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On the measurement of diammonium phosphate moisture by microwave methods

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Abstract

We applied the microwave water content measurement method to investigate the moisture level in diammonium phosphate. The measured values of moisture were then compared with those obtained by drying technique. The results of four experiments proved the possibility of water content measurement in diammonium phosphate in the operational range of moisture and temperature.

Keywords

Moisture, diammonium phosphate, microwave water content measurement, resonator technique, granular materials, fertilizers.

Introduction

Diammonium phosphate (diammonium hydrogen phosphate, chemical formula $(\text{NH}_4)_2\text{HPO}_4$) is utilized as a fertilizer in agriculture and as a fireproof material. The measurement of its moisture is important for the material's quality control and for its proper storage.

Objective

The main goal of this work was to test the possibility of water content measurement for solid (granular) diammonium phosphate by microwave resonator technique, in the operational range of moisture and temperature.

Description of material and sample preparation

The studied diammonium phosphate was supplied in the form of grains (2–5 mm — $\geq 95\%$, less than 6 mm — 100%). The material is nonhygroscopic. When heated over 70 °C, it tends to lose ammonia and to transform into

monoammonium phosphate (also known as ammonium dihydrogen phosphate, $\text{NH}_4\text{H}_2\text{PO}_4$).

We wetted the equilibrium-moisture material by 3 percent and put it into refrigerator for 48 hours to redistribute the moisture uniformly.

In our experiment, we were gradually drying the sample of initially wetted material at 60 °C— by 0.3–0.5 % for each measurement.

Method and instrumentation

We measured water content level in diammonium phosphate with the resonator-type laboratory moisture meter MR101-2. At each step, after drying and cooling to required temperature, we put the sample into the measuring cavity of resonator and then determined

Q-factor and frequency of the resonator mode. The measured parameters were converted with a special algorithm into the density-independent invariant. The measurements were carried out at the sample temperatures of 24 and 50 °C.

Results

The results of the research are demonstrated in Figures 1 and 2. In Figure 1, one can see the relation between the computed invariant M^* and moisture W . In Figure 2, the values of actual moisture obtained by the drying method are compared with the moisture indicated by the laboratory device.

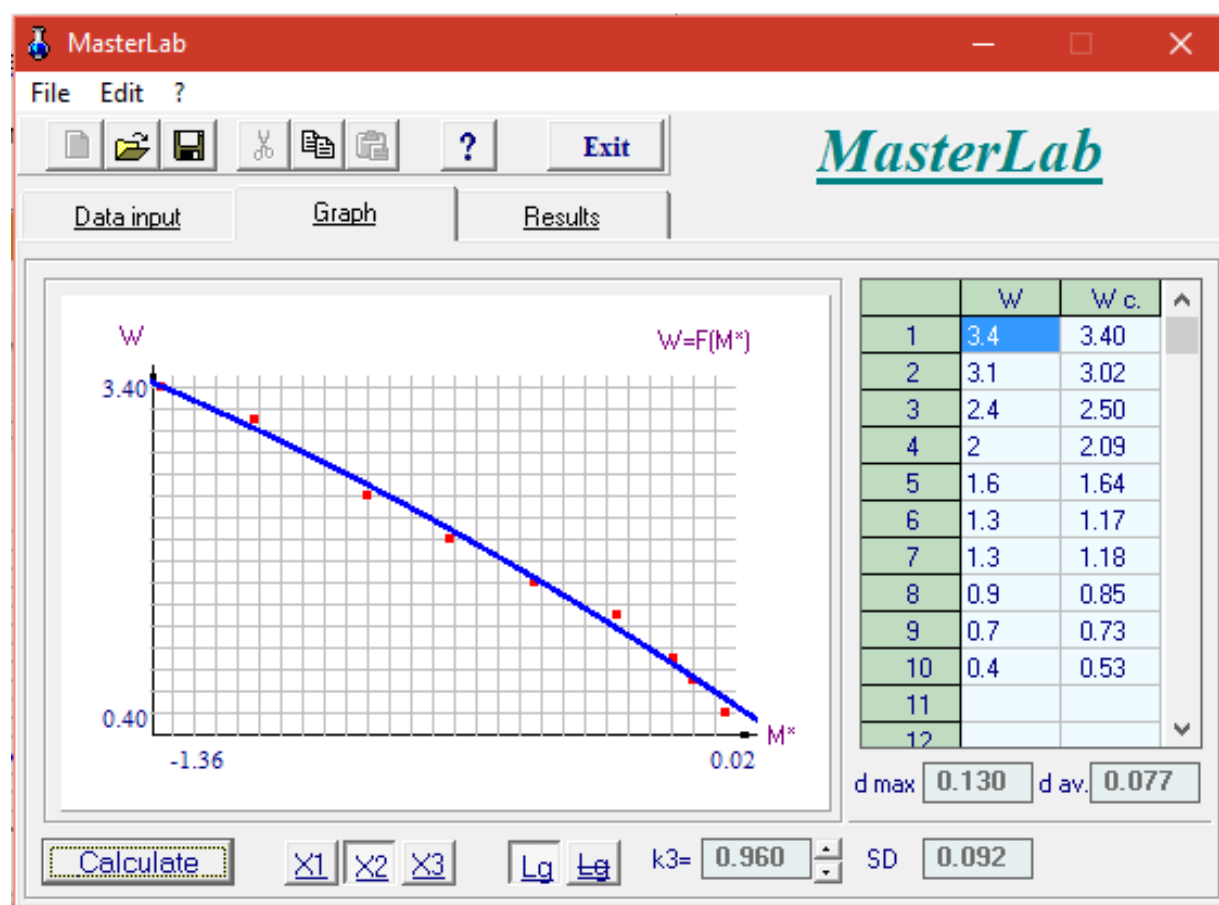


Figure 1. Relation between computed invariant and moisture at 24 °C

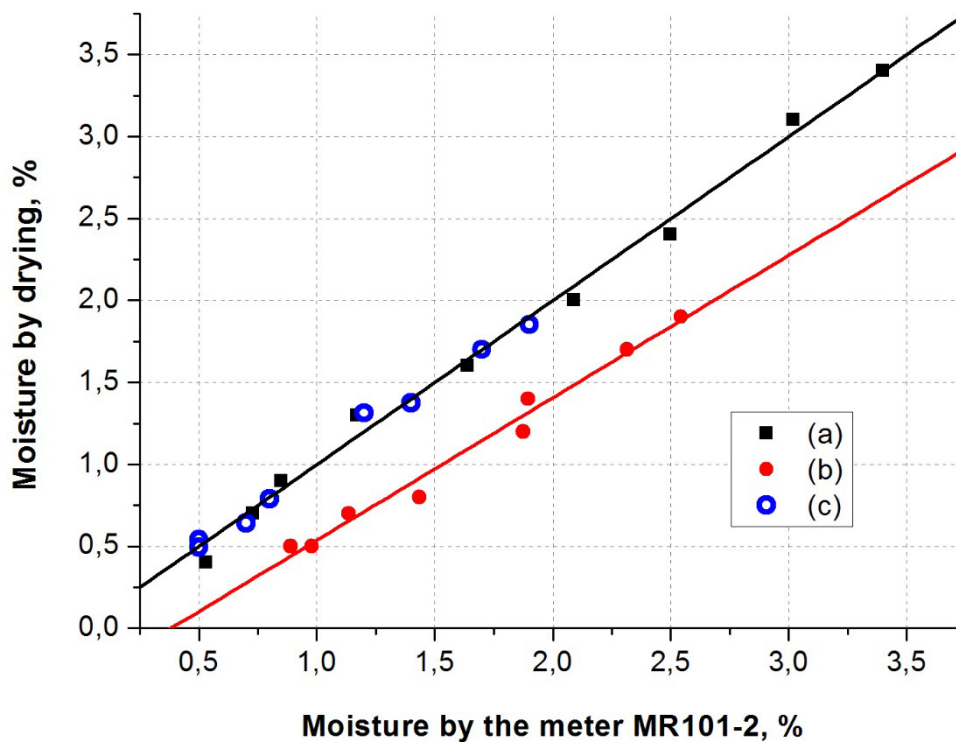


Figure2. Moisture values obtained by drying method against the moisture indicated by the instrument: (a) at the temperature of 24 °C, (b) at 50 °C, (c) at 50 °C after applying the correction for temperature

Conclusion

As it comes from our study, the resonant microwave technique at frequency 2.5 GHz is able to provide the measurement of water content in granular diammonium phosphate in the range of 0.5–3% with accuracy at least 0.2 %.

However, it is necessary to take into account that the experiments were conducted over the single material, so that variations in material composition can affect the accuracy of measurement under actual industrial conditions.