HALL

Branko STANISAVLJEVIĆ, (Mentor: Prof. Rade Karamarković, Ph. D.)

University of Kragujevac, Faculty of Mechanical and Civil Engineering, Kraljevo, Serbia

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The modern man spends 15-20 hours per day indoors, which is about 2/3 of his life, therefore, it is very important to pay attention to the analysis of the influence of the inner climate on man. Investigations on the influence of the human environment on its comfort, and consequently on its effect, have shown that the benefit of man primarily depends on the temperature and relative humidity of the air of his environment. The importance of certain conditions will be in various cases of different significance. It will depend on a number of factors, such as the purpose of the heating rooms, the available financial resources, the architectural concept of the building, the available energy sources, etc. Technical conditions are dictated by the requirements of the feeling of comfort for people who stay in a heated room. The first among them is the provision of environmental characteristics within the limits of the zone benefits, that is, maintaining the temperature, humidity and air flow.

Today's room heating needs to provide hygienic conditions for the benefits. These conditions have been supplemented with air conditioning in the last few years, automatic regulation of the desired internal temperature and humidity, its purification and similar procedures, as essential elements of hygienic heating. In order to ensure certain environmental conditions in individual premises, project requests for heating are appearing and they must be respected by the engineer, to whom this task is entrusted.

In addition to the aforementioned conditions of the benefits, it is necessary to respect the economic conditions, all of which together result in an increase in the energy efficiency of the building. This is most clearly seen from the intersection of energy consumption in households. The increase in energy efficiency is directly influenced by the insulation of floors, ceilings, walls, quality carpentry and hence good tightness of the process. It is also important to mention renewable energy sources, because their use significantly reduces the consumption of electricity, e.g. in the case of water heating, and therefore environmental pollution is reduced.

The energy situation forces us to solve the problems in this area by following the following rules:

- minimize the import of liquid and gaseous fuels, and turn to domestic coal and biomass
- Awareness of the need for thermal insulation
- Application of automatic regulation
- utilization of renewable energy sources (heat pumps, solar panels ...)

Keeping in mind the above mentioned items, we will realize savings that are directly related to finances. Also all this positively affects the environment.

1 Air condition

Air conditioning is air treatment in a certain area in order to achieve the most favorable conditions for staying people and other living beings in it. In a wider sense, the term itself can refer to heating, cooling, filtering, humidification, etc.

Air conditioning can be divided into two groups:

- Comfortable air conditioning
- industrial air conditioning

Comfortable air conditioning represents the creation of temperature conditions for people staying. With this type of air conditioning it is necessary to maintain the temperature of 20-27 ° C, and a relative humidity of 40-60% with the air flow rate in the zone of people's stay up to 0.25 m/s.

Industrial air conditioning enables the creation of optimal conditions for achieving a production or technological process. Air conditioning parameters define the technology and production requirements, and not the needs of persons residing in an industrial environment.

The most important parameters are:

- Air humidity - represents the amount of water vapor in the atmosphere and is one of the basic parameters of air conditioning. From the humidity of the air precipitation depends directly. It is also important to mention the saturated air, that is, the air containing the largest amount of steam. The transition of the water vapor into the liquid state at a certain temperature is called the point of the rose, that is, the air temperature at which the wet drops are released.

We distinguish:

- Absolute humidity (X) - is the amount of moisture in a kilogram of dry air, the unit is [g/kg].

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- Relative humidity (ϕ) - is the ratio of partial pressure and saturation pressure.
- Air flow rate [m/s] - in air conditioning systems depends directly on the air flow and pipe diameter. In zones where people are sitting speed is limited to 0.25 m / s, with a maximum tolerance of up to 0.3 m / s.
- Outdoor air as well as indoor air is subject to contamination with solid and liquid particles of mineral or organic origin. The larger particles lean on the floor, and the less and easier they stay in the air. In addition to these particles, the surrounding air contains microbes, viruses, fungi, bacteria, etc. In addition to retaining impurities, the filter should create as little resistance to air flow as possible. Otherwise, the air filters are divided into:
  1. Rough filters (prefilters)
  2. Fine filters (second degree of filtration)
  3. Absolute filters (final filtration degree)
- Noise [dB] is defined as unwanted sound, and noise control can be divided into three groups: source, transmission and reception. In ventilation, it usually occurs during transmission. Noise can arise from the fan itself, or from its blades producing vortices. Another cause is the turbulent flow that causes channel vibration. Noise can be reduced by reducing air speed, soundproofing of channels and components, installing silencers, etc.

2 Air handling units

The air conditioners are designed for central air conditioning and provide all the basic functions: heating, cooling, filtration, humidification, drying, recuperation and regeneration. They have a task to ensure high air quality, and this is especially true in today's time when there is a high level of pollution of the surrounding air. They are used in hotels, hospitals, shopping malls, sports and industrial halls, etc. They are produced in standard sizes depending on flow and purpose, ie they are made from sections. The air conditioning chamber can work with fresh air or with two currents, mixing fresh and recirculating air. Air-conditioned chambers that use waste air to heat the fresh through the recuperator are called floor chambers.

Basic parts of AHU:

1. Recuperator - used to reduce energy consumption and its task is to deliver fresh air to the heat of the exhaust air. Plain and rotary are usually used.
2. Drop eliminator - is located in all places where the drop of droplets should be prevented into the adjacent section, which can be behind the heaters, humidifiers and plate recovery equipment.
3. Fan - Usually used centrifugal and radial.
4. Filter - used for air purification, ie eliminating impurities.
5. Heater - used to prepare the air in the winter mode and when in special cases it is necessary to heat the air for years.
6. Refrigerator - used to prepare air in the summer mode.
7. Humidifier section - used to humidify the air. We distinguish water moistening and wetting.

Schematic diagram of AHU

Mixing chamber - is a part of the air conditioning chamber where the mixing of two air currents (fresh and recirculation) takes place before being inserted into the air-conditioned area.

3 Heat losses

In the winter period, the temperature needs to be maintained in the building, which is higher than the ambient temperature, and consequently heat losses of the object occur and these losses should be compensated for the temperature to be constant. The calculation of thermal losses is done for stationary heat transfer conditions because the internal temperature is kept constant and the outside minimum varies during the coldest days. The losses are divided into transmission and ventilation. We have them through: walls, floors, ceilings, windows, doors, etc.

Examples of heat transfer

Thermal losses can be significantly reduced by placing insulation on walls, ceilings and floors, as well as replacing worn windows with a new one with a very low heat transfer coefficient [K].

Isolation of walls is usually divided into external and internal. Whenever possible, external wall insulation should be applied. The inside is cheaper at the start, but in that case the conditions for condensation inside the wall are always created, causing a wall, electrical installation and the appearance of a bucket. And besides all this, the wall loses the possibility of accumulating heat.

For a sports hall, design a central air conditioning system. The hall is 3000 m², with a capacity of 2500 people. The height of the hall is 20 [m]. The external (entrance) doors are metal, and the windows are glassy. The door dimensions are 10 x 2 m, and the skylights are 60 x 4 m.

Now all the necessary parameters for calculating heat losses are shown in the table:

Sports Hall					P=	3000	m2	V=	60000	m3	R=	1	H=	3.09	
label	Side of the World	length	width, height	surface area	Number	deduction	area for budget	k	Δt	kΔt	Qo	Zd	Zv	Zs	Zh
		m	m	m2		m2	m2	W/m2K			W	%	%	%	%
EW1	south	60	20	1200	1	240	960	0.36	38	13.85	13299.71	7	7	5	20
EW2	east	50	20	1000	1	20	980	0.36	38	13.85	13576.79	Room dimensions			
EW3	north	60	20	1200	1	240	960	0.36	38	13.85	13299.71	length	width	height	
EW4	west	50	20	1000	1	20	980	0.36	38	13.85	13576.79	60	50	20	
SL1	south	60	4	240	1		240	5	38	190	45600	l=	36	m	
SL2	north	60	4	240	1		240	5	38	190	45600	a=	0.4		
FLOOR		60	50	3000	1		3000	1.21	17	20.58	61751.22	As=	10900	m2	
CEILING		60	50	3000	1		3000	0.36	38	13.69	41062.46	kd=	0.61	W/mK	
BC		10	2	20	2		40	3.3	38	125.4	5016				
							Qv=	1690.85	W	Qo=	252782.67	W	q=	4.24	W/m3
										The required amount of heat is:			Q=	254473.52	W

The calculation table of the required amount of heat

Initial parameters for summer:

Temperature 35 [°C]; Relative humidity φ= 31%

Desired parameters for summer:

Temperature 24 [°C]; Relative humidity φ = 60%

We calculate the power of:

Initial parameters for winter:

Temperature -18 [°C]; Relative humidity φ = 90%

Desired parameters for winter:

Temperature 20 [°C]; Relative humidity φ = 40%

Recuperator

$$Q = mub \cdot (h_{sp} - h_R) = \frac{57000}{3600} \cdot (63.7 - 55) = 137.75[\text{kW}]$$

Heater

$$Q = mub \cdot (h_{ub} - h_2) = \frac{59500}{3600} \cdot (27 - 10.1) = 279.3[\text{kW}]$$

Refrigerator

$$Q = m_{ub} \cdot (h_R - h_{UB}) = \frac{57000}{3600} \cdot (55 - 40.5) = 229.6[kW]$$

Values as h_{sp} , h_R , h_{ub} , h_2 are read from the Molire Diagram:

4 Chanel network plan

A blue grid is marked with an inlet net and a red reverse. The inlet channels are calculated using the method of return of the static pressure, and the return method with the reduction of speeds.

These two methods fall into the methods of calculating the air channels. The speed reduction method is used for calculating low pressure air conditioning systems, and the method of returning the static pressure is used in the high pressure system. Regardless of the method of calculation, the most important is to take into account the drop in pressure and the noise level. With the increase in speed, the noise level increases, and with increasing resistance of the flow it is also necessary to increase the power of the fan, which increases the costs of exploitation. To determine the distribution of pressure in the network, that is, to determine the required pressure on the network, it is necessary to know the part of the network of the greatest resistance.

5 Range of air curent

The range of the air jet is the distance from the surface of the inlet opening to that of the cross-section of the jet, in which the speed in the axis is set to the value - which, in comfort air conditioning, is 0.25 [m / s]. The large impact on the range of the jet has the initial primary air velocity at the exit outlet. If the speed of insertion is lower - the range will be smaller, and if the range is too weak - the space opposite the wall will not be well air conditioned. In case the range is too large, the air will refuse from the opposite wall - what will cause a slip in that part of the room. Another factor affecting the air intensity is the shape of the cross-section of the opening. For intersections of different shapes of the same surface, with the same amount of air and the same injection speeds, the range of the round jet is greater than the right angle.

$$X = \frac{K \cdot Q}{Vx \sqrt{A_0}}$$

wherein:

$V_x = 0.25$ [m / s], velocity at distance H,

A_o [m²], the surface of the grid.

Q - flow in the given opening

K – constant

By applying the formula and data, we get the scope of the premises:

$$X = \frac{3 \cdot 2500 / 3600}{0.25 \cdot \sqrt{0.26}} = 16.5 [\text{m}]$$

6 Literature

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