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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 Fluid³ (VOF) solver with a lagrangian particle tracking solver using the Multi-Phase-Particle-In-Cell¹ (MPPIC) method. The bowl rotation was modelled by the Multi-Reference-Frames² (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.

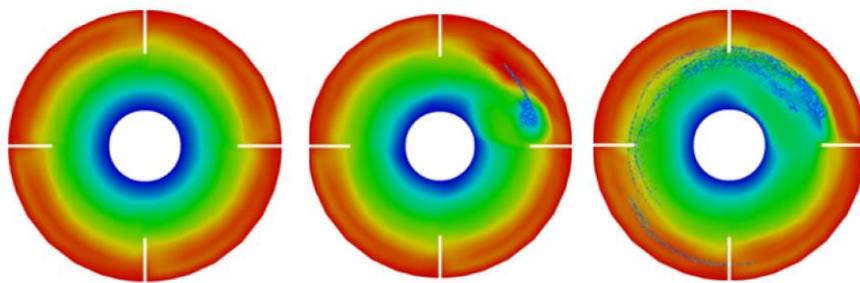


Figure 1 : Injection of particles inside the bowl

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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)