Control systems and comfort parameters in intelligent house

Frantisek Hruska

***Abstract*—**The intelligent house is equipped special systems with functions of security and control of parameters of using comfort. Staying of man in interiors of buildings and houses is monitored from many standpoints. There are in the main some parameters of thermal comfort, parameters of lighting comfort and characteristic qualities of inside air, because all the parameters are quite well controlled. There are aspects of hygienic, of energy and of comfort. The thermal and light comfort are accordance to present knowledge of the aspects, which affect quality of using of building interiors and has fundamental impact on its energy demand factor. The both requirements can be realized via known procedures very well. Questions of quality of air in interior relate above all with hygiene of staying. The problem puts on in bigger meaning already at present, when there is tendency build - up energy - saving buildings eventually energy passive buildings. In addition construction so - called intelligent buildings it offers incorporating of control system in its technological arrangement and build up its control and informatics systems very modern.

***Keywords*—** Thermal comfort, light comfort, quality of intern air, control, measurement, sensor of CO_2, sensor of VOC, forced air condition, emission.

I. Introduction

Healthy stay of man in building and house interiors at work, at home, at relaxation or retirement is now monitored according to aspects of comfort, health and hygiene and energy demand factor. It is about security and controlling correct and required parameters of interior spaces. There is ofen the solving connected also with reservation of safety factors of man stay indoors.

Development of systems for „ intelligent houses" solves in big range problems above - cited kinds of comforts for its equipment and systems technical security [1, 2, 3]. This category of equipment is part of wide system structure integrating the equipment of building and informatics and control function of others subsystems. As a basic function of modern buildings for 21. century there are :

- Environment: thermal comfort , light comfort, acoustic comfort, air quality , electro-smog and others [8].
- Security and verification: fire hazard, gas - escape, pounding, movement round the house and inside house, not allowed insinuation [6,7].
- Energy and its saving: in structure of thermal comfort and light comfort, controlling of renewable sources, controlling shutoff lightings, intelligent wiring system, electro mobile and smart grids, rainwater, backup AC power supply of 230V.
- Environmental science: according to saving of energy there is reducing emission of CO_2 [4,5,11].
- Entertainment and multimedia: switching of devices, recording of programs, control of integrated media center, communications Wifi, coupling of PC.

Scheme of systems of integrated houses can be present according to figure. 1. Central unit (1) is lined up in outward communications by way of the Internet or by way of WLAN and or serial network topology , e.g. LONWORKS for sensors of separate loops: of environment (4 until 12), lighting (15) sensor and operating devices (13 to 14), security (16) and its sensors (17 to 24), energy (25) and sensors (26 to 28).

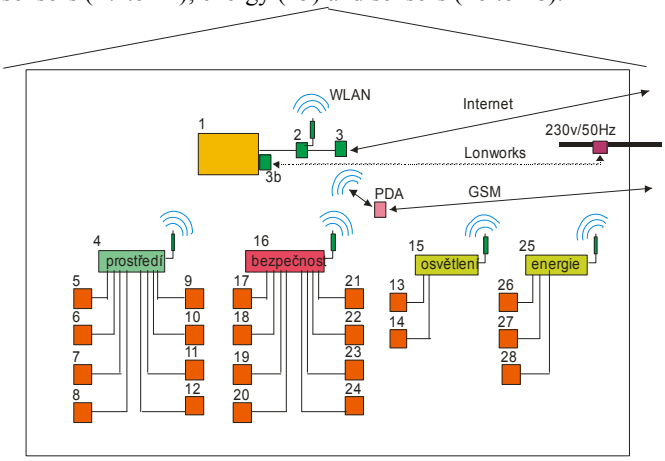

Fig. 1 Scheme of systems of intelligent buildings

II. Systems of thermal comfort

A. Describing of systems

Basic function of intelligent building is creating of thermal comfort accordance with geographic location of building. Heating technology or cooling technology of inside environment of intelligent building used to use warm - water at present most often by the help of heating bodies or flooring (warm - water or seat power control) or hot - air or cooling air (warm - water or with electric power supply). Means of control and informatics system are an important part of system thermal comfort.

System of thermal comfort has to ensure the temperature of inside air into separate rooms of intelligent buildings in value

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of representative feeling for the thermal comfort. Scheme of thermal comfort of man in interior is showed in fig. 2.

The thermal comfort of man [8,9] is depended on metabolism production of organism i. e. kind of his physical activities expressed at value W_{hh}), of thermal-insulation features of dress (accordance with way of dressing too, unit I_{hh}) and of heat-humidity environmental conditions (air temperature t_a, and of moisture of air M_a, temperature surface of all sides in rooms so - called middle radiating temperature t_r and size of air flow S_a). Detailed description of measured quantities is showed in table Nr. 1. Evaluating of thermal comfort makes a electronic device (EC_TCOMFORT) with output parameters (PMV, PPD, DR) and with controlling variable u(t).

Tab.1 The thermal-humidity parameters of interiors:

Parameters		Unit	Notes
Air temperature	t_a	°C	Range of measurement +5 to +35°C.
Air hunidity	M_a	%	Range of measurement 10 to 100% RH.
Mean radiation temperature	t_r	°C	Range of measurement - 25 to +75°C.
Speed of air flow	v_a, S_a	m/s	Measurement gives information in draught too.

Metabolism production of body is given physical activity of man in a concrete environment. When there is the body quite inactive (e.g . laying on bed) it gives out approximately 48 W/m^2 of body surface of man and 40 W/m^2 of female. When there is the physical activity connected with working , then this value get increased. E.g. at hardworking man(digger) there is the output of heat from body over 300 W/m^2. Next unit for warm out of body is (met=58,15 W/m^2).

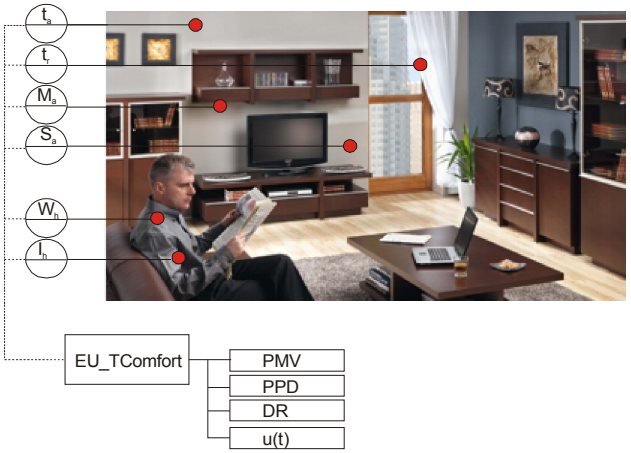


Fig. 2 Scheme of thermal comfort system of man in interiors (t_a-air temperature, t_r-medium radiation temperature, M_a- air humidity, S_a-speed of air flow , W_h-thermal output of body , I_h-kind of clothing)

Clothing, kind of dress and used materials etc. implicate thermal resistance for warm out of metabolism production of body. Therefore clothing of man in environment is important voted accordance with metabolism production of body and thermal-humidity parameters in environment. Its unit is thermal resistance (m^2.K/W) for given type of clothing or next unit (clo=0,155 m^2.K/W).

According to knowledges these 2+4 quantities there is possible accordance with model PMV [8] to evaluate thermal comfort according to coefficient PMV. When is value PMV = 0, thermal comfort is full of comfortable. The value from zero to -3 means thermal no comfortable connected with feeling chill. On the other way valuables PMV from zero to the +3 are valuables expressing warm as far as hot.

Because at present there aren't currently manufactured technical means for measurement of parameter of medium radiation temperature to calculation of PMV, there is used to evaluation of thermal comfort so - called operative temperature (3). There is always used measurement with spherical thermometer and it calculates thereat influence of air temperature and radiation of environmental surfaces yet. This measurement is loaded great uncertainty in measurement and a big dynamic heterogeneity [8].

Indicator PPD (predicted percentage of dissatisfied) – predicts percentage share of dissatisfied people and it is derivated from parameter PMV [8,9]. Indicator PMV predicts mean value of consideration of thermal sense at big man group and gives quantitative prediction of relative number of people, who will dissatisfied with classification of microclimate.

A standard show in also indicator DR – draught rating, it is a degree of harassment of draught. Value is depended on local air temperature, on average velocity of air in interior and on local intensity of turbulence.

B. Control of thermal comfort

In modern intelligent buildings there is established the parameter PMV of comfort of thermal comfort and can be used for two procedures:

1. To determination requested values of air temperature t_a at management system of heating or cooling according to other values for PMV=0. This value will be different e.g . for room in a house energy passive, energy - saving or indoors older heat insulation and without and according to size of windows, walls and e.t.c. Scheme of system evaluating thermal comfort into heating is in fig.3.
2. To determination a kind of clothing for given physical activity or for hygienic check - up.

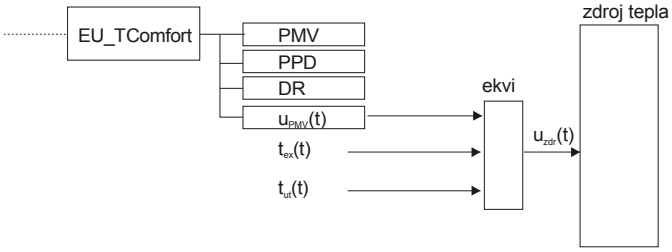


Fig. 3 Scheme of control loop of thermal comfort)

Electronic unit (EU_TCOMFORT) accordance with input metering values and worth additional values will evaluate indexes of thermal comfort (PMV, PPD, DR) and at the same time has on output signal u_{PMV} (t) like command variable for technical unit of equitherm control (unit ekvi). According to this signal and data about outdoor temperature t_{ex} - (t) and temperature in reference rooms of interior t_{ut} (t) it controls source of heating medium so, that keeps index PMV=0.

Up to now a big technical problem is absence a simple manufactured sensor for measurement of medium radiation temperature of all inner surfaces of interior. Serial producing thermometers for measurement of operational temperature have big uncertainties in measurement, have dramatically different time constant influencing negatively evaluating of thermal comfort and there're financially expensive.

Results experimental work at problems of thermal comfort make possible use solution with indirect measurement and resulting evaluation of reference radiation temperature t_{rt} of interior [5]. Principle of assessment can explain accordance with block diagram displayed in fig. 4.

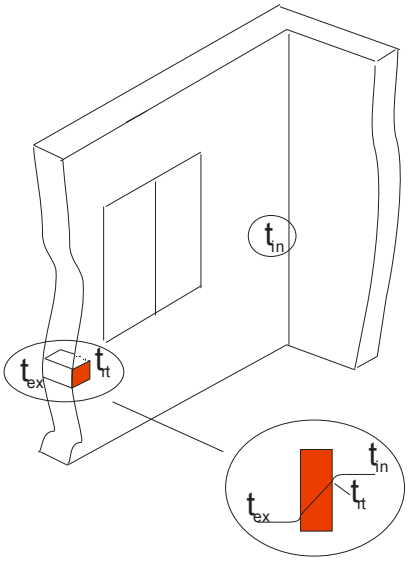


Fig. 4 Scheme of assessment of reference radiation temperature in interior)

According to physical laws for heat transmission through wall there is possible under given to presumption to determine place on outside wall of rooms you see in fig. 4, where for total specific heat flow over wall q_{st} holds:

$$q_{st} = U_{st}.(t_{in} - t_{ex}) = U^{*}{}_{st}.(t_{rt} - t_{ex}) \qquad (1)$$

where is U_{st} coefficient of heat transmission, t_{in} temperature of ambient, t_{ex} temperature of outdoor, t_{rt} temperature of indoor surface of wall.

Value of reference radiation temperature t_{rt} there is possible after eduction to determine accordance with relation:

$$t_{rt} = \frac{U_{st}}{U^{*}_{st}}.(t_{in} - t_{ex}) + t_{ex} = \frac{\left(\frac{1}{\alpha_{ex}} + \frac{d}{\lambda_{st}}\right)}{\left(\frac{1}{\alpha_{ex}} + \frac{d}{\lambda_{st}} + \frac{1}{\alpha_{in}}\right)}.(t_{in} - t_{ex}) + t_{ex} \qquad (2)$$

where is U_{st} coefficient of heat transmission, t_{in} temperature of ambient, t_{ex} temperature of outdoor, a_{in} coefficient of convection heat transmission indoor surface, a_{ex} coefficient of convection heat transmission outdoor surface, d thickness of wall, λ_{st} heat conductivity of wall.

Calculated value of reference radiation temperature t_{rt} is value for select point. To the formula for calculation of PMV and of other indexes there is appointed for parameter t_r calculated value corrected coefficient k_{rt}, which makes provision for other three - dimensional influences of interior. In the unit (ekvi) is implemented functional application doing correction accordance with formula:

$$\bar{t}_r = k_{rt}.t_{rt} \qquad (3)$$

III. AIR QUALITY OF BUILDING INTERIORS

A. Indoor environment of interiors

Quality of staying environment is solved for area of air quality in interior too. There is described character of inner environment and his interaction of staying of man and further air quality in outdoor environment including related problems with emission and pollutants. To staying of man in interior there is from hygienic argument main ventilation. Intelligent buildings and buildings in standard A- with zero power consumption and in standard B- low - energy buildings demand to install controlled ventilation with recuperation, to ensured low consumption of thermal energy during ventilation. Controlled ventilation system for getting optimal power consumption and right function of ventilation asks for framework with corresponding sensors of concentration of emission and immission, getting computing unit and actor elements. Modern view of solution those problems including connection with other subsystems of intelligent buildings is make next.

Description problems indoor environment is necessary to start classification of intelligent buildings from look of basic use. These are category: a family house, a block of flats, a multi-functional building, a manufacturing building. Character of use can be affected a definition of indoor world and a access of his influence.

Requirements on indoor climate are defined for staying environment and working environment in standards and in laws of concrete country

B. Interference of indoor environment

Man and actually all live needs to the life oxygen from air and air has to be clean. At present but human activity adds into atmosphere much emission and his constitution isn't already at present perfect. Influenced there is also indoor climate in building (by cooking, cleaning, heating, …) or also outside atmospheric environment (from industry, cars, power plants,..).

The man his indoor climate influences of his attendance, behaviors and other activities. There are parameters of air temperature and compound of indoor air accordance with concentration emissions and immission. Environment is changed also according to quantity and kinds of placed plants, intensity and frequency cooking, smoking, appearance animals, number persons, clean - up.

Exist thermal- humidity microclimate is given air temperature, humidity, radiation temperature, air flow in rooms and many - storied gradient temperature. The man affects air temperature by setting of heating. Optimum air moisture is recommended in range from 35to 50%, over 55% already can rise mould. Humidity of indoor environment is given according to humidity of external environment, which the man does not affect and further by operation of household. The man from breathing produces from 50- 70 g/h/person), he from dry washing produces from 400 g/h), from ironing there is rised about from 200 g/kg.h), cooking gives 500 g/h, shower produces 600 g/h, plants contribute by to the compartment 50 g/h.

Other influence of indoor air is e.g . concentration of radon, of using reactive materials from washing and cleaner materials and rejuvenator e.g. Linomen, terpene, $C_{10}H_{16}$ (first of all with smell of lemons). Computer and office equipment generate ozon (copy device and laser printer).

C. Outdoor environment

Outdoor environment is formed of air atmosphere. Standard constitution air is effected above all issues from industry, power engineering, transport, heating systems of buildings and others. First combustion fuelling forms emission CO_2 in rate, when nature isn't able already carry on balance.

Other component in outdoor environment there is methane and next gaseous hydrocarbons rising biological process, above all from putrefaction without input of air organic masses outdoor and from wastes, further from breeding pets, from chemical production of materials like acetylene, hydrogen, cyanides and methanolate. Methane influence greenhouse effect when it is 21 times greater than influence CO2. Monoxide nitrogen is next gas creatives espressivo greenhouse effect and it is up to 310 times more intensive than CO2.

Outdoor environment is polluted further of shiftings dust. His concentration is markeds as PM_{10},$PM_{2,5}$ and $PM_{1,0}$ according to size of elements. Air-borne dust is formed generally of sulphates, ammonium salt, carbon, some metals, nitrates, eventually and volatile organic ellements or polyaromatik hydrocarbons. Main source of dust there are diesel motors of cars, combustion of fossil fuelling and biomass, industry, mining and free natural areas.

Outdoor environment is interconnected with stay environment of man in buildings by infiltration and ventilation of buildings. The infiltration (it is blowing-through throught windows and doors) is uncontrolled change of gas and is dependent on many conditions. At leaking wooden simple window there is infiltration value i = 1,9 x 10^4 m^3/m.s.$Pa^{0,67}$, at tight windows value diminishes to and = 0,1 x 10^4 m^3/m.s.$Pa^{0,67}$.

Indicator of transmission of air in buildings is coefficient air space of blowing-through, which means volumetric flow of air in m^3 for 1 second, flowing longitude of one metre of opened up windows and doors near pressure difference between both sides of construction for 1 Pa. It has unit m^3/m.with^1.Bye - $bye^{0,67}$.

Other element incoming into these processes is air - proofness of building, so - called total air - proofness siding buildings. General air - proofness siding of buildings is established according to standard as value $n_{50}(h^1)$ of total intensity of air exchange air near pressure - difference for 50Pa. Smaller value gives bigger air - proofness of building. A passive house with forced ventilation with recuperation element of warm has extreme value $n_{50,N}$ = 0,6h^1. During 1 hour indoors outflow of air can not be more than 60% of the total capacity of building.

D. Limit of immision

Immission limit is given as most highly allowable mass concentration pollution compounds in air in laws. For Czech republic there is law 201/2012 Sb. It has got date of concentration for SO_2, NO_2, CO, O_3, PM_{10}, PM_{25}, and its limits.

E. Humidity of air

Humidity of air is other qualitative parameter and feature in interior and exterior too. Air moisture is indicated, what quantity of water vapor is contained in air volume. Representation of quantity of water vapor in air uses several quantities: partial vapor pressure, absolute air humidity, relative air humidity, dew - point and specific atmospheric moisture [4,5,13].

Air moisture in interior is between 40 and 60 %. Higher air humidity is given from cooking, spraying, washing and dry washing, number persons etc . Humidity of outdoor environment affects dampness weather and is in range of relative humidity from 20 until 100%.

Air moisture together with ambient temperature can contribute to air quality , but also to problems. A big problem is danger of rising of mould or spreading of mites first of all in winter months. Quality nearly relate to ventilation eventually accordance with used air - conditioning with control of moisture: drying or moistening of air.

F. Control system of air quality in interior

Quality of air in inside environment is done via of ventilation, i. e. replacement of inside air from outdoor air. Ventilation at buildings is natural or forced. Goal is ensuring of constitution of indoor air concentrations of harmful component below limits to give hygienic specifications.[7, 12, 13]

Natural ventilation is done hand - made opening windows for same time. It's influenced of subjective feelings and ways of man in interior. This way is uncontrollable from look at qualities of air and consumption of energy in winter period.

Forced exchange of air in interior is done by the help of air conditioning arrangement. There is modern solution for low - power and passive buildings and for intelligent buildings. Control of these exchange of air is accordance with adjusted time period or after metered quantity of emission concentration of CO_2 or VOC. Algorithm for sequence control by date supports e.g . minimum exchange 0,5 of capacity ventilated space every hour (1/h) or as far as 25 m3/h/pro person. The control of this forced ventilation controls also speed of exhaustion or size of draught, e.g . maximum into 0,2 m/with in winter and to the 0,25 m/with in summer months.

The forced exchange of air in addition can improve the parameters during exchanges incoming air , e.g . get hot, change atmospheric moisture and at low - power houses also backward extract of warm from output air and hand down this warm to the input air.

G. Measurement of air parameters

In the praxis there is measurement of concentration of gas components gas in air namely gases basic and dangerous. Basic composition pollutants in air at current usage of interior includes concentration CO_2 and or the mixture of volatile hydrocarbon VOC (Volatile Organic Compound) and eventually bigger atmospheric moisture.

During usage of interior can rise also pollutants of gases, which can evoke health problems (e.g . from presence of CO) or also of large accident or explosion (escape fluel gases).

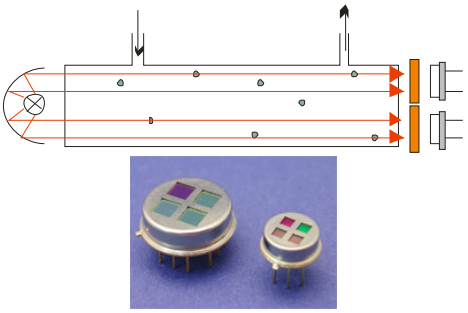


Fig. 5 Scheme of measuring principle and photo of sensors

Measurement of concentration CO2 in mixture of air in interior is make most exact by the help of sensors working in principle of absorption IR electromagnetic radiation. There is used feature of two - molar gases. Every such gas has in his spectral characteristic narrow and specific zone of absorption of the electromagnetic radiation for concrete wave longitude. Demonstration of the principle and sensors for measurement of four gases shows fig.5.

Fig. 6 Principle and real pieces of photo-ionization sensors of VOC

Volume of gas VOC hydrocarbon) is measured by sensors with principle of UV ionization eventually of solid - state way. THE UV photo ionization is modern and newly is progress principle, chart is in fig. 6.

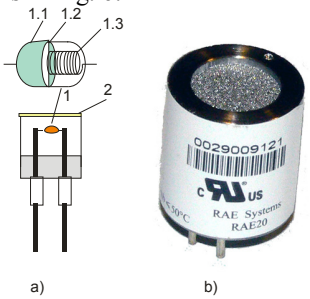


Fig.7 Scheme of principle of pellistor and its real view

Dangerous and deathly poison gas CO is able to rise at imperfect combustion of fossil fuel or at disorders combustion of earthy gas in building. The basic applied sensor signaling rise or presence of CO is a sensor with principle of catalytical combustion called pellistor, chart see in fig. 7.

H. Control system of air quality

Control system of air quality in interior realizes basic goal i. e. to have air in inside environment of building with concentration pollutants to permission limit. At present the way of controlled ventilation has possibility of backward using of warm from output current of air. (10, 11).

Basic system scheme is showed in fig. 8. Technology of control of air quality in in interior includes a unit for warm recuperation eventually with air - conditioning (1), output pipe from environment (2), input pipe for new air into interior (3), outdoor output and indoor openings (4) and control system of quality with sensors, central unit and actuators.

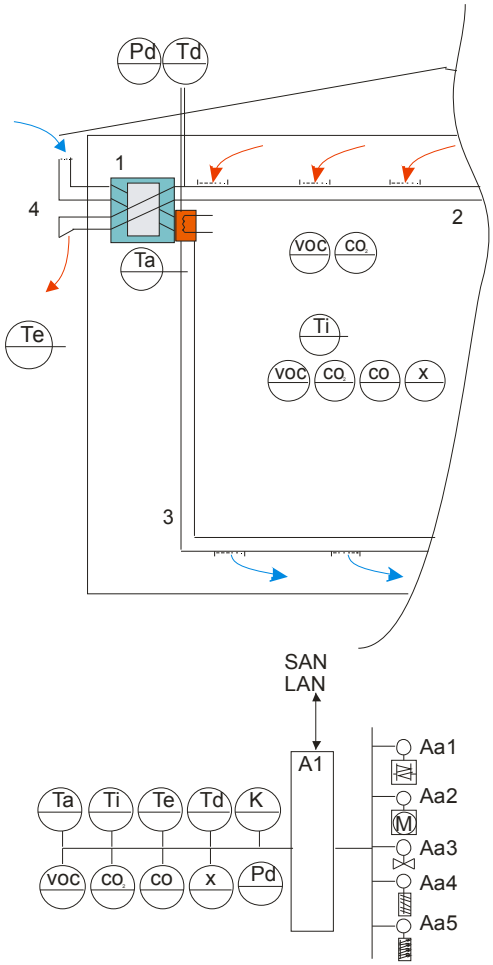


Fig.8 Scheme of control system of air quality

Detail connection diagram of control system of air quality is in next parts of figure. Input part includes system sensors to the extent after levels of steps automation. Generally are it sensor for temperature measuring (Ta- temperature of incoming air in pipe (3) from rec uperation unit (1), Ti - temperature of interior air, Te – temperature of outdoor environment, Td- temperature difference of vacuum treated concrete and air input), for measurement of gas concentration (VOC sensor , CO_2 sensor of carbon dioxide, CO sensor of concentration carbon mono oxide), for metering pressure difference in recuperation unit (sensor Pd), time unit and sensor of specific parameter X.

Central unit (A1) is type of embedded subsystem, it has at input side the connected sensors, at output side the actuators. The unit has communication interface of serial network (SAN) and local network (Local Area Network) too. The part of the unit troops is also application software.

The element (Aa1) serves for operating flow seat power control energy for warming - up, the element (Aa2) is for control of turning motors of ventilators and pumps, the element (Aa3) is for control of flow of heating or cooling water in pipeline, (Aa4) is for control of jalousie, the element (Aa5) is for control of set - up of moisture.

The all control system of air quality in interior includes many elements. Therefore there is connection a significant part of all equipment for date transmission and information transfer. At present this connection is electric and is realized as copper or optical cable or by the help of wireless.

Output signal of sensors are generally types of electric signals and are connect to central unit. According to results of evaluation there are output signals generated in central unit for control via actuators of aerating.

Connection of central unit to other system parts of intelligent buildings is other significant parts. Measured data or control processes are also information and are used for signalling, informing or for publication of danger. There are used in a few levels and technologies. Exemplary diagram is in fig. 9.

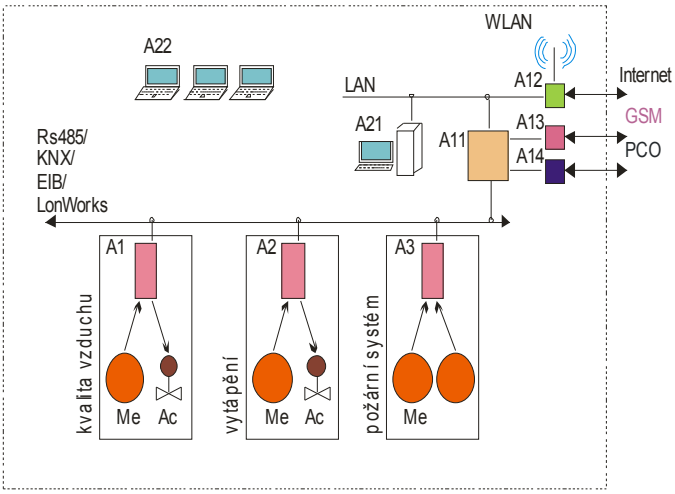


Fig.9 Architecture of control system of air quality in interiors

Data transmission of lower levels, is serial communication marked as USB, RS485, or KNX/EIB, LonWoks. This connection is local on a small distance between central periods (A1, A2, A3), and other local subsystems e.g. heating, fire.

Connection and information transmission on local level is done between computation and PC techniques of intelligent buildings and outside buildings too on Internet or GSM or desk of central protection PCO. Local connection is type LAN/Ethernet with cables or wireless type WLAN. Significant element there is computing unit, so - called head server of intelligent buildings (A11). This computation element can be connected to cable connection, can be connected on router unit (A12) and on provider of Internet as well as over GSM gate (A13) on net mobile phones or connection (A14) on PCO.

IV. Light Comfort in Interiors

The light comfort is next a significant aspect of stay of man in interior. It is about lighting of room accordance with kind of activity for sunny and artificial lighting.

A. Introduction

Man evolution has proceeded in conditions of periodic change of lights in the day-time and darkness at night depending on rotation of earth. Number of biological functions

in live organism are markedly changed in rhythm those changing.

B. Sunny lighting

Sunny (natural) lighting is sunlight incidenting on the Earth as direct sunshine or as light of sky diffused in atmosphere . Direct solar radiation has valuables intensity of illuminance in summer in sunny day as far as 100.000 lx. Spectral distribution of this lights is variably, depended on the altitude of Sun above the horizon and on state cloudiness.

Natural light penetrate into interior into lighted room directly from sky, or reflected light from outside objects and light reflected from inner surfaces in room.

According to type and design of building there is sun light comes over windows, and then also over roof windows (studios, factory halls etc.).

Power of radiation on surface earth atmosphere does 1 373 W/m^2 (solar constant). The power oscillates in consequence rotation about approximately 3 % (circa 40 W/m^2). The part of radiation is absorbed by atmosphere. The its absorption is only for some wave longitudes. The ozone layer absorbs ultraviolet radiation from wave longitude 290 nm to 320 nm. The wave longitudes of infra - red range is absorption according to volume of carbon dioxide and water vapour.

The visible range is absorbed only partial and depended on thickness of atmosphere, which it has to pass. Intensity of over going radiation of sunshine R_g has a formula:

$$R_g = R_s.k^{\frac{1}{\sin\alpha}}.\sin(\alpha - (\gamma.\cos\beta)) \quad (3)$$

where's R_S solar constant (1 373 W/m^2), k coefficient permeability of atmosphere (=0,7 as far as 0,9), α angle of high of sunshine above horizon, β azimuth of sunshine (south=180°), γ angle of level in southward direction. This energy is consumed for photosynthesis, for warming - up of vegetation and of surface of earth, for evaporation of water and for warming - up of air.

At the Czech Republic there are its values: in summer midday max. 1 050 W/m^2 , in winter midday max. 300 W/m^2, at all cloudy sky max. 100 W/m^2, at night 0,01 W/m^2.

C. Artificial lighting

Creation of positive conditions for good vision is supposed by designing and implementation of all kinds of lighting - i. e. artificial light, daily or combined in interiors of buildings generally. It is mainly visual task for users of those rooms from aspects of their placement, difficultness of tasks and their time distribution. At the same time it watches especially to valid normative documents and their requirement, resulting from parameters of visual tasks including effort of reach for visual and total comfort in light of pleasant environment at visual sense.

Lighting is therefore a important factor of life and working environment, because man accepts by eyesight most information in environmental world with the help of adequate lighting. Adequate and quality lighting is condition for seeing, keeps off rise oversize and premature tiredness, increases effectiveness and quality work, share in reducing of quantity working accidents.

D. Parameters of light comfort

Lighting of visible light is electromagnetic radiation by wave longitude from 380 to 760 nm**.**

Measurement and appreciation use luminary parameters and units are:

- Luminance I [cd candela] – base unit of SI;
- Luminous flow [lm lumen] – it is luminous flow shines into space;
- Lighting E [lx lux] (intensity of illuminance, illuminance);1 lux [lx] is lighting of surface, whose every square meter falls distributed luminous flow of 1 lumen;
- Brightness L [cd/m^2] – share luminance and surface sources.

Interior is illuminated by light over luminous filler of windows of building. Indoor lighting is defined relativity quantity, so - called factor of daily illuminance e [%]:

$$e = \frac{E_i}{E_e}.100 \quad (4)$$

where E_i is inside illuminance (lx) in reference point and E_e is comparative lighting (lx) outdoor no shrouded level (lx).

Evaluation of daily lighting is coming-out from maximum, minimum, eventually average values of factor of daily illuminance and from so - called uniformity of lighting, which is defined as relation of minimum and maximum of measured values of factor of illuminance:

$$e = \frac{e_{\min}}{e_{\max}} \quad (5)$$

Minimum of admissible value of factor of illuminance are given ot be sufficient lighting for supposed activity. Visual heftiness of permanent practicing activities in this environment is decisive criterion for determination title to global illuminance hatch.

Suitable day lighting have to be prepared for permanent residence of people (for more than 4 o'clock every day). Minimum value of factor of daily illuminance e_{mine} would be at least 1,5 %, eventually average value e_{prum} at least 3 % (for upper and combination lighting), even if for existent visual activity be enough lower values.

Objective survey about lighting of room gives into situation block plan draw in izofoties, splines connecting points of same values of factors of daily illuminance. Suitable uniformity accordance with heftiness of work is from 0,15 to the 0,3.

Quantity of daily light is given by luminous flow incoming thru transparent constructions into interior often boosted by reflections in interior. It influences all other parameters of daily lighting in interior. Cope on horizontal datum in net monitor point. Measures on horizontal datum in net monitor point. Measures on horizontal datum in net monitor point. It is measured on horizontal datum in net monitor point. It is measured on horIt is measured on horizontal comparative level in net of check points.

In standards there are values of factor of daily lighting for definite classes of visual activities.

Smallest allowable values of average illuminance E_p and uniformity r for general lighting are defined without regard on visual activity (see following table 2):

Tab.2 Parameters lighting and uniformity

	Lighting E_p (lx)	Uniformity r_{min}
Occasional stay in interior	20	0,1
Short - term stay	100	0,4
Permanent stay	200	0,65
Permanent stay without sun lighting	300	0,65

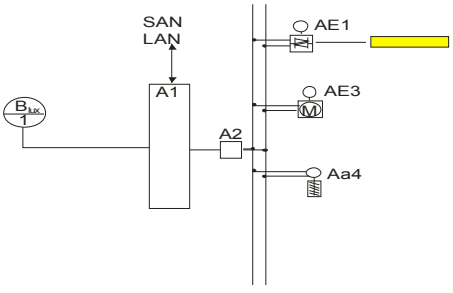
Control of daily lighting ensures unsuitable effects of daily lighting (high intensity, dazzling, troublesome influences, high bright shine). It employs devices solid and moving shutters, jalousies, sun-blinds, curtains, hangings, through-shine materials of streamlining, diffusing, absorbing etc .

E. Control of light comfort

Control of light comfort has several aspects: in part from sight of artificial and natural lighting, in part from sight of technical means of measurement, evaluating and operating. Universal chart is in fig.10.

Control system A1 receives information in level of lighting in monitored or reference room or point out of sensor $B_{vacuum\ cleaner}$. According to kind and range of application and accordance with time of day and needs of requested values of light in concrete algorithm is evaluated controlling signal and transmitted to corresponding quantity into control unit. There is continuous control of power of lighting from devices of artificial lighting E1 . There is used drive control method of phase angle for individual sine wave of supply voltage. Control of light in interior from outdoor solar lighting, first for stopping troublesome influences and impacts, there are applied motor driven controlled (activator AE3) or other shielding systems (Aa4).

Inter-connection between central evaluation unit A1 and action component unit is showed in figure as LONWorks system. Output dataflow for drivers is handed down via modem A2 into power line 230V/50Hz. Control device is connected on power line of building and controlling signal is leaded parallel in voltage 230V and is used in control action.



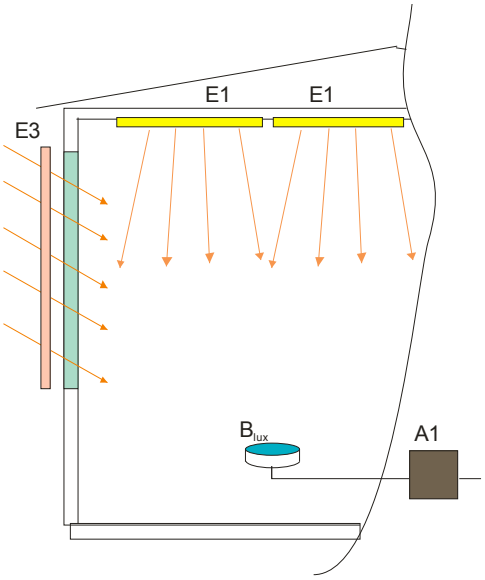


Fig.10 Way and chart of control system of light comfort (A1 evaluating device, B_r measurement of intensity lighting, E1 equipment of artificial lighting, E3 shielding element of indoor lighting, A2 – communication unit, AE1 – dimmer of light E1, AE3 control of shielding arrangement, AE4 control of sun - blinds and similar establishment).

V. Conclusion

Thermal, air quality and light comfort are significant quality factors of usage of every building. Contribution brings solving of evaluation and control of all comfort of man in interior. Significant elements of control system are sensors of all parameters, central units, actuators controls and devices of communication. Control system of comfort is connected to systems of security, voice and video and other multimedia systems.

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