In unsaturated soils it is well known that the diffusion of water vapor is inaccurately predicted by classical Fickian-based models. Much effort has been made over the past decades to describe this phenomenon, known as *enhanced vapor diffusion*, but to date a complete theoretical foundation is absent. The goal of this presentation is to show how Hybrid Mixture Theory is used to derive a vapor diffusion equation that couples both the Darcy advection and Fickian diffusion of water vapor in unsaturated soils with the chemical potential. Contrary to historically used models, the nonlinear PDE presented gives a new form of the vapor diffusion coefficient that does not rely on an empirical fitting parameter. However, upon comparing with experimental values the new diffusion coefficient gives good agreement while only taking into account a-priori information about the experimental setup. (Received August 07, 2013)