HAL
archives-ouvertes.fr

Modeling of a centrifuge device and validation of the efficiency estimate by comparison with experimental data

T. Randriamanantena, D. Ode, K. Mandrick, E. Tronche

▶ **To cite this version:**

T. Randriamanantena, D. Ode, K. Mandrick, E. Tronche. Modeling of a centrifuge device and validation of the efficiency estimate by comparison with experimental data. EFMC 12 - 12th European Fluid Mechanics Conference, Sep 2018, Vienne, Austria. cea-02338572

HAL Id: cea-02338572

https://hal-cea.archives-ouvertes.fr/cea-02338572

Submitted on 24 Feb 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Modeling of a centrifuge device and validation of the efficiency estimate by comparison with experimental data

T. Randriamanantena[a], D. Ode[a], K. Mandrick[a] and E. Tronche[a]

In the nuclear industry and specifically in the context of nuclear spent fuel reprocessing, the function of a centrifuge is to stop the particles that were not dissolved by the nitric dissolution step. Those particles are not desirable in the liquid-liquid extraction devices responsible for recovering the noble materials. The high level of radioactivity of the involved materials usually makes impossible the basic measurements required for a better knowledge and optimization of the devices.

In this context, the laboratory of chemical engineering and instrumentation of CEA Marcoule undertook a numerical modelling of centrifuges supported by experimental studies. Data acquisitions were performed on a CEPA LS laboratory scale centrifuge produced by the CEPA Company.

Experimental studies gave access to the efficiency of the apparatus under operating conditions ranging from industrial conditions to so-called degraded conditions. Two types of powder were used for this study: TiO2 powders representative of the insoluble particles of the industrial process and a PMMA powder selected for its ease of measurement by standard laser granulometers.

The numerical model, implemented in OpenFoam, handles three-phase-flows involving gas, water and particles. It is based on the combination of a Volume Of Fluid[3] (VOF) solver with a lagrangian particle tracking solver using the Multi-Phase-Particle-In-Cell[1] (MPPIC) method. The bowl rotation was modelled by the Multi-Reference-Frames[2] (MRF) method.

Comparison of the calculations with the experimental data validates the model for TiO2 particle diameters greater than 0.5 µm for centrifugal accelerations ranging from 600 to 2000g and feed rates ranging from 21 to 42L/h. Below these sizes, the numerical model underestimates the efficiency of the laboratory centrifuge. Regarding the PMMA powder, the model showed the same trends as the experimental observations which indicated a poor efficiency of the centrifuge even at 2000g.

The numerical model has been validated under operating conditions comparable to industrial conditions and can now be used as a tool to assist the industrial centrifuge management.

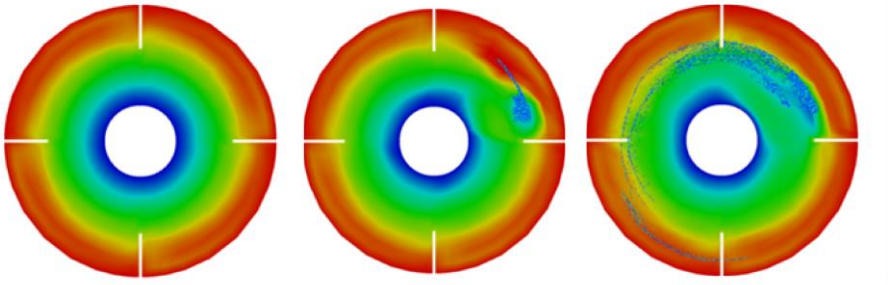

Figure 1 : Injection of particles inside the bowl

[a] DEN, CEA Marcoule/DMRC/SA2I/LGCI, Bagnols sur Cèze, 30200, France

[1] Andrews and O'Rourke, International Journal of Multiphase Flow **22**, 379 (1996)
[2] Luo et al., In *IChemE Symposium Series* **136**, 549 (1994)
[3] Hirt and Nichols, Journal of Computational Physics. **39**, 201 (1981)