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Combined application of induced MAP (Magnesium Ammonium Phosphate) precipitation and adsorption through natural zeolites for reducing NH_4^+ and PO_4^{3-} in swine wastewaters

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Modern agriculture, in response to the constantly increasing need of high crop production, requires application of high levels of N and P fertilizers to soil. These substances are mainly composed by nutrients such as NH_4^+ and PO_4^{3-} and are often applied in strong excess in order to assure high crop yield. The nutrients applied through fertilizers and not exploited by crops (estimated on average around 50%) can considerably impairs environmental quality through nitrogen losses in atmosphere (N_2O, NO_x, NH_3) and eutrophication of water bodies.

In this work, a new method for reducing NH_4^+ and PO_4^{3-} in swine wastewaters (commonly used as organic fertilizer) was studied. The aim is to reduce their environmental impact and concomitantly create a new slow-release fertilizer.

Two techniques have been combined: the induced MAP precipitation (magnesium ammonium phosphate) and natural zeolite ammonium adsorption for removing the NH_4^+ excess that generally remains in solution after MAP precipitation. Given the complexity of working with real wastewaters, in this preliminary phase a synthetic analogue was used in order to better evaluate the efficiency of this method. Two synthetic wastewaters with different Mg^{2+} : NH_4^+ : PO_4^{3-} molar ratio were tested: MR1 (1:1,5:1) and MR2 (2:1:1), which according to the literature give the best reductions of NH_4^+ and PO_4^{3-}. Since swine wastewater are naturally rich of both NH_4^+ and K^+, isotherm studies were conducted on natural zeolites for evaluating their adsorption capacity of

NH_4^+ under different levels of K^+ competition. Results showed that the potential in NH_4^+ adsorption decreased while competition with K^+ increased. The combination of MAP precipitation and NH_4^+ adsorption by natural zeolite has been tested in 2 ways: 1) zeolite was added before inducing MAP precipitation 2) zeolite was added after inducing MAP precipitation. These two treatments were compared to a blank in which only MAP precipitation technique was used.

The amount of NH_4^+ and PO_4^+ was monitored in various steps during the experiments as well as SEM observations were conducted on precipitated obtained. Results showed that adding zeolites before MAP precipitation induce a variation in the $Mg^{2+} : NH_4^+ : PO_4^{3-}$ ratio due to cation exchange processes before MAP precipitation which introduce interfering ions such as Ca^{2+} favoring calcium phosphates precipitation instead of MAP. The best test conditions, which produced the 75,1% of NH_4^+ and 99,9% of PO_4^{3-} reductions, occurred when zeolites have been added after MAP precipitation using the MR2. This new material obtained combines good N and P concentration and have therefore potentialities to be a high-quality slow-release fertilizer.