Synthesis of Nano-clay/PVA aerogels via freeze drying process in a semi-industrial pilot line and its Life Cycle Analysis

Adrián Esteban-Arranz, Ana Raquel de la Osa, Amaya Romero, María Magdalena Parascanu and Luz Sánchez-Silva

Department of Chemical Engineering, University of Castilla La Mancha, Av. Camilo José Cela 12, 13071 Ciudad Real, Spain

Presenting Author: Adrian.Esteban@uclm.es

Nowadays, aerogels are considered as the most promising thermal insulating and low density materials for different industrial applications such as: building and construction; ships and aeronautics, and pharmaceutics, among others. Sol-gel methodology stands out as the most known approach to synthesize aerogels. Using the lyophilization process to dry the wet gel, the collapse of the material structure does not occur because the experimental problems produced from the surface tension are avoided, unlike for other experimental approaches such as supercritical drying. This drying methodology is based on the extraction of the incorporated water via freezing the wet gel, where the liquid inside the pores is removed and consequently, the sublimation of the frozen part takes place under vacuum conditions.

As a consequence of the low toxicity, high content in water, and high compatibility, polyvinyl alcohol (PVA) aerogels can be used in many applications [1]. The incorporation of other particles to the gel appears to mitigate the disadvantages of some organic aerogels such as the hygroscopicity and fragility properties. Nano-clay is considered as the most suitable particles to promote the properties of the final aerogel [2]. Therefore, the aim of this study is to up-scale the synthesis process of Nano-clay/PVA aerogels via freeze-drying process in a semi industrial pilot line. Physiochemical properties of the resulting materials such as: density; thermal conductivity; morphology and mechanical properties have been elucidated. In addition, a life cycle analysis (LCA) of three possible production process scenarios (lab. scale, pilot line and optimized pilot line production) has been carried out with the aim to determine their energetic and environmental impacts.

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[2] Simon-Herrero C. et al., Nanoclay-based PVA aerogels: synthesis and characterization, Industrial & Engineering Chemistry Research, 2018, 57, 6218-6225.