The impact of salt crusts and salt cauliflowers on evaporation from a porous medium

N. Sghaier[a], M. Prat [b,c], M.Marcoux[b,c], S. Ben Nasrallah [a]

[a] *Laboratoire d'Eudes des Systèmes Thermiques et Energétiques de Monastir, Ecole nationale d'Ingénieurs de Monastir, 5000 Monastir, Tunisia*

[b] *INPT, UPS, IMFT (Institut de Mécanique des Fluides de Toulouse), Université de Toulouse, Allée Camille Soula, F-31400 Toulouse, France*

[c] *CNRS, IMFT, F-31400 Toulouse, France*

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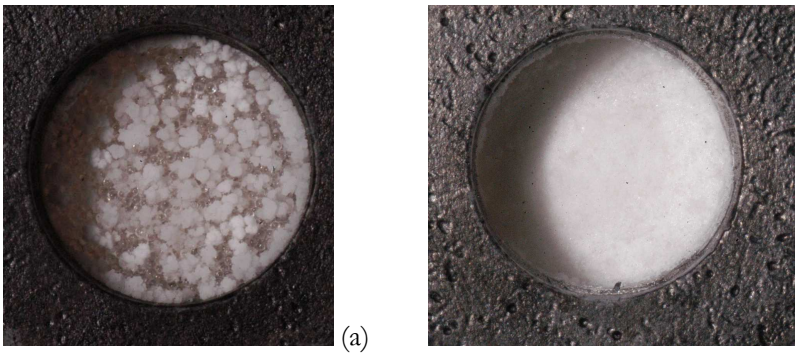
Evaporation in a presence of a dissolved salt is important in relation with various applications such as the conservation of our cultural heritage, the injection of CO_2 in saline aquifer or the soil salinization problem, to name only a few. The problem is made particularly interesting by the crystallization of the salt resulting from the evaporation process. Here we are interested in situations where the salt crystallizes at the surface of the porous medium and forms crystallized salt structures referred to as efflorescence. Although advances have been made in recent years on the understanding of the factors controlling the formation and growth of efflorescence, e.g. [1], [2], many questions are still open. Here we are interested in the impact of efflorescence on the evaporation kinetics of the porous medium.

The study is based on drying experiments in the presence of dissolved sodium chloride. By varying the average size of the beads forming the porous medium, we show that the formation of the efflorescence does not affect significantly the drying process and can even enhance the drying rate when the beads are sufficiently large. By contrast the efflorescence can greatly affect the drying process and even blocks the evaporation process for sufficiently small beads. We therefore show the existence of a transition between the two regimes, namely the blocking regime and the enhanced drying rate regime. It is shown that the two regimes correspond to two different types of efflorescence, referred to as crusty and cauliflower (or patchy) respectively. Then by varying the initial salt concentration for a given bead size, we show that the interplay between drying and the efflorescence formation leads to a non-monotonous variation of the drying rate with the initial salt concentration when the efflorescence is patchy but not when the efflorescence is crusty. This has to do with a porous medium "coffee ring" effect due to evaporation fluxes higher at the periphery of the sample.



(a) (b)

(a)Cauliflower efflorescence (bead diameter=300 μm), (b) crusty efflorescence (bead diameter=5-50 μm)

References

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