International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol. 3, Issue. 3, May.-June. 2013 pp-1458-1461 ISSN: 2249-6645

An Innovative Approach for Humidity Control by Using Deliquescent Materials in Test Chambers

Prof. L. B. Diwakar, Prof. A. M. Patil
Dept. of Mechanical Engg. PVPIT, Sangli. Maharashtra, India.

***Abstract*:** Humidity plays a vital role in the industrial spheres where there is an imminent needs to control the humidity to appraise the product quality. Among the industries are pulp and paper, sugar, textiles, pharma, air conditioner, food processing and formation of photonic band gap films. Essentially control of humidity in the above areas in the associated manufacturing industries attracts the researchers in recent days to develop latest techniques to implement control techniques effectively. Use of effective methods and to promote scopes for research oriented program for further developments in the field of computer based control of humidity to archive the goal of product quality. This is an honest attempt to review some papers published in various international journals which address the critical influences of humidity and its control strategy. To that account a brief survey on the papers titled on humidity control in various journals is also done.
***Key Words*:** Humidity, Controller, Product quality, Human comfort.

I. Introduction

The necessity to control temperature and humidity for sample testing or any such application is increasing day by day. The test chambers find wide applications in electronic, agriculture, component testing, textile and pharmaceutical industries.

The conventional approach to design such a system is to build a cooling/ heating system in conjunction with humidity control system. The humidity control system presently requires a series of complex instrumentation and controls namely a humidity transmitter, a Programmable Logic Controller, power contactors, a pan humidifier, a set of solenoid valves and a heater. All these components are high valued items and total cost of the equipment becomes prohibitive for average users who need these type of equipments.

This innovative approach would be a cost effective solution to control and maintain the above mentioned parameters namely temperature and humidity by using “Deliquescence” property of the material that is ability to absorb and release the moisture from the surroundings

II. Literature Review

Traditionally, deliquescent compounds, usually salts, are used to reduce relative humidity in a closed environment. It is well known that different compounds have varying affinity for moisture. For example, each deliquescent compound has a characteristic capacity for moisture adsorption and a characteristic equilibrium relative humidity (ERH) when hydrated.

Cerolinini et.al.[1]Desiccants can be considered humidity controllers in that they have been used to completely (or almost completely) remove all water vapor from the air from a closed system. An effective desiccant in sufficient quantity will adsorb water vapor from the air in a package, lowering the equilibrium relative humidity (ERH) to the point where condensation will no longer occur, or to a point where the threshold ERH within a sealed package or system is never exceeded under the conditions to which the package or system will be exposed.

Prowse and Wilkinson M. [3] described the specific humectant in such cases is chosen based on the desired equilibrium relative humidity (ERH). The salt may be single in nature, such as lithium chloride. A mixture of two salts may also be used. As an example, a solution of potassium carbonate has a relative humidity of about 43%. Therefore, a solution of potassium carbonate with excess undissolved crystals of potassium carbonate will maintain a constant relative humidity of approximately 43%. If the relative humidity begins to rise above 43%, the salt solution would pick up moisture from the environment thus lowering the relative humidity closer to 43%. Conversely, if the relative humidity begins to fall below 43%, the solution would release moisture until the surrounding environment reaches approximately 43%. The ERH values for different saturated aqueous salt solutions can vary from 11% to 98%.

Deschenes and Stone [4] described inventions for humidity control devices describe a viscous solution contained within a fabric or non-woven polymeric pouch. The viscous solution in such cases has included water, salt, and may have had a thickening material (such as alginate or xanthan gum). In practice, these salt solutions were difficult to handle because they are liquids which can spill or soak through the package or vessel containing them. Even a stabilized salt solution can weep or wick out of a package which must of necessity be porous to water vapor in order to function.

ASHRAE [6]Fundamental volume explained a method of determining the absolute humidity and relative humidity.Compounding this problem is the fact that the tendency to weep becomes greater as the humectants attracts moisture from its environment and becomes more fluid. With a fluid, even a thickened fluid, seepage may occur through a package if the moisture permeation rate of the film or pouch is too great, or if the surface energy or "wettability" is too high. This would obviously be counterproductive to the desired goal of protecting a product. nding on the temperature.

III. Proposed Work

A) Theoretical

The proposed work includes the manufacturing and testing of a 100 liters capacity test chamber. It will have a set temperature facility from + 4 deg C to + 60 deg C with a digital temperature indicator cum controller. It will have refrigeration and heating system. For humidity control a certain amount of deliquescent material will be kept inside the chamber. Deliquescence is a property of the material to absorb moisture from the surrounding space. These substances have strong affinity for water and absorb large amount of water. This amount of water absorbed depends on the surrounding temperature. The higher the temperature, the lower the capacity to absorb the moisture. Consequently, at higher temperatures, it will 'release' the moisture to the surroundings and at lower temperatures it will absorb more moisture, thereby, maintaining a fairly constant relative humidity of the surroundings. The process being reversible and no chemical change taking place, no frequent replenishment of the material is required.

B) Experimental Setup

1. A test chamber
2. A refrigeration system with temperature control
3. Hygrometer for measuring humidity

IV. Objectives

9.1) To design and manufacture a test chamber with provision of heating and cooling (refrigeration) system having a temperature controller with facility to set the desired temperature.

9.2) To use deliquescent materials such as zinc chloride, potassium hydroxide sodium hydroxide, magnesium chloride (any two of the above) to control humidity.

9.3) To test the chamber and monitor inside conditions.

9.4) To optimize the deliquescent material quantity for the particular volume of test chamber.

Action Plan (Methodology)

a) To design and manufacture a test chamber of about 40 liters net volume having adequate insulation.

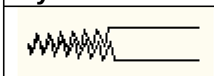
b) To provide the equipment for the chamber in order to achieve the processes of cooling, heating, humidification, and de-humidification. It will require a fractional hp capacity compressor, air cooled condenser, an expansion device, forced convection air cooled evaporator, a re-heater and a steam type humidifier.

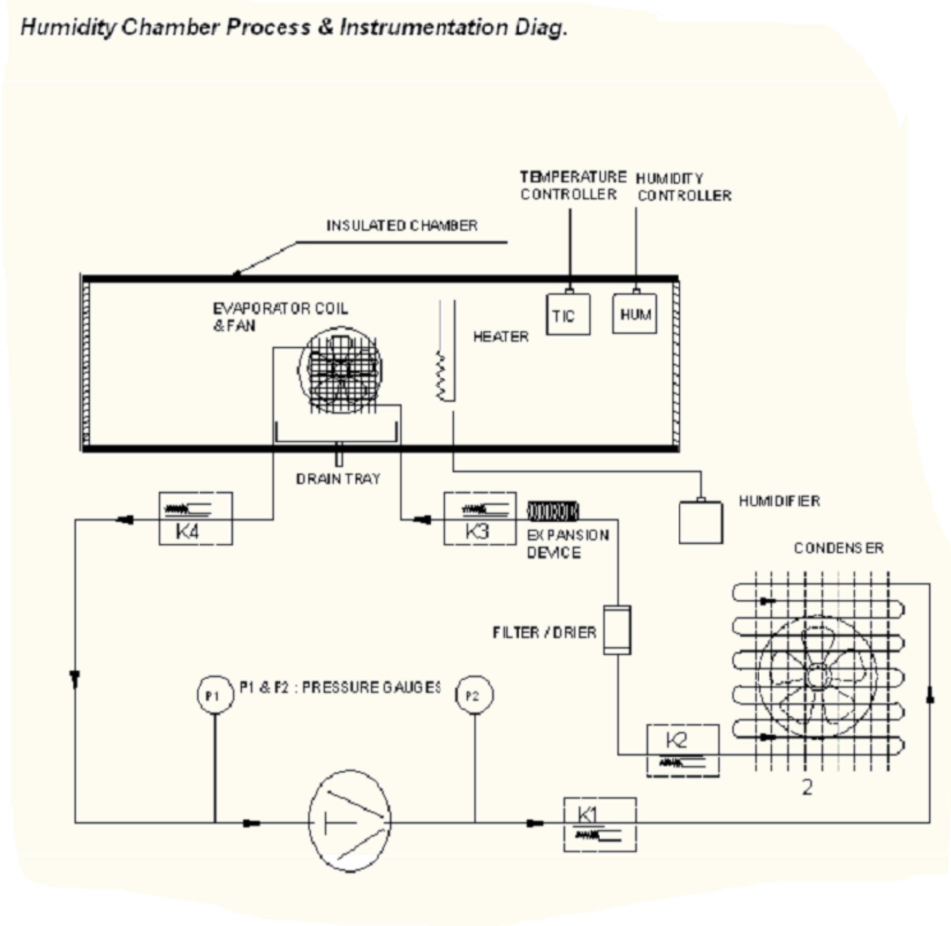
c) To incorporate necessary instrumentation including temperature indicator & controller, humidity indicator & controller to observe, record and control the required parameters such as chamber temperature and humidity.

d) To control the chamber conditions by conventional methods and by other methods as described earlier.

e) To evaluate the effectiveness of the non-conventional methods.

f) To optimize the quantity of deliquescent material for the particular range temperature and humidity control.

Symbol	Description
	Temp.Sensor, Thermocouple
→	Direction of refrigerant flow



K_1-Temp. after compression	
K_2 - Temp. after Condensation	

TECHNICAL SPECIFICATIONS OF THE TEST CHAMBER

•	*Test chamber capacity*	:	*40 liters*
•	*MOC of test chamber*	:	*CRCA Powder coated.*
•	*Insulation*		*65 mm PUF or equivalent.*
•	*Compressor*		*Hermetically sealed, Copeland or equivalent make*
•	*Refrigerant*		*R-134a- Eco friendly.*
•	*Condenser*		*Natural/forced convection air cooled*
•	*Drier/filter*		*Molecular sieve type provided*
•	*Expansion device*		*Capillary tube*
•	*Evaporator*		*Forced convection air cooled*
•	*Temperature control*		*Digital temperature controller provided. Sub-zero or equivalent make.*
•	*Humidity control*		*Digital type subzero make*
•	*De-humidifier*		*Re-heater: 125 Watts provided.*
•	*Humidifier*		*Immersion heater type provided.*
•	*Pressure indication*		*Dial type pressure gauges, 2 nos provided.*
•	*Energymeter*		*Provided to record total power consumption of equipment..*
•	*Size of the equipment*		*600 x 1200 x 600 (LxHxD) mm*
•	*Supply*		*230 Volts; 50Hz; 1 Ph.*

V. Concluding Remark

On review of various literatures on humidity control, it can be concluded that the humidity can be controlled by using specific property of various deliquescent materials. These substances have strong affinity for water & absorb large amount of water. The amount of water absorbed depends on surrounding temp. Higher the temp lower is the capacity to absorb the moisture. Hence while controlling the humidity the temp must be maintained correctly.

References

[1] S. Cerolininin M D orazio,Moisture buffering capacity of highly absorbing materials, int. jou. of Energy and Buliding,Elsevier 2009.
[2] Marnix van Belleghem, Hendric Jansteeman Design of Test chamber for investigation of Moisture
[3] Effects of humidity on mechanical properties Prowse M S, Wilkinson M.
[4] Climate change mortality and adaption Olive Descheles and Michel greenstone.