Inhibition of nitrifying bacteria by simulated phosphor recycling wastewaters containing Eu and Y

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The growing demand for rare earth elements (REE) and other metals important for modern technologies has increased interest in their recovery from post-consumer "end of life" products. New recycling processes will create new wastewaters, and in some cases disposal to a municipal wastewater treatment plant may be desired, but plant performance must be maintained. To assess potential effects of REE-containing wastewaters on biological treatment, the model nitrifying organisms *Nitrosomonas europaea* and *Nitrobacter winogradskyi* were exposed to simulated wastewaters containing yttrium or europium (10, 50 and 100 mg/L), and tributyl phosphate (TBP; 0.1 g/L). Nitrogen removal is a critical function of wastewater treatment, and nitrifying bacteria are particularly sensitive to toxins. Y and Eu are present in the red phosphors used in fluorescent lamps, while TBP is commonly used for extracting REE from ore.

Y and Eu additions at 50 and 100 ppm inhibited ammonia oxidation by *N. europaea*, and inhibition was greater at the higher concentrations, even when virtually all of the REE were insoluble. TBP added with Eu increased REE toxicity, although TBP had little or no effect when metals were absent. For *N. winogradskyi,* 10 ppm Eu or Y induced significant inhibition of nitrate production, and this increased further at 50 and 100 ppm. TBP alone completely inhibited *N. winogradskyi*. Differences between the cultures may be partly attributable to different growth media.

Our results suggest that Y and Eu can be toxic to nitrifying bacteria, TBP can increase toxicity, and insoluble forms of these metals may contribute to toxicity. The identities of these insoluble forms are unknown; comparison of measured REE concentrations with thermodynamic model predictions suggested that the experimental systems were not at equilibrium or that heretofore unconsidered phases were present.