RIGA TECHNICAL UNIVERSITY

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AIR CONDITIONING IN ROOMS WITH CONTROLLABLE HUMIDITY

Summary of Doctoral Thesis

Rīga - 2006

GENERAL DESCRIPTION

ACTUALITY OF THE RESEARCH

Due to the technological and economic progress in the Republic of Latvia it is possible and necessary to pay more attention to the providing of the microclimate in rooms.

Evaluating the potential of the providing the humidity parameters and the basis of the scientific research information in the Republic of Latvia it is possible to state that it has to be supplemented due to following reasons:

The building codes doe not contain enough data output for the quantitative evaluation of the air humidity change processes - kg/h, g/m^{3}h, etc.;

The methodology using at least the minimum of the available information from the norm to calculate the change processes of air humidity has not been worked out;

With the present amount of the data output it is not possible to provide the necessary calculations European union directive for energy efficiency in buildings (energy labeling) if the air humidifying or dehumidifying is intended.

In the paper larger attention is paid to the problem of the humidity content in the museums and historical buildings due to the fact that in industrial buildings the research of the process of air conditioning is financed by the private capital, while the historical buildings mainly are owned by the state and the research is done in campaigns, depending on the available state financing, the present budgetary situation, and the activity of the users, and the microclimate in these premises that determines the conservancy of the unique artistic property the loss of which may cause considerable or even incalculable costs.

THE AIM OF THE RESEARCH

The aim of the promotion paper is a critical analysis of the air conditioning system solutions and the methods of humidity control in the public and industrial buildings with different air exchange, temperature and humidity regimes, evaluating the dynamics of the changes of air humidity in the processes of the humidifying and dehumidifying.

The following research tasks are advanced:

- To gather information about the methods of the humidity control;

- To develop the principal control flow diagram of the humidifier and dehumidifier;
- To supplement the existing energy certification methodology of buildings with the calculations of the air humidity change parameters.

SCIENTIFIC NOVELTY AND MAIN GOALS

A new humidity content change criteria is offered- the range of the humidity changes in a time unit. Developed a model for the control of the air humidifier and dehumidifier, and capacity supervision using the offered criteria.

The evaluation of the usage of the criteria in the EU directives about the energy certification of the buildings in order to introduce it in the air conditioning systems the operation of which results in changing the air humidity content.

Offered approach to use metrological information, humidity content data applying for air conditioning design, operation and running analyzing and prediction.

RESEARCH METHODOLOGY

In the experimental research that covered 6 industrial and public buildings the data about the indoor and outdoor humidity content in different exploitation regimes of the premises and air handling processes were measured and collected to check the theoretical presumption about the operation of the criteria and the developed model of the control of the air humidifier and dehumidifier. The research completely affirmed that the criteria and the theoretical model operates also in the exploitation of the systems in the years cycle of outdoors clime changes

In the experiment completely new, before unknown interconnection between the content of carbon dioxide and humidity control which exceptionally brightly is seen in the case of low air humidity and small air exchange was stated.

ADVANTAGES IN PRACTICE

It offers to supplement the building norm of the Republic of Latvia in the sphere of ventilation and air conditioning:

- To predict the exploitation of the system on specified climatology data;

- To use a new, in the legislation of the Republic of Latvia not regulated human comfort influencing rate - minimal and maximal permissible air humidity content and change dynamics - for the system calculations and regulations.

The paper presents methodical base for the use of air humidity content in the engineering-technological calculations.

The air conditioning systems that used the results of the work operates in the following objects- Riga tobacco factory "Scandinavian tobacco" (realized in 2003), the major assembly hall of the University of Latvia (2004), in the office of the newspaper "Diena" (2005), in the swimming pool room at the Latvia University of Agriculture (2006), in the ice-hockey hall in Valmiera Olympic centre (2006), and it is included in the proposals of the reconstruction project of the Dome Cathedral, Foreign Art museum, the Museum of Applied Art.

The results of the work are used in the study programme "Heat, gas and water technology" in the Riga Technical University.

There are five publications about the research in international scientific literature, it was also reported in four international conferences.

STRUCTURE AND SCOPE OF WORK

The paper consists of three chapters and conclusions. There are 100 pages, 22 figures and bibliography that consist of 170 sources. The summary does not regard the bibliography.

The air conditioning is always connected with the outdoor air exchange, which implies many characteristics of the nature processes, changing temperature, air humidity and the atmospheric pressure.

According to the air conditioning definition mentioned in legislation- "automatically regulated process, which apart from the intensity of the outdoor changes and indoor air pollution sustains the desirable air quality in room or in a part of the room" and the quality of the air- "air characteristics (air content, the concentration of dust and bacteria, temperature, relative humidity, air speed), which affects human health or comfort". The realization of this complex question requires the totality of actions and technological elements that would:

- State the actual situation with technically available measurements according to the parameter or the group to be controlled;
- Analyzes the situation;
- Make the decision about the further actions;
- Perform the necessary air conditioning process;

- Evaluate the influence of the chosen process upon the quality of air in the room.

1 ROOM HUMIDITY CONTROL METHODS

Parallel to the control methods of the temperature also the type of the humidity control is stated according to the necessary in the room, the action of the air handling to be realized microclimate, the measurement of the air parameter and further processing options. According to the microclimate, rooms could be classified:

1) Rooms in which the condensation of the water on the room enclosure constructions or other surfaces could not be permitted. For example, computer technology factories, data carrier's archives, etc where the condensate can appear as a result of rapid temperature change. Or in the rooms with bioactive environment, where the condensate can cause the development of mould, as well in the ice-hockey areas where the corrosion of metal constructions increases and the ice surface deforms as a result of the condensate;
2) Rooms in which a definite diapason of the relative humidity has to be assured.

According to the action of air handling to be performed rooms could be classified:

1) Decreasing of the air humidity - dehumidifying:

- air cooling below the dew point temperature;
- air drying with sorption methods.

2) Increasing of the air humidity- humidifying:

- supply air with water as overheated water steam;
- supply air with water as drops;
- evaporate water from an open, moist surface.

The names of the humidity control methods are better known according to the type of the measuring instrument:

1. Relative humidity method;
2. Dew point method;
3. Wet bulb temperature method;
4. Humidity content (water steam partial pressure) method.

1.1 The characteristics of the absorption and desorption of a room external enclosure

Air humidity changes in a room are caused not only by the air conditioning or technological process but also the humidity exchange from external constructions. As a result of that it is necessary to state, prognosticate and control the process as far as it is possible.
As air conditioning is seen as a continued process, which normally lasts for a whole year, the use of the research about stationary temperature and mass (humidity) transfer of the room external enclosure under stationary circumstances is limited, that is why non-stationary circumstances are examined in detail.

1.2 The practical experience of the air conditioning systems in museums and historical buildings

In order to evaluate many processes, which to day are self-evident it is necessary to look back in the recent history assessing foreign experience in the air humidity control in the museums.
The majority of the works of art, historical buildings are made of natural materials and cohesive substances (from flora and fauna), wood, leather, paper, wool, bone, etc. The results of the last century's researches about the reaction of these items to the circumstances of changing humidity had given a publicly better-known denotation "optimal humidity level". The main idea of these recommendations is that humidity cannot decrease below the minimal level, which causes fragility, Assuring of the works of art of natural materials and it cannot increase to the level at which mould starts to develop. Overall, the recommendations agree that relative air humidity level in the exposition halls for the collections of mixed material has to be within limits between 30-70%. With rare exceptions narrower limits between 50-60% are mentioned for such objects as valuable furniture and paintings. In most cases these numbers are not based on detailed research about the characteristics of natural materials preserved in variously conditioned rooms, but from establishing facts in different museums with small changes adjusting them to the concrete circumstances of the outdoor climate.

2 THE MODEL OF THE USE AND PROCESSING OF THE DATA ABOUT AIR HUMIDITY CONTENT

In order to frame the model of the use of the data about air humidity content it is necessary to collect, evaluate and summarize the range of the set point parameters, which is based on normative scientific researches, climate measurements or other literature sources.

2.1 Parameters of the outdoor air

The data about the conelation between the maximal outdoor air temperature and humidity content have to be used in the calculations of the maximal power of the cooling and drying systems when insufficient power is not allowed and the necessary microclimate in the room is not maintained or the amount of hours of that situation has to be predicted.

2.2 Parameters of the indoor air

Normative:
The parameters of the indoor air could be stated according to the functions of the sinus curve or according to the following norms:

1. The EU norm LVS EN 13788:
   - humidity class according to the increase of the humidity load from 1-4;
   - indoor temperature is constant.
2. The EU norm in the development phase DIN EN 15026:
   - humidity class according to the increase of the humidity load from normal to high;
   - indoor temperature 20 and 25°C, with linear transition at the outdoor temperature from 10-20°C.

Actual measurements at the objects
In the data processing it has to be observed that the results in the range of the fog saturated air temperature and humidity that is under the 100% saturation curve has to be separated to evaluate the possible error of the measuring instruments or calculations in the processes where such situation is not possible from the point of view of air handling.

2.3 Humidity content and comfort zones

In order to plainly depict and graphically evaluate the human comfort range a term "comfort zone" is introduced. In various standards it is interpreted differently. Engineer-technically it is more available to depict it on the x-h diagram where the comfort zone is delimited by the lines of constant temperatures (isotherms), constant relative humidity (isolines), and constant humidity content (x). Fig. 2-1.

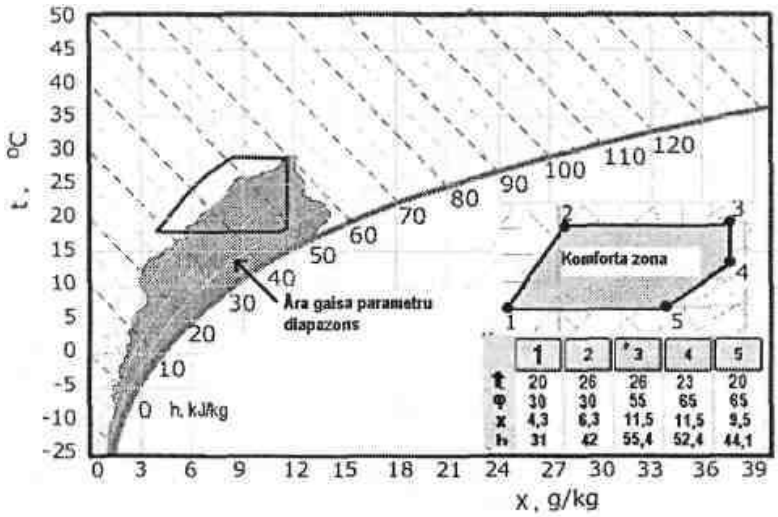


Fig 2-1 Comfort zone according to the humidity content .

Komforta zona atbilstoši mitruma saturam un gaisa stāvokļa parametru ilgumam

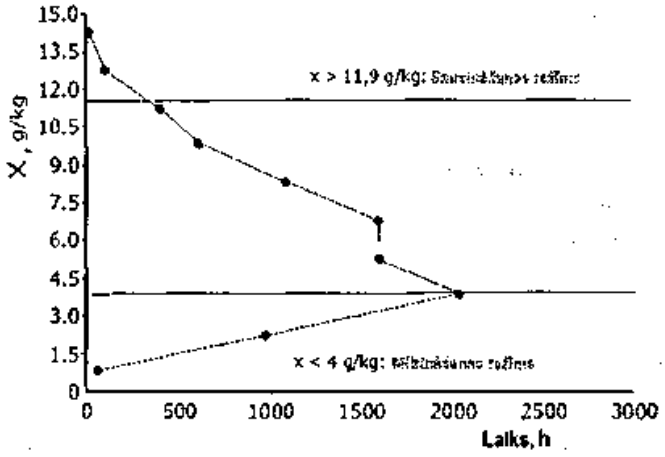


Fig 2-2 Comfort zone according to the humidity content and the duration of outdoor air parameters.

2.4 The criteria of the change dynamics of humidity content

2.4.1. The definition of the criteria

Humidity content change dynamics (HCCD) - value that describes humidity content change in time range for one unit of the dry air weight or volume unit.

2.4.2. Characteristic values and units of measure of the criteria

The units of measure of the criteria HCCD are derived from the units of measure of humidity content and time, which are used in air conditioning, g/kg, kg/kg, m^3/h, m^3/s and 1/s.

The possible combinations are presented in the table 2-1.

Tab 2-1 The units of measure for humidity content change dynamics

Nr.	Humidity content	Time	Change dynamics of humidity content (unit of measurement)	
1.	g/kg	s, h	$\frac{g}{kg \times s}$	$\frac{g}{kg \times h}$
2.	kg/kg	s, h	$\frac{kg}{kg \times s}$	$\frac{kg}{kg \times h}$

2.4.3. Boundary values and limitations of the criteria

The boundary values are determined according to the measure to be examined or controlled, for example, the limits of the outdoor air are set according to the measurements or the data of the construction climatology norm. Depending on the technological requirements boundary values, are set as: Circadian fluctuations and maximal values- for the systems where maximal drying or humidifying loads are calculated or high accuracy humidity control is needed.

Maximal values of a month- calculations of the energy efficiency of the system to predict the energy consumption evaluating the influence of outdoor air and the necessity of the change of air humidity.

Whereas the humidity content cannot be used to depict following processes which are connected with providing of humidity content in the room:

- Absorption/desorption of the external enclosure;
- Development of mould on the external enclosure.

2.4.4. The input data of the criteria and determination of the values

As the data output can serve measured, calculated assumed entities of the following components of air handling and at the same time at least for one of the air condition parameters, temperature, relative humidity, enthalpy:

- Humidity content of the outdoor air - d_{ar} ;
- Humidity content of the indoor air - d_{te};
- Humidity content of the exhaust air - d_{no};
- Humidity content of the supply air - d_{pi} .

Each of the entities mentioned above are used depending on the necessary result, type of the action of the air handling and the level of automation.

If it is not possible to acquire and process digital information about some of the air humidity entities then the graphical method has to be used to determine the values of the criteria where the available data are marked on the h-x diagram supplementing the missing information from the climatology data

If it is possible to work with digital information there opens a wide range of options for automatic calculation of the criteria and the optimization of the system operation, with values fixed in the database as well as with values acquired as a result of measurements.

To compile a fixed database of outdoor air humidity content values first the shortest time period for the possible criteria change has to be set- a minute, an hour, a circadian, a week, a month, etc., what for the processes where the only source of the air humidity changes is the outdoor air, it has to comply with following equation $\Delta d_{outdoor} \leq d_{indoor}$, $\Delta\, d_{no}$. In case of the time period is a month the data given in LBN 003 in the table 9 can be used when doing the recalculation from the partial pressure of the water steam to the air humidity content. In addition if the difference between two months exceeds permitted value gradual correction has to be performed evening to the days starting from the end of that month counting to the beginning of the month and for the next month counting ahead as it is showed in Figure 2-3

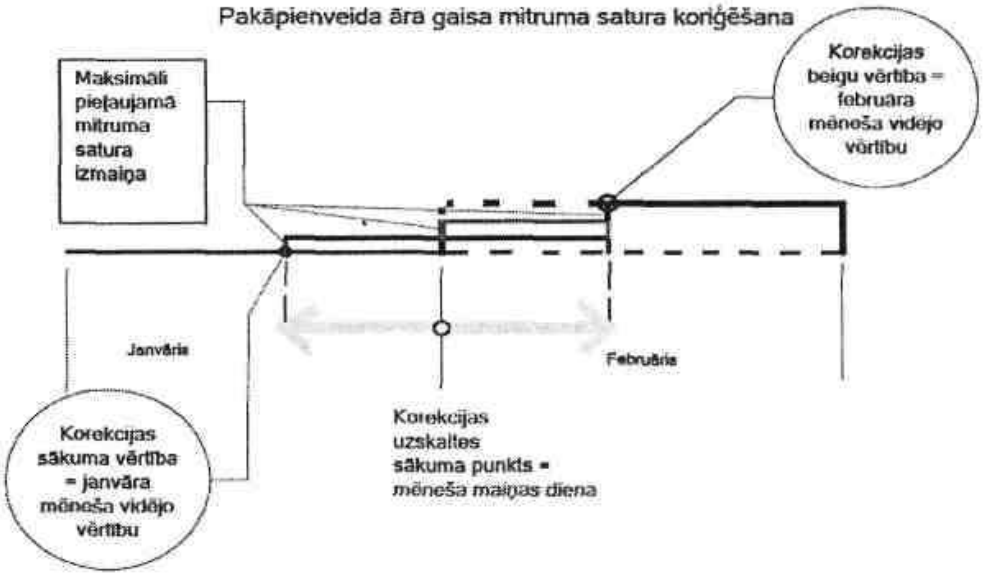


Fig.2-3 Gradual outdoor humidity content correction

2.4.5. The importance of the measurement accuracy and technical possibilities

Each error is analyzed by the square root method. According to the standard accuracy mentioned in the table 2-1 it is evident that the highest accuracy is showed by the dew point sensors. The amount of the error in the whole range of the measurements is approximately 2%. The error from the measurements or the relative humidity - 5%- is rather low at high humidity, but it increases at low humidity below 35%. These peculiarities of the measurements of relative humidity have to be taken into account when calculating humidity control and analyzing the operation of the air dehumidifying systems because decreasing the relative humidity the error acquires greater importance upon the results of the measurement. Investigating the errors from the measurements of the wet bulb the increase is observed if the humidity content is below 4g/kg of air.

Tab. 2-1 Standard and high accuracy measuring instrument errors

	Temperature	Relative humidity	Pressure
Standard accuracy	60,3 °C	63% rel. humidity.	60,13 kPa
High accuracy	60,15 °C	61% (0-90%) 63% (90-100%)	60,13 kPa

For the instruments with standard accuracy shown in the table the result of the dew point method usually depends 15 more on the dew point error than on the error of the pressure. For the wet bulb method, the wet bulb error usually has 2-5 times greater influence than dry thermometer and 15-60 times greater than that of the pressure. For the relative humidity method the error of the measure has 1-100 times greater influence than that of the dry thermometer and 20- 150 times greater than that of the pressure. The influence of the relative humidity transmitter upon the result can be stated in low range of the relative humidity.

2.5 Structural control scheme of the humidifier and dehumidifier

Using the criteria of the humidity content change dynamic, has been developed and approved on experimental field tests the structural control scheme of the humidifier and dehumidifier The obligatory elements:

1. Data about the temperature and humidity which could be acquired by the sensors in several ways:

- option A- air temperature, relative humidity and atmospheric pressure;
- option B- air temperature ad humidity content;
- option C- air temperature and dew point temperature;

- option D- air temperature and partial pressure of the water steam.

If there is a necessity to acquire information about the total power of humidity change the air flow data should be taken parallel- air mass flow (calculated by measuring capacity flow and multiplying it by air density).
As an additional option for the rooms in which a constant gas content and dust concentration is maintained CO, CO_2, and dust parameters should be taken to limit the exceed if they are advanced as higher priority than humidity parameters.
The information is processed by programmable processor according to the following algorithm:

- For the processes without humidity discharge the set point value is compared to the humidity content of outdoor air or exhaust air (for the systems with recirculation) humidity control and in the case of negative deviation humidifier is turned on but in case of positive deviation- dehumidifier. Neutral or stand-by period when the transfer from humidifying and dehumidifying processes takes place is stated depending on the requirements of humidity parameter maintenance, i.e., in the case of constant humidity that corresponds to the minimal permissible deviation, in the case of limiting the minimal and maximal humidity that corresponds to the value between the minimal and maximal value.
- For the processes with humidity discharge in the room, the regulation is analogue to the previously described with the difference that additional control of the feed-back takes place when the equipment receiving the signal turns on or off or increases power with time delay to check if there are any humidity processes which corresponds with desirable effect and thus could be used (e.g. In case of humidifying it is possible that partly the room is humidified by the exhaled air and mechanical humidifying is not necessary).

For the processes where additional requirement is constant or set relative humidity the starting signal before transmission to the humidity change equipment has to be corrected by the help of the depicted relative humidity evaluation module that limits the relative humidity result acquired as a result of the humidity regulation to the permissible result of the room relative humidity.

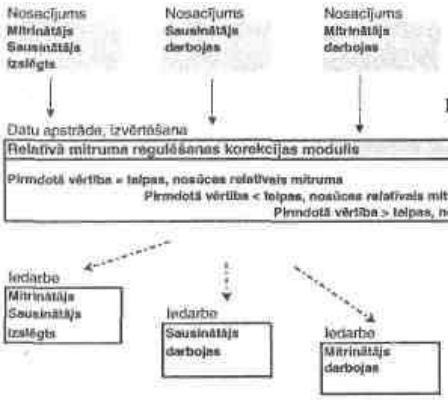
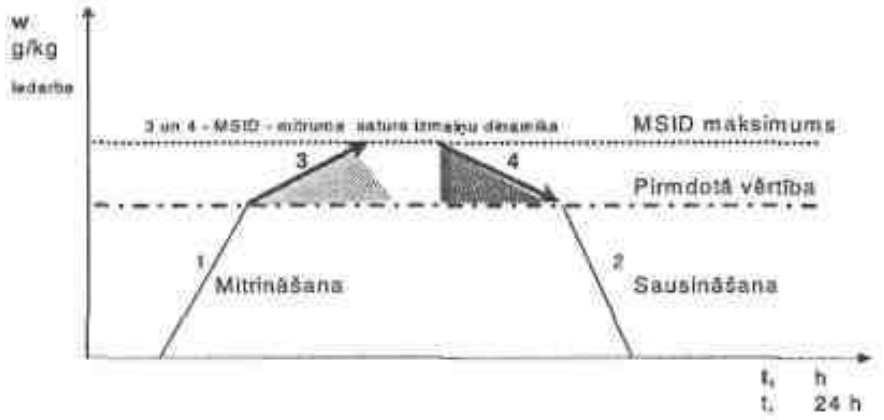


Fig 2-4 Evaluation module of the relative humidity signal

Fig.2-6 The use of the humidity content change dynamics criteria (HCCD)in the regulation scheme.



Humidity content change dynamics criteria is used as additional module, concluding in the line after the humidity content regulation and relative humidity correction modules, air conditioning systems for which the dynamics of the humidity change in the room are calculated or regulated. Using constant set point value where analyze the dynamics of the humidity change in the supply air, to predict impermissible deviation of the room value.

2.6 Building energy certification, taking to account the humidity changes in the rooms

As regarding the introduction of the energy consumption certification wide discussions about the supplementing the evaluation criteria for the buildings takes place including also the quality parameters of the microclimate which are connected with high energy consumption, the evaluation of the humidity change could be used only for the buildings with equal and precisely qualified requirements for the humidity maintenance. Whereas dwelling houses and public buildings do not belong to this category. Thus the inclusion of the humidity change could be used for the buildings with technological requirements, i.e., museums, industrial buildings, swimming pools etc. that do not belong to the group indicated in the EU directive although they are characterized by high energy consumption and thus wider possibilities for optimization. Hopefully the energetic comparing of the buildings will be promoted by initiative of the local governments, concerns, professional associations and private business in order to diminish running costs of the buildings.

It is offered to use the formula of the criteria of standardized heat consumption worked out by the scientists of Riga Technical University for the energy certification supplementing it with the humidity change consumption of energy and acquiring a new formula 2-1

$$q_{st} = q_{apk}\frac{G_{st}}{G} + q_{k.\bar{u}}\frac{A}{Cn} + q_{mitr}\frac{M_{st}}{M}, \qquad (2\text{-}1)$$

where

q_{st} - standardized heat consumption, kWh/m^{2}year;
q_{apk} - measured heating system consumption;
$q_{k.\bar{u}}$ - measured hot water system consumption;
G_{st} - degree days on standardized year;
G - degree days on actual year;
A - heated area;

n - actual amount of tenants;

C - density of tenants, m^2/tenant;

U st - standardized water quantity for humidifying, kg/year;

U - measured water quantity for humidifying, kg/year;

$q_{mitr.}$ - standardized or calculated water consumption for humidifying, kWh/kg.

$$q_{mitr.} = \frac{M \times r_{iztv}}{3600} \qquad (2\text{-}2)$$

where

M - humidifying hours for standardized year gh/kg/a;

M_{st} - humidifying hours for actual year, gh/kg/a;

r_{iztv} - water evaporation heat, kJ/kg.

$$r_{iztv} = 2495 - 2{,}36t \qquad (2\text{-}3)$$

where

t - air temperature, °C.

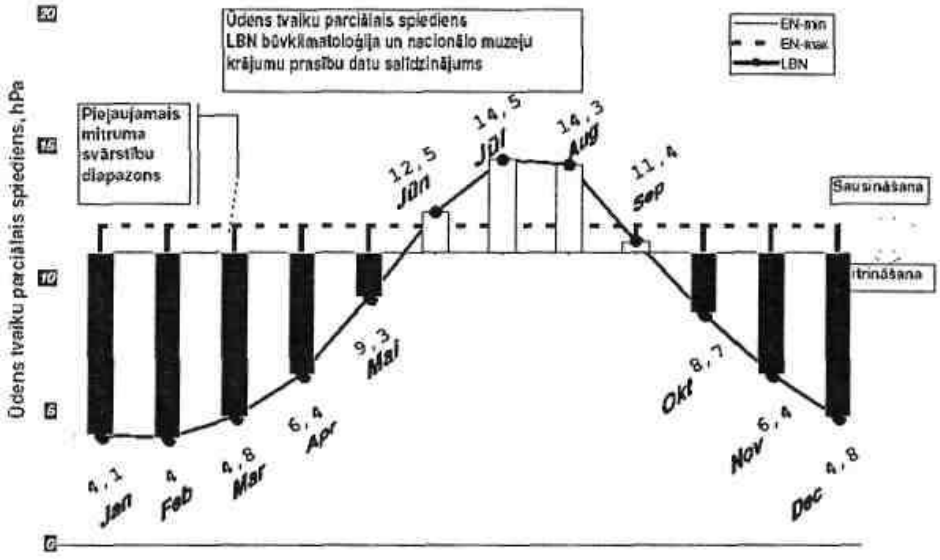


Fig. 2-1 Partial water pressure data comparison of building code and national museums rules

3 EXPERIMENTAL RESEARCH

3.1 Public, historical building operation function change and artworks interaction

The task of the air conditioning systems in historical building would be to take care of preserving the artistic property which in the Regulation issued by the Cabinet is limited in technically and financially unfavorable diapason setting narrow range of temperature and humidity change range which practically is difficult to evaluate and use for specific situations where for wooden statues permissible air relative humidity fluctuation is 1% within 24 hours but at the same time the range of fluctuation for the exposition is not given. For example, Dome Cathedral concert hall and the major assembly hall of the University of Latvia where artistic property is held are used as public rooms and store rooms at the same time.

Evaluation of the measurements

Graphical summary of the requirements marking required temperature and humidity range on X-axis and parameter for evaluation and its impact on Y-axis permit evaluation of it for a definite object and dynamic adjusting of the climate for the room.

The Figure 3-1 shows that examining just the temperature range necessary for wood only 2 degrees (19-18° C) are in the human comfort diapason. The energy consumption for decreasing temperature may increase while the consumption for increasing temperature (heating) may decrease. The calculation of the energy consumption is rather complicate because data about the heating and cooling powers indoor and outdoor are needed.

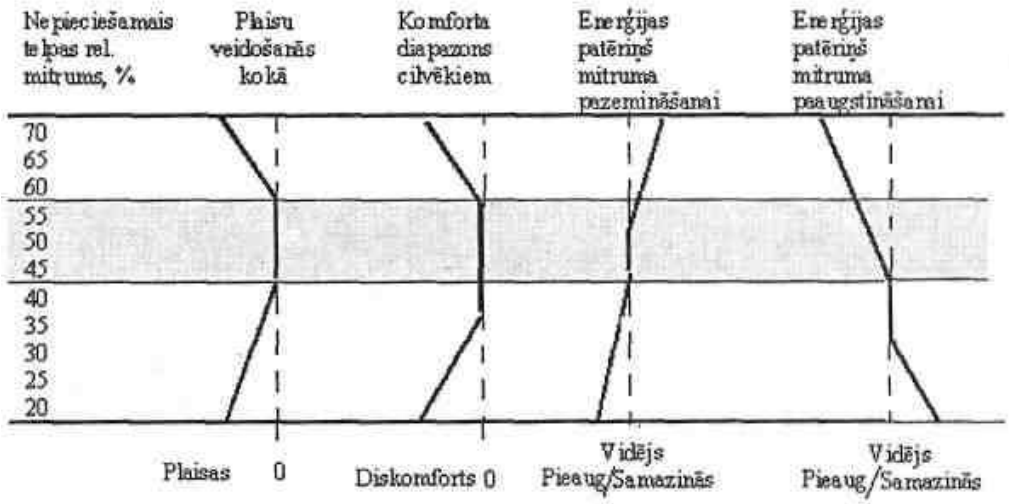


Fig 3-1 United graph of the indoor temperature parameters

The published clime data is not sufficient because do no provide enough information about the relative humidity change of the temperature within 1 hour, but the average and maximal parameters of a day, week, month. Due to the previously mentioned reason the curves of the energy consumption in the graph are shown relatively according to the amount of degree hours.

3.2 Maximal permissible air humidity content and dehumidifier operation in a conference hall of a public building

As the norm regulates the amount of outdoor air pro person the conference halls with variable number of people are equipped with air conditioning system according to the maximum number of people. Whereas the law does not regulate the use of outdoor air to provide the temperature and relative humidity thus recirculation is permissible. Recirculation gives possibility to economize energy sources in the preparation period. To optimize air conditioning it is necessary to balance preparation and human comfort requirement regimes. The analysis of air humidity and $C0_2$ parameters gives new possibilities for the optimization of these regimes.

Indoor air humidity level and its changes are important factors of the indoor air quality. The humidity of the room depends on the combination of different humidity sources, e.g., outdoor air exchange, people, bordering constructions and outdoor air parameters. This paper deals with the influence of the short-term (up to 48 hours) absorption and desorption qualities of the surfaces of external constructions upon the prognostication of air conditioning enginery operation regimes.

Doing periodical measuring during the time period when people were staying in the rooms it was stated that humidity content of the indoor air changed in the range 2-3g/kg below outdoor air humidity. Humidity increase above outdoor air humidity was stated in the cases when the amount of the outdoor air was diminished to 8-10 m^3/h pro person. Humidity change dynamics depends on temperature change in the room. Knowing the speed of the temperature change and humidity content in it is possible to predict the possibility of exceeding relative humidity in the room if the absorption has happened and the outdoor air humidity continues to increase - measurement nr 26 and 27 Fig 3-2.

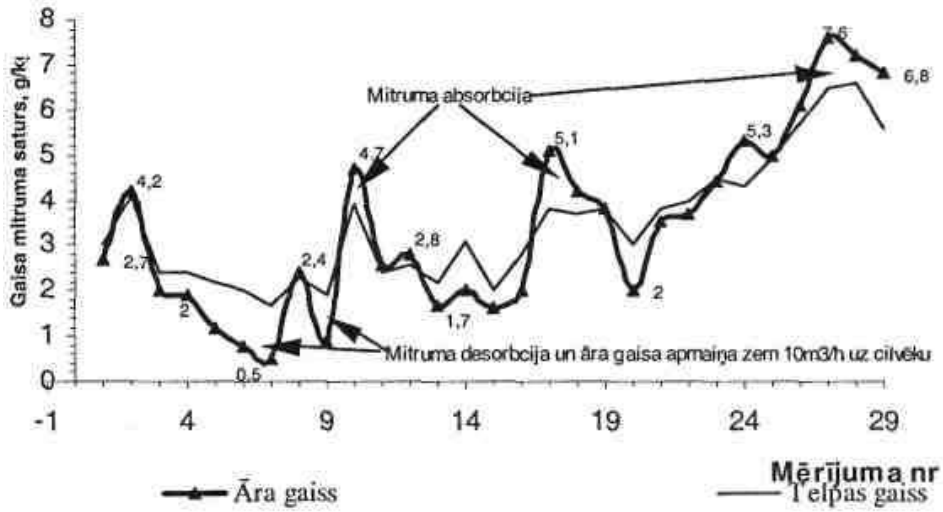


Fig. 3-2 Measurements of indoor and outdoor air humidity content. Humidity absorption and desorption zones.

3.3 Constant air humidity content and humidifier operation in the store room of industrial building

Air humidity is a very important factor for the quality of production and operating costs in very many production processes.

The measurements were taken in the time period starting from October 2002 till May 2003. Control measurements, indoor air temperature, and relative humidity parameters by indications from the control processor and laboratory thermograph "Lambrecht" are registered in tables.

For the data registration the control processor of the ventilation unit "DDC" (direct digital control), control processor the programme element of which "h,x Modul" gives the possibility to calculate all air condition parameters, i.e., enthalpy, absolute humidity, dew point temperature, wet bulb temperature, actual water steam partial pressure and air density, by using air relative humidity and barometrical pressure measurements. The control processor is freely programmable in "C-Bus" network. Updating at full load (22 users) is completed in 2 seconds.

Data analysis was done separately with MS Excel programme.

Maintaining the temperature of the supply air +17°C, the temperature of the room was constantly within the limits of +21 °C till the outdoor temperature of 0°C, hereto the change was 1-2 K, at warmer conditions the temperature increased to +24 to +26 °C and became stable. It was possible to fix the humidity precisely and fast enough, in addition in the neighboring room it was possible to observe even 0,5 - 2 g/kg higher humidity content, which could be

explained by higher room temperature and humidifying of the cut tobacco. The momentum of the room temperature is minimal, i.e., 2-5 minutes because the humidity content at projected air exchange 4-8 times per hour depends directly on the supply air humidity.

4 Recommendations for the introduction to the building norms

4.1 Characterization of outdoor air parameters

To state humidity change maximum, analogue to the heating system calculations, it is useful to summarize and publish the data in LBN 003 "Climatology for Construction" in the following form:

Tab. 4-1 LBN 003 proposal to add outdoor air parameters

Nr.	Parameter description	Day Significance/Use	Month Significance/Use
1.	Absolute humidity content maximum and minimum	Necessary	Necessary
		To determine system maximum efficiency and frequency of the parameters	To determine system maximum efficiency
2.	Humidity content each hour	Necessary	-
		To determine precisely efficiency and expenditure of energy	-
3.	Average humidity content	Desirable	Desirable
		To determine and prognosticate average expenditure of energy	To prognosticate average expenditure of energy
4.	The number of days of humidifying season according to the humidity of the room with 5% step for the range from 30- 60%.	Desirable	Desirable
		To determine and prognosticate average expenditure of energy	To prognosticate average expenditure of energy

4.2 Microclimate requirements for museums

To regulate humidity change maximum analogue to the air relative humidity and temperature data, it is useful to summarize and publish in the Regulations issued by the Cabinet nr 311 354 "Regulations about National Museum funds" summarized for following artistic properties:

Table 4-1 Enumeration of supplements for the Regulations nr 354 issued by the Cabinet of Ministers.

Nr.	Parameter descriptions	Day/Topicality/Use	Month/topicality/Use
1.	Humidity content fluctuation	Polychrome and wooden statue Unpainted wood and	
		+/- 0,5 g / 24h	+/- 2 g / month (to develop more precise division proportionally to outdoor air humidity content and set point value monthly changes.

CONCLUSIONS

1.	A new criteria for humidity change dynamic- humidity content change diapason in a time unit- is offered. Using the criteria a model for the air humidifying and dehumidifying regulation and efficiency control is developed.
2.	The use of the criteria for the introduction to EU directives about the energy certification of buildings to be applied for air conditioning systems the operation of which results in air humidity content change is evaluated.
3.	The access to the meteorological information, the use of the data about air humidity for system design, exploitation and operation analyzing are offered.
4.	In the experimental research which covered 6 industrial and public buildings data about indoor and outdoor air humidity content in different air handling equioment and room exploitation regimes were measured and summarized to test the theoretical presumption about the operation of the criteria and developed model of air humidifying and dehumidifying control. As a result of the research it was completely affirmed that the developed criteria and model could operate also in the exploitation of the systems throughout the whole year's cycle of outdoor climate change.
5.	During the experiment new, previously unknown connection between the content of carbon dioxide and humidity content was discovered which is seen especially bright in low outdoor air humidity and small air exchange situation.
6.	The paper provides methodical basis for the use of air humidity content in engineer technical calculations.
7.	Supplement for the norm of the Republic of Latvia in the sphere of ventilation and air conditioning is offered. To prognosticate system exploitation on the basis of specified climatology data. To use a human comfort influencing entity not regulated in the legislation- minimal and maximal permissible air humidity content and its change dynamics for the system calculations.

LIST OF PUBLICATIONS

Nr Publication

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