Comparison for humidity absorption using various silica gel in experimental chamber

A.A.M. Damanhuri*, Q.F. Zahmani, A. Ibrahim, S.N. Mokhtar, S.N. Sulaiman, M.R.A. Majid

Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

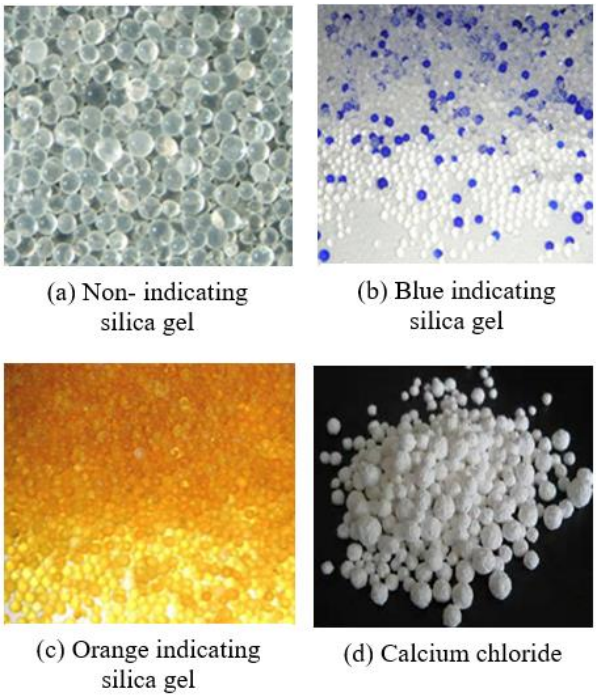
*Corresponding e-mail: amir.abdullah@utem.edu.my

Keywords: Silica gel; humidity; air quality

ABSTRACT – Air conditioning are used to absorb humidity. Improper humidity control could affect mold and bacteria growth inside the building. This experiment compare 4 types of desiccant silica which white/ non indicating silica gel, blue indicating silica gel, orange indicating silica gel and calcium chloride. Two sealed experimental chamber ($0.125m^3$) were used which connected by pipeline. Silica gel are located inside the connection pipelines and result comparison were measured on how effective these silica gel to absorb and reduce humid air by using humidity sensor. Calcium chloride significantly shows the most effective silica gel in absorption of humidity compare to other three types. However, at certain saturated content, solid silica gel of calcium chloride will transform to liquid form. Further investigation are needed to study effectiveness of silica gel for application in real environment either in cases of performance and safety consideration.

1. INTRODUCTION

The acceptable range for specific physical parameter the lead to healthy and comfort for Malaysia typical tropical humid climates are range between 23-26°C while humidity 40-70% [1]. The presence of fungi and bacteria by improper control of relative humidity (RH) may give significant affect to the occupants [2]. Desiccant molecule are hygroscopic substances use for dryness and absorbs moisture which widely used in food product and shoes packaged. The specialized form of desiccant may be in solid form. The use of desiccant in controlling humidity and comfort have been widely used in hotel, office building, medical facilities and homes. Commonly, air conditioning were used to absorb and control space humidity, but this could lead to excessive use of electricity. Meanwhile, the capital cost and initial cost are in decline [3]. Therefore, the aim of this paper are to compare 200 gram desiccant silica gel used to achieve 50-60% of RH based on 4 types solid desiccant silica gel. Meanwhile, referring to Figure 1(b) of blue indicating silica gel that made from cobalt chloride with impregnated and a heavy metal salt. The color will change after the silica gel absorbs moisture and change from blue to pink until desiccant becomes saturated and need to replace. The blue indicate suitable use for electronic equipment with non- dusting packing. Referring to the Figure 1(c) the orange indicating is made from cobalt chloride free organic indicator. Orange indicating silica gel will active went absorb moisture and change from orange to yellow color desiccant and change to green when it becomes saturated. This type of silica gel is suitable for food and pharmaceutical products. Meanwhile Figure 1(d) shows calcium chloride that made from ionic compound of calcium chlorine ($CaCl_2$). The product is common use in refrigeration plants, ice and dust control on road [4] .



(a) Non- indicating silica gel (b) Blue indicating silica gel (c) Orange indicating silica gel (d) Calcium chloride

Figure 1 Four types of silica gel used.

2. METHODOLOGY

This experiment start with fabrication of small experiment chamber for desiccant testing. Two tightly 0.5m X 0.5 m closed box were selected and connected to each other by using PVC pipe [5].

2.1 Experimental work

Small 50 ft^3/min fan were used to extract the air from the other box [6], and through the silica gel that installed and located inside the PVC pipeline. Figure 2 shows experimental chamber diagram of this experiment carried out. Kettle were put in box A to produce vapor. RH data logger and LEV monitoring device are used to record the through the experiment.

Small electric kettle was used to create vapor and located inside box A.

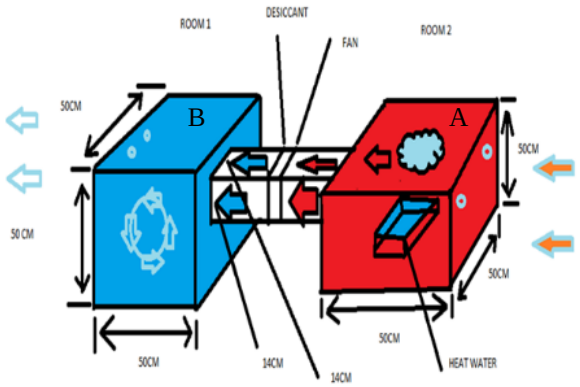


Figure 2 Experimental chamber for silica.

2.2 Experimental procedure

Time interval to record the data is 5 minutes and 3 data were taken. Average data then were tabulated and plotted into graph. Every single changing of silica gel to run the experiment, both box was purged by using mechanical blower to make sure box are really empty and clean. Before running out of this experiment, leak test was performed by using smoke test. Control experiment also runs to compare the readings.

3. RESULTS AND DISCUSSION

Data were recorded through this experiment. Box A were fully vapor which is around 90-100% of RH. Based on Figure 3, after the air through the silica gel that are located at the pipeline, RH at box B were drop to the range between 65-82%. White silica gel/non indicating silica gel and calcium chloride shows significant gradually decrease of RH that are below 70%. This indicate that these type of silica gel could not efficiently absorb humidity. However, only calcium chloride are maintain to be decrease of RH until it reach 51%. Blue silica gel, orange silica gel does not represent good adsorption of humidity compare to calcium chloride. Since calcium chloride to be the most effective silica gel to absorb humidity compare to other three types, calcium chloride however will change to liquid form when it becomes saturated. The solid desiccant then need to be dry using oven at 120 °C for 30 minutes.

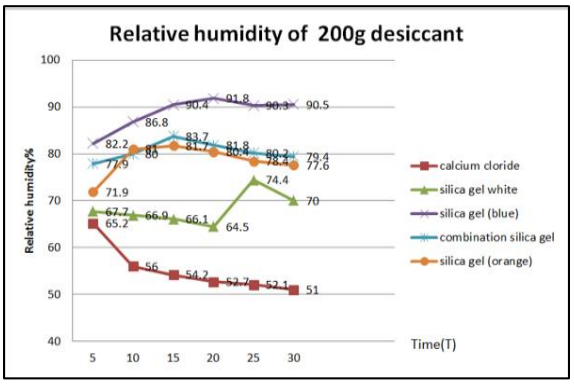


Figure 3 Relative humidity comparison of 200g of 4 types of desiccant.

4. CONCLUSION

In conclusion, solid calcium chloride was effectively absorbing humidity in these small chamber experiment comparing to other three types. However, after fully loaded absorption by humidity process, calcium chloride will change to liquid form and drying process needed to maintain calcium chloride in solid form. Several consideration need to be taken if we want to apply silica gel in dehumidification process depending on the application, material and safety consideration to the human. Further investigation are needed to measure effectiveness of silica gel in real environment.

REFERENCES

[1] DOSH, “Industry Code of Practice on Indoor Air Quality- Department of Occupational Safety and Health Ministry of Human Recources Malaysia,” vol. JKKP DP(S), 2010.

[2] A. Chen and V.W.C. Chang, “Human health and thermal comfort of office workers in Singapore,” *Build. Environ.*, vol. 58, pp. 172–178, 2012.

[3] A. Pesaran, “A Review of Dessicant Dehumidification Technology,” in *Electric Dehumidification: Energy Efficient Humidity Control for Commercial and Industitutional Building Conference*, pp. 1–8, 1993.

[4] L. Moosavi, N. Mahyuddin, N. Ab Ghafar and M.A. Ismail, “Thermal performance of atria : An overview of natural ventilation effective designs,” *Renewable and Sustainable Energy Reviews*, vol. 34, pp. 654–670, 2014.

[5] Desicco Pty Ltd T/A Silica Gel Australia, “Sillica Gel Australia,” *Available online http://www.silicagel.com.au/Pages/Silica-Gel-Requirement-Guide.Html*, 2013. .

[6] R.W. Haines and C. Lewis Wilson, HVAC System and Design handbook Fourth Edition, McGraw-Hill, 2003.