Innovative precipitation in emulsion process: application to the precipitation of bismuth subnitrate

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A precipitation in emulsion process has been proposed for the continuous precipitation of lanthanides or actinides as oxalates [1], in order to either increase the production capacity (in pulsed column) or allow the precipitation of long-life radioactive elements under optimum safety conditions (Couette column), thus allowing their transmutation. The principle of the method resides in the containment of the reactants to precipitate in droplets of aqueous phase dispersed in an inert organic phase and flowing counter-currently in the device. Nucleation is initiated by the coalescence of the drops containing the reagents. The emulsion method further allows to overcome the problems of injection and micro-mixing, often the cause of lack of reproducibility in conventional precipitation process. The process feasibility and performances were experimentally evidenced for the precipitation of cerium oxalate [2]. These prior studies have shown a strong correlation between the emulsion properties and those of the particles produced, thus enabling the size and morphology of the powder to be tuned by varying the droplets properties (such as their size, velocity and residence time), the latter being controlled by the column operating conditions.

Beyond nuclear applications, this process thus appears as an attractive alternative to conventional processes for the synthesis of high-value precipitates.

In this context, the feasibility of the precipitation of bismuth subnitrate (BSN), a veterinary product, was studied. Indeed, the emulsion implementation seems to be an attractive alternative to the actual industrial process: it offers efficient temperature regulation of the exothermic reaction and improvement of the product appearance is expected.

$$\mathbf{5\ Bi(OH)_2NO_3 + OH^- \rightarrow Bi_5O(OH)_9(NO_3)_4 + NO_3^- + H_2O}$$

The choice of the organic phase and the influence of the hydrodynamic and chemical operating conditions on the properties of both the droplets (sizes) and the solid particles (color, morphology, etc.) are discussed, based on a parametric study conducted in a stirred-tank reactor.

[1] Borda, G *et al.* Patent WO 2008/025823

[2] Borda, G., Brackx, E., Boisset, L., Duhamet, J., Ode, D., Nuc. Eng. Des. (2011) 241:809-814.