Elaboration and catalytic performances of a new inorganic-organic hybrid material

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A new vanadophosphate (VPO) material, Li(C₄N₂H₁₂)[(HPO₄)(VO)(PO₄)₃], has been hydrothermally synthesized and structurally characterized by single crystal x-ray diffraction. The hybrid compound crystallizes in the orthorhombic system (SG: Pna₂₁) with the following parameters (Å): a=14.6207, b=8.709, c=17.6208. Its structural motif, consisting of layers oriented parallelly to bc plane, is made of alternating polyhedra VO₅, VO₆ combined with PO₄ or HPO₄ tetrahedra. The layer stacking is extended to provide cavities in where the Li⁺ cations locate in the eight membered rings, exactly at the opening window of the layers, while the protonated organic molecules reside between the interlayer space as a template that maximizes the hydrogen bonding interactions with the inorganic moiety in a three-dimensional arrangement. Thermal stability and reactivity of the hybrid material were studied by thermal analysis methods (TG/DTA). The potential of vanadophosphate material was investigated on the adsorptive removal of methylene blue (MB) dye in aqueous solutions, via an adsorption batch process with variation of different parameters: pH, temperature, initial dye concentrations and contact time. The kinetic study, reveals that the adsorption of the organic dye by vanadophosphate material was a gradual process, that exhibits a removal efficiency of 99% for initial MB concentrations of 50 ppm at pH=7. Also, the catalytic performance of the hybrid compound was investigated, and the complete degradation of MB was attained after 3h of oxidative reaction.

Figure 1. Projection of the asymmetric unit of Li(C₄N₂H₁₂)[(HPO₄)(VO)(PO₄)₃] shown with 50% probability displacement ellipsoids; (V: green, P: yellow, N: blue, O: red, H: gray, Li: pink).

Figure 2. Polyhedral view of the inorganic entities of Li(C₄N₂H₁₂)[(HPO₄)(VO)(PO₄)₃] forming a layer with two different cavities.