International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

Vol.7., Issue.3, 2019
May-June

RESEARCH ARTICLE

ISSN: 2321-7758

AIR CONDITIONING SYSTEM OF ONE REPRESENTATIVE FLOOR OF A1 BUILDING

Dr. MOHAMED MUSTAFA ABDULGALIL[1], Dr. IMHAMED M. SALEH ALI[2]

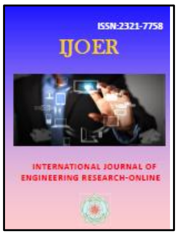
[1]Higher institute of sciences and Technology, Sirte, Libya.

Email- alsewe7803@yahoo.com.

[2]Mechanical Engineering- Sirte University.

Email: isa6@su.edu.ly

Doi: https://doi.org/10.33329/ijoer.73.64



ABSTRACT

Current experimental work deals with the development of the air-conditioning system for the recently restored high-rise A1 building. Reconstruction of the structure resulted in a change in thermo-technical conditions impacting the dimensioning of the air conditioning system. The development of the air-conditioning system depends on the estimation of heat loss and heat gain, as well as on important psychometric measurements. The size of air conditioning equipment which provides required internal microclimate will be determined from the calculation results. Currently there is Detail design elaborated including technical report and material specification. At 26 ° C temperature, the cooling capacity is 50.5 CH Q & kW. At 30 ° C with half the fresh air, the cooling capacity is = 51.1 CH Q & kW. The difference between the volumetric flow rate of supply and exhaust air is caused by the amount of air exhausted in the sanitary facilities and by the amount of air creating a building overpressure of 3 to 5%.

Key words: Air-conditioning, Cooling, Internal microclimate, Heat gain, Heat loss

1.0 Introduction

Environmental technology deals with technical means to ensure optimum environmental status. One experiences a significant part of life in the indoor environment, i.e. in the interior of buildings where it performs various activities. The interaction between man and his environment is primarily through human activity. The acquisition and operating costs of air conditioning are one of the most important items. Therefore, high demands are placed on the device. These include, in particular, ensuring a high-quality indoor climate, easy maintenance and an economical and trouble-free operation of air conditioning with a minimum impact on the environment over its lifetime[1].

The air conditioner is used for forced ventilation of air-conditioned rooms and at the same time to eliminate pollutants and produced moisture and to compensate for thermal loads and losses. The devices treat the air to achieve the desired cleanliness, temperature and humidity. It must be able to provide filtration and basic psychometric functions for supply air treatment (heating, cooling, dampening, and dehumidification). All these functions are managed automatically throughout the year [1].

2.0 Combined air conditioning systems

In this system, the heat transfer medium is both air and water. The unit located in the engine room can serve ten floors above and below the engine room.

International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.7., Issue.3, 2019
May-June

It treats the necessary amount of fresh ventilation (primary) air through the high pressure manifold to the end elements. These are induction units connected to the distribution of heating and cooling water.

Induction units are most often designed to be placed under a window or ceiling. The incoming primary air exits from the induction unit through nozzles that suck in the secondary air from the room by ejection. This principle is evident from the picture of the induction unit, which is placed in the suspended ceiling.

2.1 Altitude Building A1 in the Field of Current system

Object characteristics: It is a reconstruction of the high-rise building A1 available in Sirte, Libya, situated on the premises of the Faculty of Mechanical Engineering.

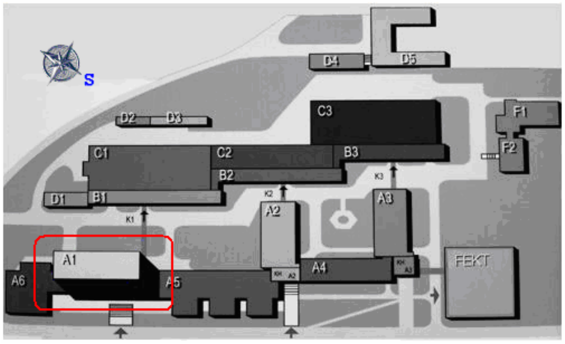
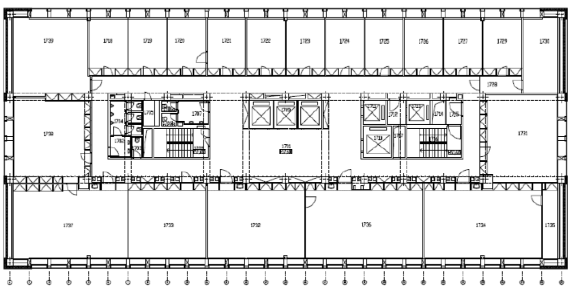


Figure 1: Map of A1 Building selected

The starting point for the beginning of the calculation are the building drawings of the object in digital form processed in AutoCAD (Figure 2). The drawings are used to acquire the spatial layout of the building, as a source of information needed for calculations and, last but not least, to draw and deploy an air-conditioning element.



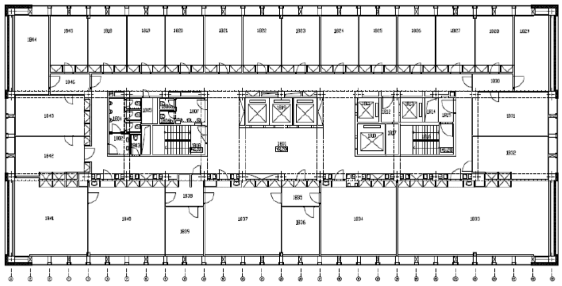


Figure 2: building drawings

3. PROPOSAL FOR AIR CONDITIONING

Air-conditioning technology costs are one of the most important acquisition and operating costs of a building. The task of air conditioning is primarily to ensure a good indoor microclimate and to meet the fresh air requirement. It is therefore necessary to design a system that ensures these conditions with the minimum of maintenance requirements and is economical to operate with minimal environmental impact. However, they must conform to the dimensions, often not too large, provided for the ducting or unit placement[1].

One way to cover it is just the supply air. The amount of supply air at tp = 20 ° C required to cover the total heat load can be determined as:

$$Q_i = m_p\, c_p\,(t_i - t_p) => m_p = \frac{Q_i}{c_p\,(t_i - t_p)} \quad \ldots Eq\ 3.1$$

$$m_p = \frac{175805}{101.10^{-3}\,(26 - 20)} = 29.0\ kg/s \ldots Eq\ 3.2$$

Where Qi : total thermal load of air-conditioned space [W]

mp : mass flow of air supplied to the air-conditioned space [kg • s^{-1}],

cp: specific heat capacity of air at constant pressure [kJ · kg-1 · K^{-1}],

ti: internal design air temperature [° C],

tp: supply air temperature to the air-conditioned room [° C].

The volumetric flow can then be calculated:

Impact Factor 5.8701 (ICI)
International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.7., Issue.3, 2019
May-June

$$V_p = \frac{m_p}{\rho} \quad ...Eq\ 3.3$$

$$V_p = \frac{29.0}{1.2} = 24.17m^3.s^{-1} = 87000m^3.hod^{-1}$$

Where

m_p the mass flow of air supplied to the air-conditioned space [kg · s^{-1}],

ρ air density [kg · m^{-3}].

Large air conditioners would be needed to adjust large amounts of air to the required values, which, due to their size, would not fit into the air-conditioning machine rooms. In addition, the air duct ducts are not large enough to accommodate such large amounts of air. The piping dimensions are based on the recommended velocities of the air flowing through it. The velocity in the pipeline should be around 5 m/ s, which would correspond to a flow area of approximately 4.8 m^2.

The reconstruction of the air-conditioning space cannot be expected during the reconstruction. Given the availability of buildings, this type of air conditioning must be abandoned and another system designed to meet these requirements should be devised.

A low-pressure single-channel air-conditioning system supplemented by a water system with internal fan-coil units located directly in the air-conditioned space seems to be a suitable way of air-conditioning of the high-rise building A1.

The air conditioner provides a forced supply of hygienic amount of fresh air and at the same time it covers part of the total heat load. At outdoor temperatures above 26 ° C and below 0 ° C, this amount of fresh outdoor air is reduced to 50% and replenished to the required quantity with recirculating air[2].

The air conditioning unit is equipped with a heat recovery device (HRD), which is used to heat fresh air by extracting heat from the exhaust air in winter. This device is also used in the summer to recover cold air from the exhaust air. A steam humidifier located outside the unit is used to moisten the air. The nozzles of the steam humidifier are located in the duct due to the technological requirement of the prescribed distance of a straight duct behind the humidifier. This results in a shortening of the air conditioning unit, which is only beneficial due to the limited space of the air-conditioning machine room. The diagram of the low pressure single duct air conditioner with the steam humidifier placed outside the air conditioner is shown in the following diagram (Figure 3).

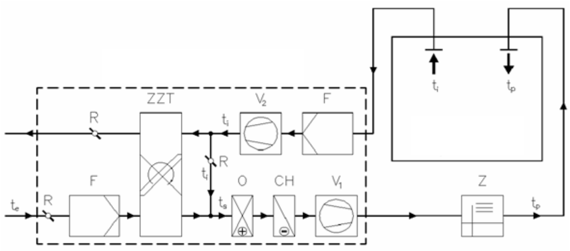


Figure 3: Diagram of low pressure single duct air conditioner

A water system with internal fan-coil units located directly in the air-conditioned space is designed to cover the remaining heat load. This system is used for cooling, ie to cover the remaining thermal load, which is not covered by the air supply.

4. DETERMINING FRESH AIR FLOW

There are several options to determine the amount of fresh outdoor air for air conditioning:

- from the balance of pollutants in the ventilated area,
- from the heat balance of the ventilated area,
- moisture balance of the ventilated area,
- from air doses per person (animal or fixture),
- the recommended air exchange rate[1].

The main factors deteriorating the quality of the indoor environment in the A1 FSI building high-rise building are the gains from the insolation and the occupants. As mentioned above a large amount of air would be required to cover the total thermal load, but this is not feasible due to the confined spaces.

In this case, the determination of the amount of fresh outdoor air is based on the air dose per person. The amount of air per person is directly determined by Government Regulation No. AZ24/2016 Coll. It is prescribed to supply 50 m^3/ hr^1 per person performing work with an average energy expenditure of up to 105 W/ m^2. Decree 410/2005 states that if it is an educational facility, only 30 m^3/ hr can be delivered to the student [3]. At outdoor temperatures above 26 ° C and below 0 ° C, the amount of fresh outdoor air can be reduced, but not more than halved[3].

The volumetric flow rate of fresh outdoor air shall be determined by:

$$V_{e1} = i_k.d_k + i_{st}.d_{st} \quad ...Eq\ 4.1$$

$$V_{e1} = 122.50 + 378.30 = 17440\ m^3.hod^{-1}$$

where:

i_k number of cantor [-] (determined from the floor area),

d_k air volume per cantor [$m^3 \cdot hr^{-1}$] (according to [21] is 50 $m^3 \cdot hr^{-1}$),

i_{st}number of students [-] (determined from the floor area),

d_{st} airflow per student [$m^3 \cdot hr^{-1}$] (according to [21] is 30 $m^3 \cdot hr^{-1}$).

The fresh air volumetric flow rate should be increased by the amount required to ensure that it is replaced once in the engine room. Actually it is about ensuring the operational ventilation of the engine room.

Ground plan the room area is determined as:

$$V_{e2} = S.h.n \quad ...Eq\ 4.2$$

$$V_{e2} = 45.7 * 3.2 * 1 = 146 = 150\ m^3.hod^{-1}$$

where:

S room area [m^2]

h room height [m],

n exchange rate [-].

The sum of these two values determines the total amount of fresh outdoor air:

$$V_e = V_{e1} + V_{e2} \ ...Eq\ 4.3$$

$$V_e = 17400 + 150 = 17590 m^3.hod^{-1} = 4.89 m^3.S^{-1}$$

V_{e1} volumetric flow rate of fresh outside air per person [$m^3 \cdot hr^{-1}$],

V_{e2} volumetric flow rate of fresh outside air for the ventilation of the machine room for ventilation [m].

The fresh air mass flow rate is equal to:

$$m_e = V_e.\rho \quad ...Eq\ 4.4$$

$$m_e = 4.89 * 1.2 = 5.86\ kg/s$$

V_e volumetric flow rate of fresh outdoor air [$m^3 \cdot s^{-1}$],

r air density [$kg \cdot m^{-3}$].

5. AIR CONDITIONING DESIGN

The reconstruction of the A1 FSI Building high-rise building will change the thermal properties of the building. These significantly affect the sizing of the air-conditioning system, while ensuring the requirement for microclimate conditions in the workplace. It is mainly about keeping temperature, humidity and sufficient air exchange in the workplace. In the case of fresh air supply to the workplace[3].

The nameplate of the air-conditioning unit located at FSI building and the equipment is morally and technically obsolete. Therefore, its refurbishment is not expected. This would be about as expensive as buying a new unit. It is therefore necessary to request a new device that will provide the required parameters of the indoor microclimate.

The temperature gradient of the water for the heater is 70/50 ° C, for the radiator it is 6/12 ° C. Individual parts of the unit:

• Filter chamber. It serves to maintain the required air purity in the air-conditioned space. The secondary function is to protect the heat exchangers from clogging. Filters are divided into:

- Filters for normal ventilation (dust). These are further distinguished into gross (classes G1 to G4, now EU1 to EU4) and fine (classes F5 to F9, now EU5 to EU9).

- High-efficiency filters (aerosol). Subsequently, they are divided into HEPA (classes H10 to H14, now EU10 to EU14) and ULPA (classes U15 to U17, now EU15 to EU17).

Depending on the version, filters can be distinguished:

- Liner. It is further divided into plate (frame), pocket and folded (compact, cassette, cartridge) (Fig. 4).

- Tracked.

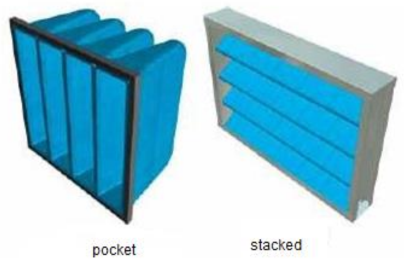


FIG. 4: Cartridge filters [2]

An EU5 pocket filter is sufficient for air conditioning. A bathtub under the filter is designed under the pocket filter on the fresh air inlet side. Condensed water can flow into it, causing the water to flow freely from the unit to the engine room. In winter there is a risk of sucking snow together with outdoor air, which then condenses on the filters[1].

• Heat recovery device chamber. They mainly use two types:

- Plate heat exchanger. The air flows in it at the same time, and the energy is transferred through a wall separating them (figure 5).

- Rotary regenerative heat exchanger. The storage mass is alternately in contact with a cooler and warmer medium. Moisture can also be transferred in the case of a special filling. (Figure 5).

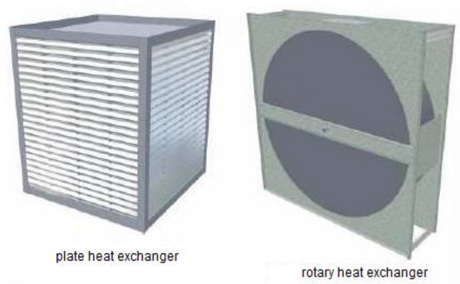


FIG. 5: Heat recovery equipment [2]

A rotary regenerative heat exchanger is chosen for the air conditioning of the A1 FSI VUT high-rise building, as it does not interfere with the possible partial mixing of the exhaust air with fresh outdoor air, and especially its length dimensions[1].

• Heater chamber. The heater is a heat exchanger. There are tube and plate heat exchangers. Tubular heat exchangers with ribbed surface on the air side are often used. The heaters are further divided according to the medium used to heat the air, namely water, electric gas (Fig. 6) and steam.

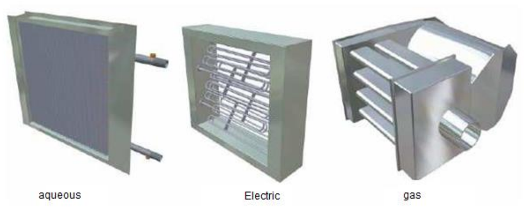


FIG. 6: Water, electric and gas heater[4].

As mentioned above, a psychrometric calculation is performed for the 0 ° C limit temperature. The heater power for this limit temperature = 36.2 O Q & kW is higher than for the temperature of -12 ° C, where the power is = 31.5 O Q & kW. The size of the heater is adapted to the power requirement at a water temperature gradient of 70/50 ° C. [2]

Cooling chamber. It is also a heat exchanger, respectively

The cooler must be dimensioned at the higher of these values at a cold water temperature gradient of 7/13 ° C. The indicated temperature gradient of the cold water is for the possible reserve of the chiller due to possible cooling water cooling.

Fan chamber. The fan is used to transport air to the air-conditioned space. The blower pressure Dp must be sufficient to overcome the pressure loss of the air in the ducts caused by friction. Fans are screened according to flow to:

- radial
- axial,
- diagonal.

In air-conditioning units, radial fans or fans with free impeller are used (Fig. 7).

FIG. 7: Fans used in air conditioners [2]

It is also possible to divide them according to the transport pressure into:

- low pressure (up to 1000 Pa),
- medium pressure (1000 to 3000 Pa),
- diagonal (above 3000 Pa).

The air conditioning unit includes a fan for the inlet and outlet sections. It is a low pressure fan with free impeller (radial) equipped with a frequency converter. These fans are smaller in size and their main advantage is the possibility of any direction of exhaust rotation. [2]

The volumetric flow through the fan of the supply branch is Vp 17 590 m^3 . hr^{-1} and the delivery pressure is Δp = 350 Pa. For the exhaust section, the fan has a delivery pressure of Δp = 300 Pa and a volumetric flow of approx. V = 15 370 m^3. hr^{-1}. All required parameters per unit are part of the air handling unit diagram (Fig. 8). On the basis of the schema sent to the unit designer, the specifications of the designed unit corresponding to the required parameters are sent back together with the drawing in electronic form. The unit is shown in the next figure (Figure 9).

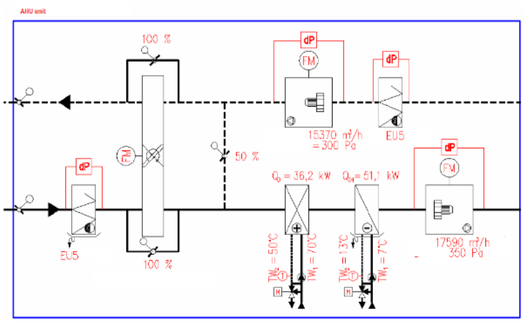


Figure 8: Scheme of air handling unit

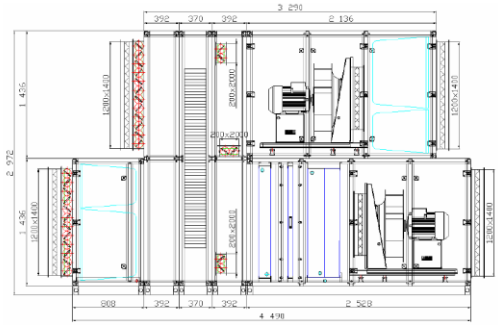


Figure 9: Designed air handling unit

Steam humidifier in the duct

In winter with low outside temperatures, the air must be heated to the required temperature before entering the air-conditioned room. Heating takes place at a constant specific humidity. This is about 1g/$kg_{s.v}$ for outdoor air in winter. When heating a relative air humidity of about 10 to 15% is achieved at 20°C. If there is no large source of steam production in the air-conditioned room, air is dried in the room. When the relative humidity is low, the feeling of well-being is reduced by drying up the airways. Therefore, the relative humidity should not be below 30%. [1]

Moisture is carried out in the unit or in the pipeline to prevent this problem. The air can be moistened in two ways. The first option is to moisten the air with water in surface, membrane, spray, spray and ultrasonic humidifiers. Air humidification with water is adiabatic. The other way is to moisten the air with sterile and odorless steam, and steam can be obtained from the steam distribution system or from its own source. This is an isothermal event. [1]

Since there is no source of hygienically harmless steam in the building, a proper source of steam is designed. Steam humidifiers can be distinguished:

• Steam humidifier with electrode steam generator. Water heating is based on the conductivity of the water, which allows current to pass between the electrodes. The steam quantity is controlled by varying the electrode immersion depth.

• Steam humidifier with resistance steam generator. It is not dependent on water quality. Descaling takes place due to thermal expansion.[1] Due to the harder water in Lcoal Area [5] a resistance steam humidifier is chosen, for which the water hardness does not

International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.7., Issue.3, 2019
May-June

affect its performance. The steam humidifier must be able to deliver 83.5 kg • hr-1 steam to the air. The design is based on the data sheets of Carel Ltd., which leads the steam humidifiers under the name heater Steam. The device is equipped with heating elements from the NiFlon surface from which limescale falls off spontaneously (Figure 10).

Figure 10: HeaterSteam electric resistance steam generator [6]

There is no one device for the indicated amount of humidification capacity and therefore it must be composed of two devices. The heaterSteam UR027 and heater Steam UR060 are selected from the datasheet.

6. DESIGN OF COOLING EQUIPMENT

From the previous discussion, the supply of 20 ° C air into the air-conditioned space does not cover the total thermal load, which is approximately 175.8 kW . The choice of air-conditioning is always based on an agreement between the HVAC designer and the architect. investor. Cooling with indoor ceiling fan-coil units placed in the construction-made gypsum case seems to be the most suitable for the construction. It determines the amount of thermal load for each room, which is covered by the amount of air supplied to the room. By subtracting from the maximum total heat load of the room, the remaining amount of heat load to be covered by the cooling system is obtained. From the results, two unit sizes are chosen, which should be used to cover the thermal load

6.1 Design of CH1 - office cooling

The design of indoor ceiling fan-coil units, under the trade name Power-Geko, is based on data sheets from GEA LVZ a.s. In the case of office cooling, the fan coil must be able to cool 2 kW at a cold water temperature gradient of 6/12 ° C. The design procedure is analogous to the example given in the catalog. The assumed pressure drop is 50 Pa[7]

• Determination of the cooling power correction factor. First, it is necessary to determine the correction factor of the cooling capacity. This is then used to determine the new cooling capacity, since the cooling capacities for different external pressures are designed for a temperature of +27 ° C and a relative air humidity of 46%. The inlet temperature to the unit is +26 ° C and the relative air humidity is 50%.

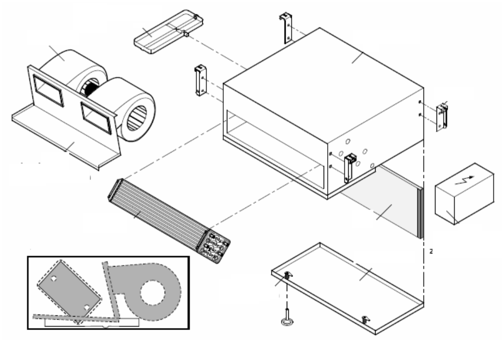


FIG. 11: Power-Geko fan-coil diagram

• **Determine the size of the unit**. When selecting a fan-coil, the desired speed ratio combinations are entered. These achieve system variability. In the event of a sudden major demand, the system will run at a higher speed. The fan will run at these higher speeds until the desired state is reached. The fan is a source of noise and its intensity increases with higher speed. Noise is an adverse phenomenon that disrupts human concentration and adversely affects the well-being of the environment. For this reason, the design effort is to select the unit so that its operating mode is at a lower speed. The selection is based on cooling capacity. For an external pressure of 50 Pa and the first speed[8]

6.2 Design of CH2 - cooling of classrooms

The process of designing indoor ceiling fan-coil units designed to cool mostly classrooms will be analogous to the previous procedure. Cooling capacity is 3.5 kW.

• Determination of the cooling power correction factor. The cooling power correction factor is the same as the one determined in the previous section. This is $f_{CH}\left(\frac{6}{12^oC}+\frac{12^oC}{50\%}\right) = 0.97\ \ Eq\ 6.1$

• Determine the size of the unit. Again, it is based on the cooling capacity. For the external pressure of 50 Pa and the first speed, the cooling capacity is found in the catalogue. The selection parameters are marked with arrows in the header. Power series 2 is selected. The cooling power read from the calculation is 3.3 kW.[8]

•Use of silencer. After determining the noise parameters in the previous sections, these units also have a silencer on both the suction and exhalation sides. This reduces the sound pressure level and power.

7 DESIGN OF COOL WATER PRODUCTION EQUIPMENT

In order to achieve the required air temperatures during the summer operation of the air-conditioning system due to hygienic or technological requirements, it is necessary to cool the supply air. Since tap water is not sufficient to cool air in air-conditioning systems today, it is necessary to use a cooling device that is used to produce cool water for the air-conditioning system. A cooling device is a device that lowers the temperature of a cooled substance.

The cooling is distinguished direct, where air is cooled directly in the evaporator, and indirect, when the air is cooled by flowing cool water in the cooler, which water is cooled in the evaporator. The cooling equipment can be further divided into:

- compact or with a separate capacitor,
- water or air cooled,
- condenser fans are axial or radial,
- Compressors are reciprocating, screw, helical, rotary or turbo compressors.

Due to the complexity of the selection of suitable equipment, BM KLIMA sro. The required cooling device is a chiller with a separate condenser in an outdoor silent design with a total cooling capacity Qo = 179kW. The required temperature gradient of the cold water is 6/12 ° C. Back from Ing. Pigeon obtained technical and quotation for the required equipment [1]

8 AIR VENTILATION

One of the important tasks of the air-conditioning project is to prevent the spread of odors from the sanitary facilities. It is a vacuum ventilation, or forced air extraction from these rooms. The supply to these rooms is done by sucking air from the adjacent rooms. Up to 100 m^3 • hr-1 this is done through a door without a threshold, otherwise by means of grilles located in the door, resp. in the wall. (Fig. 12)

FIG. 12: Door grilles with their possible placement [8]

The minimum amount of air discharged from these areas is given through a suitable design of the air conditioning system for this building, where the amount of air per fixture is determined. In order to better ventilate the sanitary facilities, the amount of exhaust air to the device is increased on a device that is a larger source of odor. This results in better ventilation of the resulting odor. The amount of air per individual fixtures is:

- sink 30 m^3/ hr
- urinal 30 m^3/ hr (according to25 m^3/ hr),
- toilet bowl 80 m^3/ hr (according to 50 m^3/ hr),
- spout 50 m^3/ hr.

Thanks to a suitable location of the sanitary facilities in the building, all rooms on the floor can be connected to a common exhaust. In other words, one fan is sufficient to extract the exhaust air into the central shaft. This shaft will be maintained in a vacuum mode (not discussed in the work) by another device located on the roof of the building. Where these are listed for one device, the total air volume flow is a fan. V=660 m^3/ hr to be

International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.7., Issue.3, 2019
May-June

designed. The design is based on data from Elektrodesign. When selecting a ventilatorm a ventilator is selected that belongs to the group of ventilators in a circular duct according to the company classification. A suitable ventilator for extraction from the sanitary facilities has the company name RM - metal (Fig. 13).

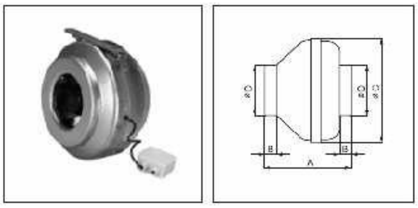


FIG. 13: Fan for circular duct RM – metal [9]

From the given volumetric flow rate and diameter, which is given by the recommended air velocity in the duct, its dynamic pressure is obtained by entering it into the operating curve of the fan. This design is shown in the following figure (Figure 14). This value shall be sufficient to cover the pressure loss of air in the duct. The choice of a given fan also determines its sound power in different octave bands.

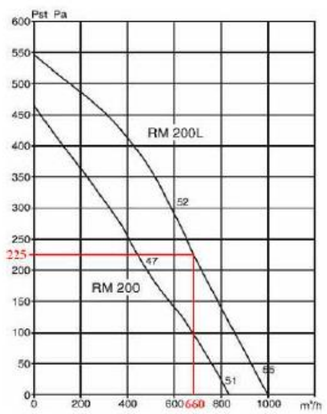


Figure 14: Fan curves RM 200 and RM 200L

Due to the noise level of the fan, it is advisable to include a silencer in the piping network, which prevents the noise from the fan towards the end elements. A silencer is recommended, recommended in an assembly with the same diameter as the fan. As the space for the installation of this device is small, a shorter MAA 200 shock absorber is provided (see Fig. 15).

FIG. 15: Muffler MAA 200

9. SERVER ROOM COOLING

The server is an expensive device with large production of sensible heat and zero production of bound heat. This property is located in control room. The room in which the servers are located will be cooled separately, as the room temperature requirements are determined by the technology. The required temperature for this room is 22 ° C.

Placing a room with four servers with a total power consumption of 2 kW is unsuitable for layout. The servers only produce noticeable heat, which must be constantly covered to prevent the temperature in the room from rising and thus potentially damaging the device. From this point of view, it is unsuitable to place the device in a room with windows, where the influence of sunlight increases the sensible heat and thus the temperature. It is far more appropriate to place this room somewhere near the center of the building, where the temperature would not rise due to the gains from the sun.

Since no one is permanently present in the room, it is not necessary to supply air to the room, but it is necessary to calculate the heat load through the windows by hours according to the procedure performed above. The results shown that the sensible heat production in the room is greatest. The gain from server power is increased by the thermal load from solar radiation (approx. 1.1 kW). The system design is based on the largest value of perceptible heat production per day.

A split system is chosen for cooling the server room, as it is not possible to use a special air conditioning unit due to a blocked fresh air supply. Air intake through the façade would not be allowed due to the architectural design. The disadvantage of the split system is the large cooling of the air on the evaporator, which condenses moisture and the air gets dry. Since a certain moisture limit is not required, this device can be designed. The split system is doubled so that in the event of failure of one device, the other (backup) device will start up. Wall-mounted indoor units are selected with a placement so that there is no risk of refrigerant leaking into the server. From this point of view, the most suitable location is the location of the device above the door.

The design is based on Carrier catalogue sheets. The main requirement is to ensure a minimum cooling capacity of 3.2 kW in year-round operation. As can be seen, the operating conditions of the equipment are in the temperature range of 15 to 43 ° C. Year-round operation of this device is possible after placing this requirement when ordering. The functionality of this device is conditioned by the maximum length of the pipe and the cant between the outdoor and indoor unit.

10. DRAFT AIRCRAFT NETWORK

The air-conditioning network is used to transport air from the outside to the air-conditioning unit, from there to the air-conditioned unit and vice versa. It is not only made up of pipelines, but also includes silencers, fire dampers, control dampers, end elements and other components.

The dimensioning of the pipeline network is based on the recommended pipeline speeds set for individual types of equipment and buildings. These values are recommended due to their good pressure and noise ratios. For public buildings, the recommended pipeline velocity in the horizontal plane is between 3 and 4.5 m • s-1 and in the vertical plane is between 5 and 6.5 m • s-1. Therefore, if the volume flow rate and the recommended velocity in the pipeline are given, it is necessary to adapt the piping dimensions accordingly. These will be larger the greater the volumetric flow rate of air and the smaller the prescribed value of the recommended velocity. However, it is not always possible to meet these recommended speeds due to the limited space devoted to air conditioning. Nevertheless, the speed in the duct should not exceed about 8 m /s. If it is exceeded, noise and noise from the air stream may be generated in the pipeline.

The velocity in the pipe network must also be adapted to the various elements that have the recommended velocity for their correct functioning. The investment costs for air-conditioning, which are not a negligible item, also depend on the piping dimensions. Therefore, the aim is not to size the pipe unnecessarily large. The speed in the duct should gradually decrease from the fan towards the elements. [1]

The same outlets are always selected for inlet and outlet. Three diffusers are used:

• Comfortable square diffuser. These are two rows of diffusers (Fig. 16) with regulation R3, the individual sizes are chosen so that the speed in the net cross-section does not exceed 2.1 m • s-1. This type of diffuser is used in offices and classrooms for supply and exhaust of ventilation air as well as for supply and exhaust of cooling air.

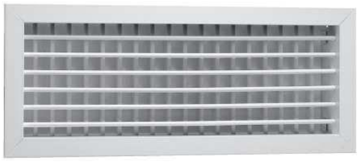


FIG. 16: Comfort square outlet [37]

• Swirl diffuser DF-RO. These elements are designed for supply and exhaust of cooling air in the corridor and also in the projection booth. The size, which is given by the number of slots, is chosen according to data sheets.

FIG. 17: Swirl diffuser DF-RO

• Plastic poppet valve. These elements are located in places with low air intake (small corridors) and on sanitary facilities. Disc valves are placed in the ceiling and connected via a flexible hose (Fig. 18).

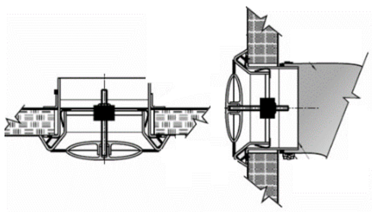


FIG 18: Installation of poppet valve

10.1 System Setup

An important part of each project is the calculation of pressure losses and subsequent regulation of the system. The task is to ensure the required volumetric air flow through the branch. If this calculation and subsequent adjustment of the grid is not carried out, there is a risk that no volumetric air flow may flow through certain elements at the end of the branch. This air would escape in places with less pressure loss, or in laymanship, in places with less resistance.

The calculation of pressure losses is carried out by means of the program Pressure from substrates [10]. By entering the required quantities, the pressure loss of the individual air duct element is obtained. This loss is recorded in the pipe color directly to the element. After recording the pressure losses of all elements, the individual elements are gradually added from the element to the branch. The same applies to the second branch connected to the branch. If this difference is greater than 5 Pa, the network with a lower pressure loss value is adjusted by adding a control damper. In case of a pressure loss of more than 50 Pa between individual sections, a flow restrictor for the VFL piping is used instead of the flap (Fig. 19).

FIG 19: Flow restriction regulator for VFL piping [11]

For better regulation of the large air-conditioning network it is used on the main branches of the constant flow controllers of the EN type (Fig. 20)

FIG. 20: Constant flow controller EN

During regulation, it is found that the pressure loss from the unit to the element with the greatest pressure the loss is higher than the transport pressure of the unit Δp =350 Pa. Because of this problem is again addressed the designer of units asking for modification of the unit. Request for adjustment unit is to increase the delivery pressure of the fan to Δp =400 Pa. According to his words, it is not the fan of the unit needs to be changed as the fan is designed with some reserve.

11 CONCLUSION

The subject of the paper is the design of the air-conditioning system of the A1 high-rise building. The designed air-conditioning system is intended to provide the required indoor climate after reconstruction.

The heat loss calculation of the object after reconstruction is performed. The calculation values are for information only, as the air-conditioning system does not cover heat losses during winter operation. In winter, people are more comfortable using radiators, which radiate heat and thus increase the mean radiation temperature in the room than air heating.

The aim of thermal insulation is to reduce the cost of heating energy. Due to significant thermal insulation of the building, the heat loss of one floor after reconstruction is small. Paradoxically, this leads to a problem with overheating of some rooms in winter. Since the object is divided into individual rooms, it is not possible to prevent the simultaneous operation of cooling and heating. Therefore, it is important to build a system that suits individual rooms with different operations.

For this reason and with regard to the result of the calculation of the thermal load of the building, the most suitable air conditioning system of the building is chosen. This system consists of an air conditioner to supply hygienic air. In summer, it will also partially cover the heat load. To cover the remaining heat load, a water system with ceiling fan-coil units is selected to cool down the remaining heat load according to the individual needs of each room. The choice of this system also seems appropriate with regard to the layout. The types of inlet and outlet diffusers are adapted accordingly. Their sizes correspond to the requirement that the output speeds do not exceed the permissible values and noise parameters.

The proposed air-conditioning system is based on the appropriate standards and complies with the regulations of the amount of supplied air concerning the amount of supplied air. The ventilation duct is fitted with fire dampers, which fulfils the requirement to prevent the spread of fumes between individual sections.

References

1 SZÉKYOVÁ, M., FERSTL, K., NOVÝ, R.: Větrání a klimatizace, Bratislava: JAGA GROUP, 2006. 359 s. ISBN 80-8076-037-3

2 Akbari and Konopacki, H. Akbari, S. Konopacki, Calculating energy-saving potentials of heat-island reduction strategies Energy Policy, 33 (2005), pp. 721-756

3 H. Akbari, S. Bretz, D.M. Kurn, J. Hanford, Peak power and cooling energy savings of high-albedo roofs Energy Buildings, 25 (1997), pp. 117-126

4 L. Doulos, M. Santamouris, I. Livada ,Passive cooling of outdoor urban spaces, the role of materials Sol. Energy, 77 (2004), pp. 231-249

5 E. Krüger, D. Pearlmutter, F. Rasia, Evaluating the impact of canyon geometry and orientation on cooling loads in a high-mass building in a hot dry environment, J. Appl. Energy, 87 (2010), pp. 2068-2078

6 C.W. Mackey, X. Lee, R.B. Smith, Remotely sensing the cooling effects of city scale efforts to reduce urban heat island, Build Environ., 49 (2012), pp. 348-358

7 H. Taha, D.J. Sailor, H. Akbari, High-albedo materials for reducing building cooling energy use Lawrence Berkeley Laboratory, Berkeley, CA (1992)

8 Amrane, Karim, and Xudong Wang. 2015. "Update on Phase II of the AHRI Low- GWP Alternative Refrigerants Evaluation Program." In Technical Forum on Research Projects for Alternative Refrigerants in High Ambient Countries. Dubai, United Arab Emirates

9 Seretoudi, N. (2005), "Air conditioning and ventilation study of an industrial facility", diplomathesis, Department of Production and Management Engineering, D.U.TH, Xanthi

10 Company documents of AZ KLIMA

11 Kiriakou, G. (2008), "Heating study of an industrial facility", diploma thesis, Department of Production and Management Engineering, D.U.TH, Xanthi