NMR RELAXOMETRY FOR HYGROSCOPICITY EVALUATION IN FERTILIZERS

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According to the FAO, global fertilizer consumption may reach 200 million tons in the next few years in order to fulfil the global demand for food [1]. Reducing nutrient losses and improving physicochemical characteristics of fertilizers are important strategies for sustainable intensification of agricultural production. However, the techniques currently available for the evaluation of these important parameters are time consuming and/or inaccurate. Hygroscopicity is one of the physical characteristics to be studied, since it plays a role in fertilizers losses during storage and in its field application [2]. This work aimed to evaluate the effect of increasing amounts of anti-humectant (zeolite) in the dynamics of water absorption in high hygroscopicity urea-based fertilizers in a saturated atmosphere through NMR measurements. For this study, fertilizer samples were prepared with anti-humectant contents in percentages of 0-30% (w/w). The water absorption kinetics was monitored by NMR experiments each 5 min. The distribution of the transverse relaxation times (T_2) of each sample and time was obtained by the Laplace Inverse Transform in the time domain of CPMG decays, [3] and with this it was possible to accurately partition the water into urea or zeolite (Fig1a). Seeking to preserve the physical characteristics of nitrogen fertilizers containing urea, fertilizer moisture should be the lowest possible and never exceed 0.3% [4]. Based on this, the exposition times required for all fertilizer formulations to reach 0.3% moisture in the urea only were estimated. Zeolite increasing proportions resulted in an exponential delay in the water adsorption by the urea (Fig1b) and also the final urea moisture, after 83.33 h of continuous exposure to the atmosphere saturated with water vapor, decreased exponentially, for blends containing up to 20% zeolite. Fertilizers containing 30% of zeolite did not present significant differences in water adsorption dynamics, suggesting that the amount of water available in the system was not sufficient to saturate the zeolite pores in this treatment.

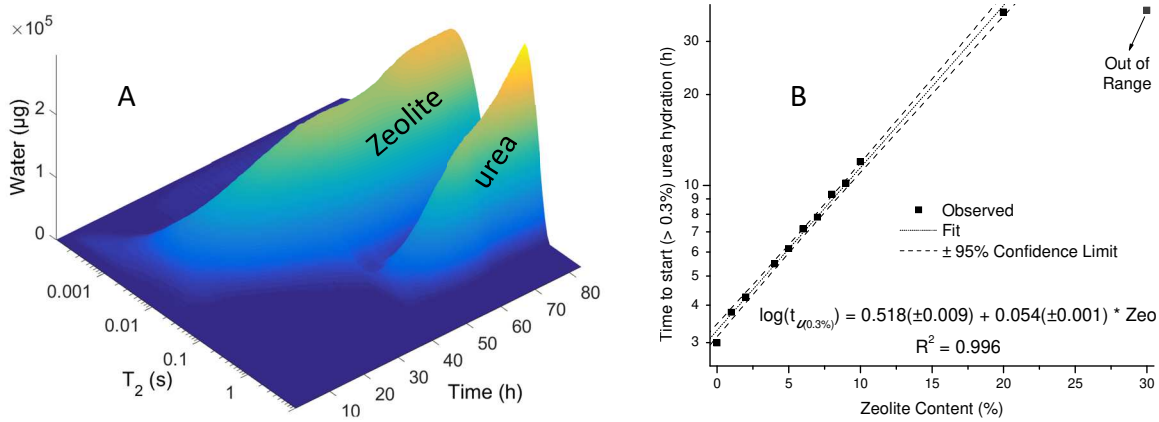

Fig 1 – (A) T_2 distributions for Urea:Zeolite 70:30, following the moistening process. (B) Delay in the start of urea hydration (time to reach 0.3% of moisture content) due to the zeolite presence.

Through this study, it was possible to determine the amount of zeolite to be used for the production of fertilizers according to storage conditions, as well as to estimate the time required for its hydration, reinforcing the potential for use of Low Field NMR in the study and development of fertilizers.

References

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