METHODOLOGY FOR THE STUDY OF THE HUMIDITY ADSORPTION OF RAW MATERIALS AND CERAMIC PRODUCTS

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1. INTRODUCTION AND OBJECTIVES

There is an entire group of natural and synthetic materials that are used in different industrial settings for their water adsorbing properties. The fields of use are wide ranging and include waste disposal, additives in the food industry, irrigation control, the chemical industry, and medical applications [1].

Adsorbent or swellable minerals are also used in the ceramic industry as additives [2] to provide the unfired product with greater mechanical strength during transport, before firing, without needing to increase the pressing pressure. In this case, it is important to study not only the humidity-adsorbing properties of the additives used, but also their desorption capacity, since this can influence the industrial drying process.

The present study was undertaken to fine-tune a new test method that would allow the water vapour adsorption isotherms of raw materials used in the ceramic industry, as well as in other industrial sectors, to be determined. The humidity determination was automatically performed, using gravimetry, in an environment with a controlled humidity of up to 90% relative humidity.

2. RAW MATERIALS AND EQUIPMENT

The water vapour adsorption–desorption curves were obtained of materials of different nature used as raw materials in various industrial sectors, including the ceramic industry, such as sepiolite, kaolin, bentonite, synthetic aluminosilicates, diatomaceous earth, attapulgite, zeolite, aluminium hydroxide, metakaolin, montmorillonitic clay, and γ-alumina. The experimental measurement factors, such as test time, ambient humidity, and starting mass, were optimised for each material. An Aquadyne DVS gravimetric water vapour sorption analyser was used for the test. This instrument records the variation of sample mass as a function of the relative humidity of the water vapour that remains in a test chamber during an optimised time (Figure 1).

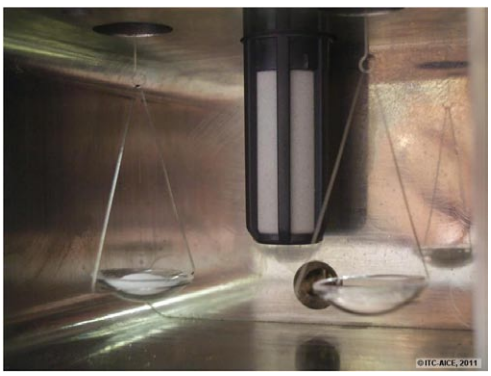

Figure 1 AQUADYNE gravimetric balances

3. RESULTS

A plot of the results obtained (adsorbed water vs. relative humidity) for each tested sample is shown in Figure 2.

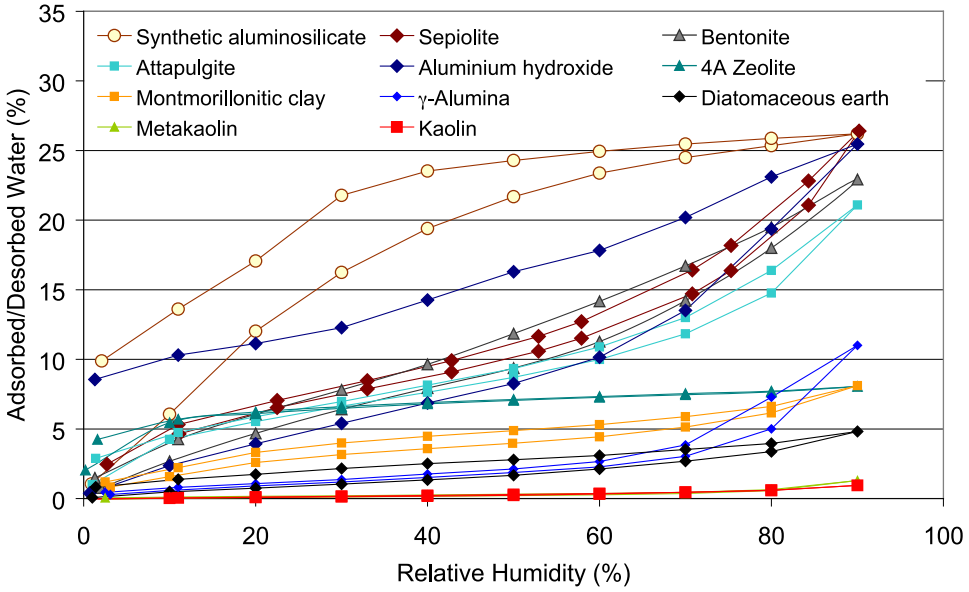

Figure 2 Adsorbent capability of different raw materials used in the ceramic industry

The results obtained showed that there were significant differences between the adsorbent capabilities of the different raw materials, which were mainly studied within the usual relative humidity working range (40–50%). The sample that exhibited the greatest water vapour adsorption capacity in practically the entire range of humidities was the synthetic aluminosilicate, with values of about 20% adsorbed mass. Then followed materials such as sepiolite and attapulgite, which are excellent raw materials for working at very high relative humidities. Though aluminium hydroxide displayed considerable adsorption, it exhibited a high hysteresis in the desorption process. The rest of the raw materials displayed no adsorbent characteristic with regard to water vapour, since their mass increased less than 5%. In the study it was also attempted to relate the adsorbent capability to the specific surface area of the tested raw materials: however, no direct relationship was observed, because the intrinsic characteristics of the nature of the surface also play an important role in controlling adsorption.

4. CONCLUSIONS

An analysis method has been fine-tuned to obtain water adsorption isotherms. The test times required by this method are much shorter than those needed using the traditional methods with the climatic chamber.

The obtainment of the adsorption isotherms allows the behaviour of a material with relation to water adsorption at different ambient humidities to be predicted, and the adsorption capacity and ease of desorption to be evaluated.

ACKNOWLEDGEMENTS

The study has been supported by the European Union through the European Regional Development Fund (ERDF) and by IMPIVA (Generalitat Valenciana). (IMDEEA/2011/82).

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