UNIVERSITÀ DEGLI STUDI DI SALERNO

Department of Industrial Engineering

Master's Degree Course in Food Engineering

Analysis of the impact of fluid dynamics conditions on nanoparticles production process

Thesis in

Transport Phenomena

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Ever tried. Ever failed.

No matter.

Try again. Fail again. Fail better.

Samuel Beckett

This text is privately printed, in Times New Roman

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Abstract

Liposomes - small spherical vesicles with dimensions ranging from 25 nm to 1 μm in diameter - generally consist of a double layer of natural non-toxic phospholipids or cholesterol. Due to their size and amphipathic character, as well as their biocompatibility, liposomes are promising systems for drug delivery. The properties of liposomes differ greatly with their lipid composition, surface charge, size and method of preparation.

In this thesis work the effect of fluid dynamics conditions in the simil-microfluidic production method of nanoparticles is investigated. In this method a stream is injected in a second one in a co-current configuration. At the interface of the two nanoparticles should be formed. Since this approach is based on the microfluidic findings, the standard operative conditions set the flow rates of the two fluids on a value that assure laminar conditions. However, the finding of *Lim et al., ACS Nano (2014)* suggested that turbulent fluid dynamic conditions could improve the quality of the produced nanoparticles, reducing their size.

In this work the fluid dynamic behavior of the water/ethanol mixture with a ratio of 1:2 by volume in both streams, as well as the behavior of pure ethanol (injected stream) and water and the pure water/water. Fluid dynamics was observed through the use of a tracer and a camera. Videos were recorded and analyzed through the use of MATLAB®. This made it possible to obtain important information concerning the regimes of motions obtained as a function of the Reynolds number N_{Re} and the ratio of the velocities FVR.

Thanks to the data collected from the fluid dynamics analysis and taking into account the properties of the formulations - density and viscosity - and the design parameters of the equipment, it was possible to implement a model capable of providing information on the process on

COMSOL Multiphysics® Software. The fluid dynamics trend on COMSOL® software was obtained using a turbulent *k-ε RANS model*. Once the information on the production phase was obtained, the production of nanoparticles of zinc phosphate and liposomes were carried out. The characterization of the samples produced was carried out using the DLS: as regards the liposomal productions, the characterization also took into account the analysis of the samples with the Nano Zetasizer and the optical microscope.

So, summarizing, in this thesis work the effect of fluid dynamics in the production process of zinc nanoparticles was analyzed, then implementing the results obtained for the production of liposomes through the use of a microfluidic-like technique. The results obtained determined the presence of a decrease in the average size of the nanoparticles obtained, passing from a laminar regime to a turbulent one.

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