International Journal of Education, Modern Management, Applied Science & Social Science (IJEMMASSS)
ISSN : 2581-9925, Impact Factor: 6.340, Volume 04, No. 01(III), January - March, 2022, pp.163-167

HUMIDITY CONTROL AND MEASUREMENT USING DEW POINT METHOD

Dr. Deepti Rani*

ABSTRACT

Humidity plays important role in atmospheric environment. A specific level of humidity is required for pleasant environment. Therefore, one must measure it correctly and control as well through various scientific techniques. The study discusses the impact of humidity in various industries and illustrates use Dew point method in humidity measure besides examining its accuracy.

Keywords: *Relative Humidity, Equilibrium Relative Humidity (ERH), Static Charge, Dew Point.*

Introduction

Humidity is one important measure which determine the amount water contained in surrounding air. More water present in the surrounding air implies more humid condition and less water implies dry air. As it is one of the important determinant affecting surrounding environment, understanding its impact on various living as well as nonliving being becomes important issue before any researcher/scientist. The study has been conducted to identify impact of humidity on various industries and also discusses the Dew Point method of humidity measurement so as to take necessary steps for maintaining required level of humidity suitable for particular activity/place.

Observations

In order to have pleasant working environment, it is important to ensure that relative humidity does not go below 40% otherwise it may lead to health issues. Another important observation when we have dry air or low humidity includes the following:

- **Formation of Static Electricity**

Dry air can create static electricity which can be avoided by increasing the relative humidity of air. In manufacturing units where there are number of active machines functioning for longer period of time, more friction will take place and the risk of static electricity increases. Such situations are more probable in dry environment. The relative humidity level around 30% has greater chance of having this kind of problem.

- **Products having Tendency to Maintain a Certain Level of Moisture**

The relative humidity of environment keeps on changing but some products have tendency to maintain moisture stability means the ability of a material or product to maintain a certain level of moisture. Sectors/products such as vegetables, fruits, flowers and grains are example of this kind of behavior. Therefore it is essential to store them at places where controlled level of humidity can be ensured.

- **Effect on Heath**

In the normal course, as temperatures increase, relative humidity tends to decrease. Dry air can result in health effects, such as dry nose and throat which may subsequently lead to virus infection. It has been observed by many researchers and experts that the relative humidity range between 40 and 60% is optimum and prove effect in avoiding climate for bacterial growth. For people, relative humidity is most pleasant between 40 and 60%. In case of people suffering from allergies and astma, relative humidity between 45 and 55% is considered suitable.

---

* Associate Professor, Department of Physics, MMH College, Ghaziabad, U.P., India.

- **Paper Industry**

Machinery for printing paper or cardboard, coating paper with aluminum, and other types of unique applications, are quite sensitive to the properties of the product to be transformed and to any variation of some physical phenomena. One parameter that has long been recognized as influencing the properties of paper and cardboard is moisture. Equilibrium relative humidity and the relative humidity of the storage and work areas are responsible for changes occurring in the moisture content of the product. Various studies have demonstrated the importance of equilibrium relative humidity (%ERH) control.

Dimensional Changes

Paper fibers absorb or desorb water depending on the ambient relative humidity. This causes selling or shrinking of the fibers, which affects the diameter of these fibers more than their length. In a sheet of paper most fibers run parallel to the running direction of the paper machine. Accordingly dimensional changes which are the results of moisture variations, are more important along the axis that is perpendicular to the running direction of the paper machine, than along the axis that is perpendicular to it. At approximately 50% ERH a humidity change of 10% ERH results in a change of typically 0./1% 0.2% in the length of the paper. Such a humidity difference gives a dimensional variation of 1 to 2 mm (39.4 to 78.8 mil) on a 1 x 1 meter (3.28 x 3.28 ft) paper and could therefore cause poor and inaccurate printing. Paper running through an offset press usually gains water since it is moistened the process. The change in the moisture content depends not only on the % ERH of the paper but also on the ambient %RH.

Deformations of Paper Due to Humidity

Paper in stacks or rolls shows deformation if too much moisture is exchanged with the surrounding air through the edges of the stack or roll. This is due to the uneven distribution of this moisture as it is exchanged with the ambient air during storage or transport. Water- vapor-tight packaging protects the paper and it should not be removed without first checking % ERH of paper and #%H in the ambient environment. Differences upto+5% RH will not cause problems, while a difference of 8% -10% RH could be critical.

- **Pharmaceutical Industry**

Many medical instruments, including one-time use items for urological and blood work, are sterilized after packaging by exposure to ethylene oxide (ETO) gas. These medical devices are usually packaged in a sealed plastic or polymer envelope and boxed in card- board cartons for shipment. Pelletized cartons are then placed inside a humidity-controlled houseroom. Where humidity is controlled in the range of 60% -70% RH helps precondition the packaging, and enhances penetration of the ETO gas.

- **Museums**

Preserving centuries old art is becoming more and more important. In recent years, there has been an increasing awareness of the need to maintain environmental conditions in which museum artefacts are stored and displayed. Pieces of art have, in the past, often been subjected to candle soot, salt deposits, moisture, and other contaminants. Today's conditions present additional threats, which include automobile emissions and chemical pollutants. However, nothing poses a greater threat to such art than condensation resulting from rapid humidity and temperature changes. Primarily it is relative humidity and temperature that are the major concerns as changes in these conditions affect the stability of delicate and perishable objects. Organic material, such as wood, leather, and canvas, is most Susceptible to damage resulting from poor relative humidity and temperature conditions. Paintings can crack as a result of low relative humidity, and leather and fabrics can develop mold growth at relative humidity levels above 60% RH. Since it is the equilibrium relative humidity of the objects themselves, which are to be considered, it seems logical to directly monitor their water activity. Water activity (Aw), is defined as the free moisture available in a material as opposed to the chemically bound moisture. It is directly related to equilibrium relative humidity (%ERH). Quite simply %ERH is expressed in terms of 0-100%, and water activity in terms of 0-1. While water activity represents a very useful assessment of the free moisture of a material or substance for a wide variety of quality purposes, it does not necessarily reflect the total moisture content percentage which is an entirely different measurements requiring the use of other principles. The total water content percentage equals the sum of bound water and free water. In simple terms, water activity is the equilibrium relative humidity created by a sample of material in a sealed air space, and expressed on a scale of 0 -1 for 0 -100% ERH. The above discussion highlights the varying degree of relative humidity under different scenario. According to experts, the recommended level of desired temperature and relative humidity is summarized below in table 1.

Table 1: Recommended Level of Temperature and Relative Humidity under Different Environment

Activity	Temperature (°C)	Relative humidity (%)	Activity	Temperature (°C)	Relative humidity (%)
Backery			***Leather***	1	
Biscuits and cookies	*16-18*	*50*	*Storage room*	*16-Oct*	*40-60*
Fermentation	*24-27*	*70-75*			
Flour storage room	*18-27*	*50-65*	***Libraries and Museums***	*21-27*	*40-50*
Bread cooler	*21*	*60-70*			
Confectionery	*24-27*	*65-70*	***Paper products***		
Mixing bread dough	*24-27*	*40-50*	*Binding*	*21*	*50-65*
Yeast storage room	*0-7*	*60-75*	*Wrinkling*	*24*	*60-65*
			Printing office	*24-27*	*45-55*
Granes			*Storage room*	*24-27*	*40-60*
Packing	*24-27*	*45-50*			
			Textile		
Confectionery			*Cotton processing*	*24-27*	50-55
Chocolate sales	*17-18*	*50-65*	*Cotton spinning*	*16-27*	50-70
Storage room	*16-20*	*50-65*	*Articficial silk spinning*	*20-24*	*85*
			Cotton weaving	*27*	*56-60*
Food industries			*Wire torsie articficial silk*	*21*	*60*
Apple storage room	*-1*	*75-85*	*Silk processing*	*24-27*	*65-70*
Banana ripening	*20*	*90-95*	*Wool refining*	*27-29*	*65-70*
Banana storage room	*16*	*85-90*	*Wool spinning*	*27-29*	*50-60*
Citrus fruits storage room	*16*	*85*	*Wool weaving*	*27-29*	*60*
Eggs storage room	*13-Feb*	*75-80*			
Granes storage room	*16*	*30-45*			
Mushrooms storage room	*0-2*	*80-85*	***Tabacco***		
Potatoes storage room	*16-Apr*	*85-90*	*Sigars and sigarettes*	*21*	*55-65*
Sugar	*27*	*30*	*Processing and storage*	*24*	*70-75*
Tomatoes storage room	*1*	*85*	*Packing*	*32*	*88-95*
Tomatoes riping room	*21*	*85*			
			Wood processing		
Hospitals			*End products*	*18-21*	*35-40*
Children's ward	*24*	*50-65*	*Fixing*	*24-24*	*40-50*
Operation room	*24*	*55*	*Processing*	*18-24*	*35-40*
Hospital rooms	*24*	*40-50*			
			Conservatories	27	70-80
Painting companies	22-24	40-50			

(Source : https://www.lenntech.com/calculators/humidity/relative-humidity.htm)

Traditional Method of Humidity Measurement

Among the various techniques of humidity measurement, Dew point method can be easily used. Under this study, relative humidity calculated using Dew point is compared with Humidity shown by hygrometer to examine the accuracy or uncertainty in calculated value of Rh with the help of Dew Point.

Determining Relative Humidity using Dew Point Method

In simple terms, the dew point of the air is determined by finding the temperature at which the air needs to be cooled to (at constant pressure) in order to achieve a relative humidity (RH) of 100%. At this point the air cannot hold more water in the gas form. Once the air temperature reaches to a level when fog, dew, or any type of precipitation is formed, the temperature in such situation can be referred as Dew Point. Thus the dew point is the temperature to which air must be cooled to become saturated without changing the pressure. Any change in pressure would affect the vapor pressure as a result of which the temperature at which saturation occurs also gets changed. Thus, change in pressure can result in change of the dew point temperature. If there is less difference between the dew point and the air temperature, we can estimate that the closer the air is to saturation.The equation relating dew point , air temperature and relative humidity is given as

RH: =100*(EXP((17.625*TD)/(243.04+TD))/EXP((17.625*T)/(243.04+T)))

Where

TD(Dew Point) : =243.04(LN(RH/100)+((17.625*T)/(243.04+T)))/(17.625-LN(RH/100)-((17.625*T)/(243.04+T)))*

T (Air temperature): =243.04(((17.625*TD)/(243.04+TD))-LN(RH/100))/(17.625+LN(RH/100)-((17.625*TD)/(243.04+TD)))*

(T and TD are in Celsius)

(EXP and LN are the exponential and natural logarithm functions)

With the help of above equation one can easily determine Relative humidity by calculating air temperature (T) and Dew point (Td).

The air temperature has been measured using dry bulb thermometer where for the purpose of finding dew point , following procedure was adopted.

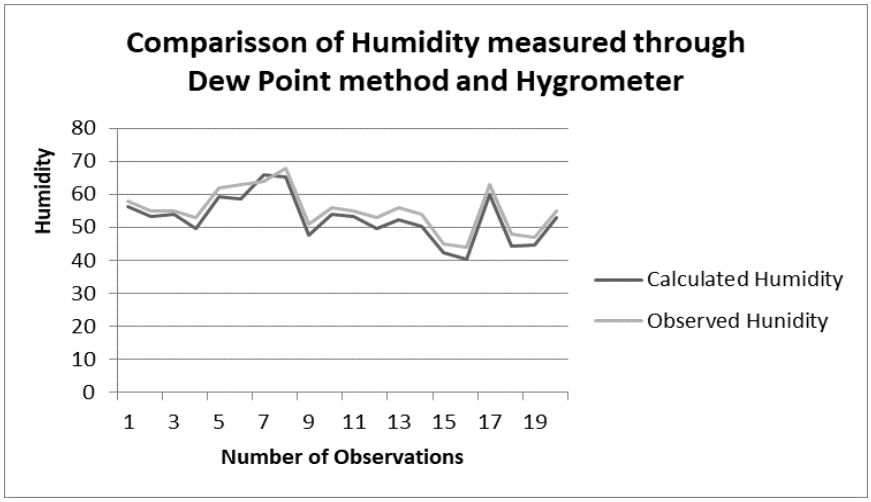
- Water was taken in a copper vessal and placed on tripod stand.
- Some ice cubes were inserted in the water and allowed it to get melted gradually.
- After few minutes, thin condense layer start appearing on the surface of vessal.
- At this stage, temperature of water was taken, this is the dew point temperature.
- Relative Humidity was also measured of the environment with the help of hygrometer for the purpose of comparison.

The process was repeated number of times in different environments and different days. Following observations were made:

Table 2: Values of air Temperature, Dew Point , Calculated and Observed Relative Humidity

S.No.	Air Temp (in Degree Celsius)	Dew Point (in Degree Celsius)	Calculated Humidity	Observed Humidity	Difference between Observed value and Calculated value
1	34	24	56.1	58	1.9
2	36	25	53.37	55	1.63
3	38	27	53.86	55	1.14
4	33	21	49.49	53	3.51
5	31	23	59.13	62	2.87
6	29	20	58.42	63	4.58
7	29	22	66.04	64	-2.04
8	25	18	65.2	68	2.8
9	37	24	47.6	51	3.4
10	38	27	53.86	56	2.14
11	36	25	53.37	55	1.63
12	34	22	49.75	53	3.25
13	32	21	52.35	56	3.65
14	36	24	50.27	54	3.73
15	37	22	42.18	45	2.82
16	39	23	40.23	44	3.77
17	36	27	60.05	63	2.95
18	35	21	44.28	48	3.72
19	36	22	44.55	47	2.45
20	34	23	52.86	55	2.14

As can be observed from the figure (1) shown below, the humidity measured using hygrometer is close to humidity calculated using dew point method.



It can be observed that the humidity value calculated using dew point method are in close approximation to the values observed by the hygrometer. Difference in the range of 1.63 to 4.58 were observed which can be attributed to the uncertainty in the measurement of air temperature and dew point. It can be concluded that dew point method is acceptable method of humidity measurement provided air temperature and dew point is measured accurately with least uncertainty**.**

Conclusion and Suggestion of the Study

The observations discussed above clearly indicates importance of humidity in human life as well in various aspects related to human welfare. One must ensure maintenance of correct level of humidity at various places to ensure smooth operations. In the absence of hygrometer, use of dew point can be made to estimate humidity level as the method has been found to provide level of humidity with fair accuracy .The range of desired humidity level varies from one industry to other. Thus, correct humidity measuring tools be used at these places and appropriate scientific humidity generators /dehumidifiers be installed to overcome the problems relating to low as well as excess level of relative humidity.

References

1. Alduchov, O. A., and R. E. Eskridge, 1996: Improved Magnus' form approximation of saturation vapor pressure. J. Appl. Meteor., 35, 601–609.
2. August, E. F., 1828: Ueber die Berechnung der Expansivkraft des Wasserdunstes. Ann. Phys. Chem., 13, 122–137.
3. Cintura, Eleonora & Gomes, Maria. (2020). Influence of Humidity on Environmental Sustainability, Air Quality and Occupant Health. 10.5281/zenodo.3669158.
4. Davis, Robert & Mcgregor, Glenn & Enfield, Kyle. (2016). Humidity: A review and primer on atmospheric moisture and human health. Environmental Research. 144. 106-116. 10.1016/j.envres.2015.10.014.
5. D.D. Biehler, G.L. Simon, The Great Indoors: Research frontiers on indoor environments as active political-ecological spaces, Progress in Human Geography 35 (2011) 172-192.
6. S.-B. Su, B.-J. Wang, C. Tai, H.-F. Chang, H.-R. Guo, Higher prevalence of dry symptoms in skin, eyes, nose and throat among workers in clean rooms with moderate humidity, Journal of Occupational Health 51 (2009) 364-369.
7. J. Wan, K. Yang, W. Zhang, J. Zhang, A new method of determination of indoor temperature and relative humidity with consideration of human thermal comfort, Building and Environment 44 (2009) 411-417.
8. L. Reinikainen, J. Jaakkola, Significance of humidity and temperature on skin and upper airway symptoms, Indoor Air 13 (2003) 344-352.

❖◆❖