Searching for new solutions Humidity measurements in the environments

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Abstract *– More attention is nowadays being paid to the quality of the air we breathe, resulting in an increasing need for humidity measurements in the home and office environments. Maintaining the proper level of relative humidity is also necessary to avoid conditions of extreme humidity condensation in buildings.*
The facts that construction problems and excessive water and humidity often go together is well-known around the world today. Moisture and water damage is a well known problem in construction in many countries.
Problems of all construction are caused by humidity and 50 per cent of all buildings have some kind of moisture-related problems. Growing awareness of percentages such as these has led to greater attention being paid to construction humidity and its measurement throughout the world in recent years.
This paper presents a condensed review of nowadays humidity sensors technology, problem implicated and some modern tendencies.

Keywords: *humidity sensors, measurements, environment*

I. INTRODUCTION

The electric and electronic instrumentation is used on large scale for measuring a significant number of no electrical dimensions in various fields of activity.
The improvement of the measurement means has conditioned and allowed new discoveries in science and technique. This thing has reflected upon the achievement of some exact, quick and flexible measurement means. At present, the target is the achievement of as many facilities as possible from the measurement instruments: easy configuration and utilization, automation of measurements, flexibility, and means of quick adjustment to different lab necessities or industrial processes.

II. FOCUS ON HUMIDITY PROBLEMS. USING OF HUMIDITY SENSORS IN MEASURING SYSTEM

Humidity sensors have bigger and bigger signification in various measurement environments as well in automatic conduction technology. Producers not only that improve their durability in different environments, at the same time reducing the size and the price.
The paper presents an overview regarding new complex models of measurement system, which will include the humidity sensors. The main characteristics and classification of humidity sensors are presented below.
The HM 34 humidity and temperature meter is a battery-operated pocket-size meter for the measurement of ambient relative humidity and temperature.
The humidity and temperature sensors are housed at the type of an extendable probe, where a semi permeable membrane filter protects the humidity probe against water and dust.
For humidity measurement, the HM 34 utilizes Vaisala's high accuracy, high reliability Humicap® humidity sensor, and the H sensor. Temperature measurement is based on a Pt 100 temperature sensor, [1].
The meter is intended for ambient measurements in such applications as:

- industrial monitoring and inspections;
- spot checks;
- laboratory and research use;
- occupational health and safety.

The technical specifications of the HM 34 are:
-measurement range: humidity 0 ÷ 100% RH, temperature -20º C÷ 40 º C;
-accuracy: 20º C, temperature dependence +0.04% RH / º C;
-resolution: 0.15 RH; 0.1 º C;
-response time for humidity at 20 º C : 15 s.
When the HM 34 is used in an electromagnetic field of 3 V/ m, with the frequency of 200 ÷ 220 MHz, the temperature deviation is maximum ± 3 º C.
The features are: ideal for spot checking humidity levels; measurement range 0 ÷ 100% RH; fast response with ± 2% accuracy; incorporate Vaisala Humicap® sensor that provides high accuracy, excellent long term stability, negligible hysteresis and, insensitivity to dust and most chemicals; extendable probe.
The HM 34 provides a fast and convenient way to accurately spot check relative humidity and temperature.
The HMI 41 types is an easy -to-use portable humidity and temperature indicator for a variety of applications, including such as industrial monitoring and inspections, occupational health and safety, laboratory and research use, spot checking.

Technical data of the HMI 41 indicator are:
-maximum measurement error caused by the indicator at 20º C: humidity ± 0.1% RH, temperature ± 0.1º C;
-resolution: 0.1% RH; 0.1 º C;
-calculated variables: dew point temperature, absolute humidity, wet bulb temperature, mixing ratio;
-operating humidity and temperature range: 0 ÷ 100% RH non-condensing, -20 ÷ 60º C;
-storage temperature: - 40 ÷ 70º C.
There are six different probe types that can be used with the HMI 41 indicator.
The indicator recognizes the probe type automatically, so there is no need to change settings each time the probe is changed. All probe types are optimized for different applications:

- HMP 41 probe can be used for measuring humidity and temperature in various applications, such as in spot checks;
- HMP 42 is specially indicated for measurements in very tight places. This probe head has a diameter of only 4 mm and is 23.5 cm long.

The HMP 42 has been optimized for taking measurements in structures and tight places. Using the HMP 42 for measuring equilibrium humidity in structures:
In figure 1, the screw of the shower holder is removed- no drilling is needed as the HMP 42 is small enough to enter this screw hole.
Technical data of the HMP 42 probes are:
-measurement range: humidity 0 ÷ 100% RH non-condensing, temperature -40 ÷ 100º C;
-accuracy at 20 º C: ± 2% RH (0÷ 90% RH) and ± 3% RH (90÷ 100% RH), ± 2º C;
-response time: 30 s;
-temperature dependence of electronics:± 0.05% RH / ºC.

- HMP 44 and HMP 44L are used for measuring humidity in concrete and other structures;
- HMP 45 probe is indicated for measurements in channels and other places that are difficult to reach and therefore require a probe head with cable;

Technical data of the HMP 41 and HMP 45 probes are:
-measurement range: humidity 0 ÷ 100% RH non-condensing, temperature -20 ÷ 60º C;
-accuracy at 20 º C: ± 2% RH (0÷ 90% RH) and ± 3% RH (90÷ 100% RH);
-response time: 15 s;
-typical ranges of calculated variables: dew point temperature -40 ÷ 60º C; absolute humidity 0÷ 160 g/m3, wet bulb temperature 0 ÷ 60º C, mixing ratio 0÷ 160 g/kg.

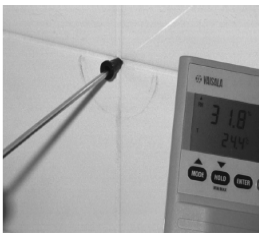

Fig. 1: Measuring humidity in a bathroom

Fig. 2 Measuring humidity in a concrete floor

In figure 2 is shows a measurement in a concrete floor.

- HMP 46 is optimized for measurements in relatively high temperatures, in dirty processes and in general in applications that require a robust probe structure.

Technical data of the HMP 46 probes are:
-measurement range: humidity 0 ÷ 100% RH non-condensing, temperature -40 ÷ 100º C (temporarily 180º C);
-accuracy at 20 º C: ± 1% RH (0÷ 90% RH) and ± 2% RH (90÷ 100% RH), ± 2º C;
-response time (90%) at 20º C: 15 s, [2].
Dew point temperature, mixing ratio, absolute humidity and wet bulb temperature are calculated from the measured relative humidity and temperature values.
The HMP 46 probe can be temporally used in high temperatures. For example, the probe can be installed in +180º C for 30 minutes provided that the probe handle and 10 cm of the metal tube are at room temperature. When the HMP 46 probe is used in high temperature, it warms up.
The HMI 41 indicator displays relative humidity, temperature and dew point temperature readings. In addition to these, one of the following quantities can also be chosen: absolute humidity, wet bulb temperature or mixing ratio.
The indicator also features an automatic power-off function which can be disabled, and a continuously updated display. The display can be frozen to show the current readings, and it can be used for checking the minimum and maximum readings measured during data collecting. The automatic power-off function is not active during data collecting even if it was previously selected. The versatile HMI 41 indicator also includes a data collecting feature, [3].
Data collecting can be either automatic or manual. During automatic data collecting, the probe takes measurement only just before storing each measurement. In order to minimize the consumption and to maximize the battery life turned off for the measurement interval and the display is dim except when the readings on the display are updated. If required, the collected data can be transferred to a PC through a serial interface cable. The measurement system has a special flexibility if the sensor is equipped with additional intelligence. By interfacing the measuring instruments to computer it‘s may achieve additional functions. The humidity measurement range is 0 ÷ 100% RH. The temperature measurement range depends on the probe used. Relative humidity is measured with the accurate and stable Humicap® 180 humidity sensor which uses an operating principle based on the changes in the capacitance of the sensor as its thin polymer film absorbs water molecules.

Fig.3: The HMI 41 indicator and probes

Long-term exposure of the Humicap© 180 sensor to certain chemicals and gases may affect the characteristics of the sensor and shorten its life.
If the measurement of humidity and especially in calibration it is essential that temperature equilibrium is reached. Even a small difference in temperature between the measured object and the sensor causes an error. For example, if the temperature is +20º C and the relative humidity is 50% RH, a difference of ±1º C between the measured object an the sensor causes an error of ±3% RH. If the temperature is +20º C and the relative humidity is 90% RH, the corresponding error is 5.4% RH.
The error is at its greatest when the sensor is colder or warmer than the surroundings and the humidity sensor reacts rapidly to changes in the amount of water vapor in the air, the probe temperature changes more slowly. To avoid errors caused by temperature differences the probe must always be left to stabilize to ambient temperature before starting measurements: the bigger the temperature difference, the longer the stabilization time.

A. Searching for new solutions

More attention is nowadays being paid to the quality of the air we breathe, resulting in an increasing need for humidity measurements in the home and office environments. Maintaining the proper level of relative humidity is also necessary to avoid conditions of extreme humidity condensation in buildings.

1. Humidity monitoring in man-made environments

Is monitor and study indoor environments to analyze humidity and temperature conditions inside buildings and in constructions materials. Such man-made environments include all the places where people spend their time, from living rooms to offices. The indoor environments changes, for example, if air conditioning or floor carpets are used. If is don't know the house and its materials well, it's can't protect it from humidity condensation. I have tried to solve the condensation problem by choosing the correct ventilation system.

2. Peoples – part of the environment

The people are affected also by the indoor environments. Is monitor and examine changes in the human body – breathing and sweating. It's clear that human comfort is much improved when humidity levels remain within the desired range in the buildings.
The factors measured in this kind of research include the humidity and temperature in rooms, walls and ceilings. Are includes items such as the moisture permeation through textiles, and the humidity and temperature inside bed clothes.

3. Sensors measures humidity condensation

Is examines the correlation between condensation and ventilation in houses, and the problem caused by condensation.

- Relative humidity and temperature in the room;
- Relative humidity and temperature outside the building;
- Humidity condensation on windows or walls;
- Perspiration of people and moisture permeation.

B. Wide-ranging construction humidity measurement

Moisture and water damage is a well known problem in construction in many countries.
The fact that construction problems and excessive water and humidity often go together is well-known around the world today. Problems of all construction are caused by humidity and 50 per cent of all buildings have some kind of moisture-related problems. Growing awareness of percentages such as these has led to greater attention being paid to construction humidity and its measurement throughout the world in recent years.
Construction humidity can be caused by a variety of reasons. Too tight project schedules, which do not allow the concrete to dry properly before laying carpet, are one of the reasons for construction humidity. Also the type of construction details used in assembly of the building envelope can be a cause for construction humidity problems. Later on, if maintenance is neglected, there may also be failures in water pipes. Weather plays an important role, and moisture problems caused by rain penetration and tropical storms are well-known.

C. Advanced measurement technology

Vaisala has been manufacturing construction humidity instruments. Vaisala's special HM 44 Kit for concrete moisture measurements has gained a lot of interest in the world. Concrete dries unevenly, and its surface measurement alone may give misleading information.
Only a 4 mm in diameter, Vaisala's HMP 42 probe is a new member of the construction humidity measurement family. It is an ideal choice for construction moisture detection. This remarkably thin probe is designed and optimized for measurements in structures and confined places. The replaceable filter of the high performance sensor prevents it form being affected by dust and particles which are common on construction sites. In addition, HMP 42 can be used to measure humidity and temperature in air conditioning channels.
The HMP 42 and HMP 44 construction humidity probes use the same indicator – the HMI 41. This has an easy-to-read, two-line, and liquid crystal display in user-selectable metric or no metric units. In addition to displaying the humidity and temperature readout, the HMI 41 indicator calculates dew point and wet bulb temperatures, absolute humidity and mixing ratio. The collected measurement data can also be transferred to a PC.

Fig.4: HM 44 set for measuring humidity in concrete

D. HM 44 - concrete humidity measurement system

Excess moisture in structures can cause problems and economical losses. In new construction, the tight time for structures to dry completely. Later, excess moisture can cause surface deterioration, room air impurities, and in severe cases-mold. These problems often lead to expensive repairs.
Kit HM 44 is the ideal solution for measuring humidity in concrete, [4]. This includes, see figure 4:

- HMI 41 indicator
- HMP 44 RM&T probes
- Protective cover lid
- Rubber plugs
- Plastic tube set.

Are two measurement methods:

1. Reliable bore-hole method

Measuring relative humidity in a structural material such as concrete is a clear indication of whether the material is dry enough.

2. Measures in fresh concrete.

The HM 44 also measures humidity in fresh concrete. The advantage being that you do not have drill the concrete.
Both methods, drilling into hardened concrete and pre-installation into wet concrete.
The HM 44 set is a practical tool for humidity measurements of concrete or other structures. The accuracy and reliability performance of the HMP 44 probe comes from advanced Vaisala Humicap© 180 sensor, [5].
In humidity measurement and especially in calibration it is essential that temperature of the probe and measured object is the same.

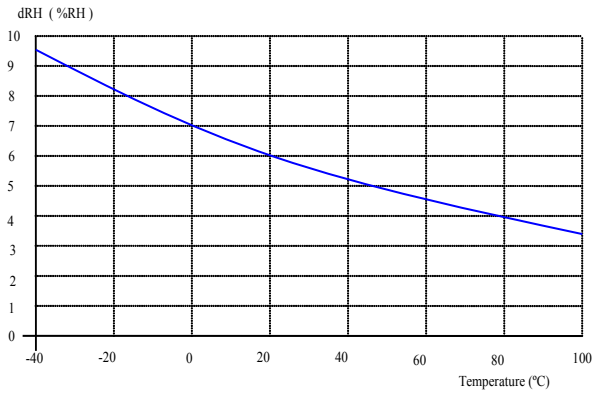

Fig.5 : Measurement error at 100% RH

Even a small difference in temperature between the measured object and the probe causes an error.
A temperature difference of a few degrees can also cause water to condense on the sensor surface. Sensor starts to function normally as soon as the water has evaporated. If the condensed water is contaminated, the life span of the probe may shorten and calibration may change, figure 5 - measurement error at 100% RH when the difference between the ambient and sensor temperature is 1ºC.
Humicap hand-held humidity and temperature meter HM 70 is a user friendly meter for demanding spot-checking humidity measurements. It is ideal for field checking and calibration of Vaisala's fixed humidity instruments.
The features of the HM 70 are: -multilingual user interface; -shows measurement trends graphically;-proven Vaisala Humicap Sensor Technology;-temperature measurement ranges between -70 ÷ 180º C;-multi probe operation, dew point and CO2 probes can also be connected;-displays preheat and chemical purge options for demanding conditions;-data can be logged, and transferred to a PC via MI 70 Link software;-rugged and reliable - even in extreme conditions.
HM 70 consist of two main units: HM 70 indicator and HMP 75 / 76 / 77 probe. HM 70 hand-held humidity meters incorporates technology which enables reliable and high performance humidity measurement. HM 70 are available with optional, read-to-use Microsoft Windows® software, which allows an easy way to handle measurement data using a serial line or a USB instrument cable, [6].
In humidity measurement and especially calibration it is essential that temperature of the probe and measuring environment is the same.
The HM 70 is a generic indicator that can be used with Vaisala interchangeable dew point and carbon dioxide probes. Two different probes can be used simultaneously.
The HMP 75 is a general purpose probe for humidity measurements between -20 ÷ 60º C.
The HMP 76 is a long stainless steel probe for humidity measurements between -50 ÷ 120º C. it is especially suitable for spot – checking in ducts.
The HMP 77 is a small probe at the end of a five meter cable. The probe is ideal for difficult-to-reach areas and for on-site calibration of Vaisala's process transmitters. The measurement range is for temperatures up to 180º C.
The fully digital MI 70 measurement indicator represents the latest generation of hand-held indicators. The indicator has been designed to be robust and easy to use. A clear graphic display together with an intuitive menu-based interface makes it easy for the user to get accustomed with the indicator.


Fig.6: HM 70 indicator and HMP 75 / 76 / 77 probe

Graphical trends enable the user to monitor the stabilization time of the measurement and in this way indicate when a reliable reading can be taken. Furthermore, a sophisticated Windows software program is available to transfer data from the indicator to a PC, where it can be processed further and copied to other measurement results can also be transferred to a chard recorder or to an external control system.

The MI 70 measurement indicator automatically recognizes the connected probe and displays which parameters the probe is able to measure. This makes it easy to measure different parameters by simply changing the probe. Two probes can be connected to the MI 70 simultaneously and three measurement parameters can be displayed and logged into the indicator memory at the same time.

Its durable and rugged structural, compact size and light weight make the MI 70 suitable for a wide variety of applications.

The HM 70 directly measures relative humidity and temperature. Based on the measurement of these parameters, the MI 70 calculates dew point, absolute humidity and several other humidity parameters, which can then displayed numerically or graphically and stored in the data logging memory.

Calibration of the HM 70 is easy. The indicator provides a guided calibration procedure which can be used together with the HMK 15 Calibrator.

Main features of HM 70 series are:

-graphical trend display shows stabilization;

-multi-lingual user interface;

-programmable shortcut keys;

-measurements easily reported to PC;

-two probes can be connected and measured simultaneously.

In humidity measurement and especially in calibration it is essential that temperature of the probe and measuring environment is the same.

III. CONCLUSIONS

In this paper we presented a condensed review of nowadays of development of humidity sensors. The utilization of such up-to-date essential elements in any technical system is compulsory and followed by technical advantages and a better management.

The facts that construction problems and excessive water and humidity often go together is well-known around the world today.

Problems of all construction are caused by humidity and 50 per cent of all buildings have some kind of moisture-related problems. Growing awareness of percentages such as these has led to greater attention being paid to construction humidity and its measurement throughout the world in recent years.

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