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Surface-modified phillipsite-rich tuff from the Campania region (southern Italy) as a promising drug carrier: An ibuprofen sodium salt trial

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Abstract

The encapsulation and delivery of drugs often involves the use of expensive microporous materials, and we have investigated the potential for natural zeolites from the widespread volcanic formations of southern Italy as alternatives to these carriers. Surface-modified natural zeolites (SMNZs) with diverse micellar structures (patchy and complete bilayers) were obtained by using different cationic surfactants [cetylpyridinium chloride (CP-Cl), benzalkonium chloride (BC-Cl), hexadecyltrimethylammonium chloride (HDTMA-Cl), and bromide (HDTMA-Br) with phillipsite-rich tuff from the Campania region (southern Italy)]. Loading and release kinetics tests of sodium ibuprofen (IBU) were carried out with organo-phillipsite composites using Fourier transform infrared spectroscopy (FTIR) and thermal analysis coupled with evolved gas analysis (EGA). Results from these tests were mathematically modeled to evaluate IBU adsorption and release mechanisms.

The maximum loaded amount of IBU was attained for organo-phillipsite modified with HDTMA-Br (PHB), which showed a complete bilayer micellar structure. Whenever a patchy bilayer micellar structure formed, the lowest adsorptions of IBU were observed. Equilibrium adsorption results were fit using Langmuir, Sips, and Toth models. Pseudo-first-order and pseudo-second-order fits to the loading kinetic data provided significant goodness of fit. Good fits to the release kinetic data were obtained using first-order and Weibull equations, shedding new light on the release mechanism of IBU from phillipsite. The active amount of IBU on the modified zeolite surface was almost totally available for pharmaceutical purposes.

Keywords: Phillipsite, Neapolitan Yellow Tuff, ibuprofen sodium salt, functionalization, SMNZ, carrier, drug delivery, Sips model, Toth model; Microporous Materials: Crystal-Chemistry, Properties, and Utilizations