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Heat Exchange and Unsaturated-Saturated Flow in Porous Media

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Infiltration of water into a 2D unsaturated porous media is investigated. Infiltrated water and porous media matrix underlie boundary heat and water fluxes. The corresponding mathematical model consists of a coupled system of elliptic-parabolic differential equations describing the water flow, energy transport and heat conduction in the porous matrix. The flow in unsaturated porous media is modelled by a strongly nonlinear Richard's equation based on van Genuchten/Mualem empirical capillary pressure flow model. The saturation distribution can have sharp fronts near the partially saturated and dry zones. Moreover, the governing equation changes its type from elliptic to parabolic when crossing from fully to partially saturated zones. This is very difficult task for numerical realization taking into account the dynamical character of zones position. The amount of heat exchange energy depends on the level of local saturation. The coupling is linked to the heat energy exchange between water in pores and porous media matrix. Also the heat energy transport is dependent on water transport and dissipation in porous media structure, which leads to strongly nonlinear functions for water fluxes.
We have developed an efficient numerical method for solving direct and related inverse problems. The numerical method is based on a finite volume method and flexible time stepping following the idea in [1]. The resulting nonlinear algebraic system is solved using quasinewton iteration-linearization method. Due to the time stepping we can separately solve flow, energy transport with heat exchange and heat matrix conduction. The time step is controlled by convergence of iterations and prescribed error tolerances. Series of numerical experiments and a discussion of linked inverse problems are discussed.

[1] M. A. Celia, and Z. Bouloutas, Water Resour. Res. 26, pp. 1483-1496, (1990).

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Synthesis of Pseudoboehmite from NaOH and AlCl3.6H2O for Controlled Release of Drugs

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The sol-gel obtained pseudoboehmite is an aluminum compound [AlOOH].xH2O, a non-metallic synthetic inorganic nanomaterial with high purity and high specific surface area. Studies are currently being held to

use it in the controlled release of drugs. Drugs of controlled delivery aim at offering a therapeutically dosage to a predetermined place in the body, keeping a desired drug concentration, thus controlling the speed release and how long it is retained in the body. The present work seeks to obtain pseudoboehmite as support to the controlled release of Acyclovir. The pseudoboehmite nanoparticles were obtained through sol-gel process using aluminum chloride hexahydrate in sodium chloride and sodium hydroxide solution. A 3.00 OH/Al molar ratio was kept and synthesis with a 0.4 and 0.5 [OH]- molar concentration at 20°C and 65°C were carried. The aging effect at 95°C/120h was also analyzed. For the Acyclovir in vitro analysis in the gastric medium, the acyclovir dissolution with pseudoboehmite was realized in a HCl 0,1 mol/L. For the in vitro analysis in plasmatic absorption, in the intestinal system, the release of Acyclovir in distilled water was analyzed. Pseudoboehmite showed a structure with high specific surface area, which remained stable in both environments used to emulate the Acyclovir liberation. The results made evident that the pseudoboehmite used as excipient to the controlled release of Acyclovir kept the drug's chemical stability, without degrading it or the pseudoboehmite. The Acyclovir concentration curves shows that pseudoboehmite synthesis with low temperatures and not aged results in more uniform dissolution rates, a desired characteristic in the drug release. The experiments shows that there is also a correlation between these synthesis conditions and the pseudoboehmite superficial area and porosity.

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PCM's for Moisture Control of Old Residential Buildings: A Numerical Approach

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The condensation of water vapour on inner surfaces of residential buildings is a crucial problem, which influences the health and thermal comfort of the occupants. It also has important detrimental effects on the appearance and durability of construction materials. The mitigation of condensation risks is not simple, particularly in the process of rehabilitation of old buildings. The preservation of architectural features precludes the possibility of using thermal insulation materials in facades. The installation of these materials inside buildings (on walls and ceilings), when possible, leads to other problems, such as: (i) breeding of thermal bridges; (ii) reducing of thermal inertia; (iii) reducing the interior area.
Phase Change Materials (PCM) can be incorporated into traditional building materials with the aim to increase heat storage capacity, enable stabilization of interior surface temperatures of buildings whereby influencing the thermal comfort sensation and the stabilization of the interior ambient temperatures and without influencing the aspect of those traditional building materials. This paper aims to assess the possibility of using PCM plastering mortars to mitigate condensation risks in the inner surfaces of walls of old residential buildings. The use of PCMs in internal coatings can potentially avoid (or strongly reduce) the occurrence of condensation temperatures in the inner surfaces, thus fulfilling their twofold intent: improvement of inner thermal comfort and minimization of condensation risks. Numerical simulations are used to predict dew point temperatures due to exterior climatic conditions and envelope characteristics of typical Portuguese old residential buildings. The influence of PCM on condensation risk mitigation is assessed and the global results are presented with the goal of highlighting behavioural differences in regard to common construction materials.