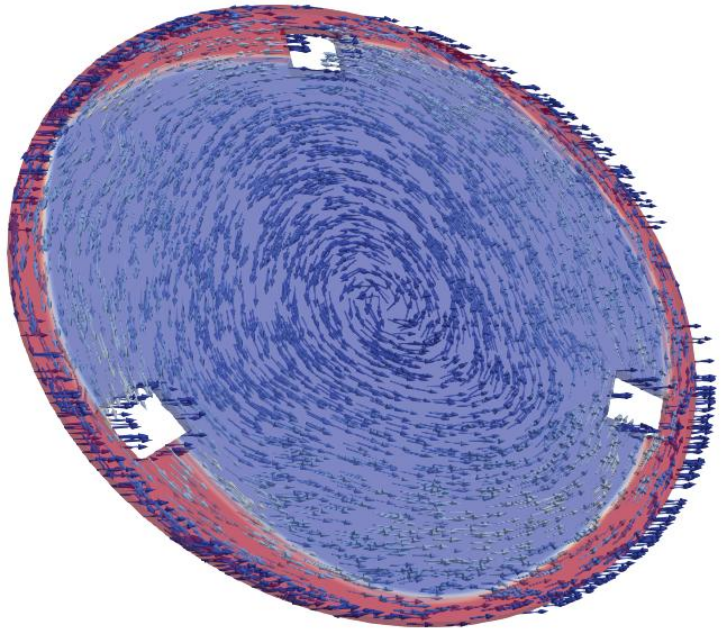

TOWARDS RIGOROUS MODELLING OF A WIPED FILM EVAPORATOR

GONÇALO VENÂNCIO LOUREIRO PARDAL

PROF. DR. FERNANDO PEDRO MARTINS BERNARDO

PRR Plano de Recuperação e Resiliência
REPÚBLICA PORTUGUESA
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CInTech Inovação · Translação · Industrialização
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The Problem

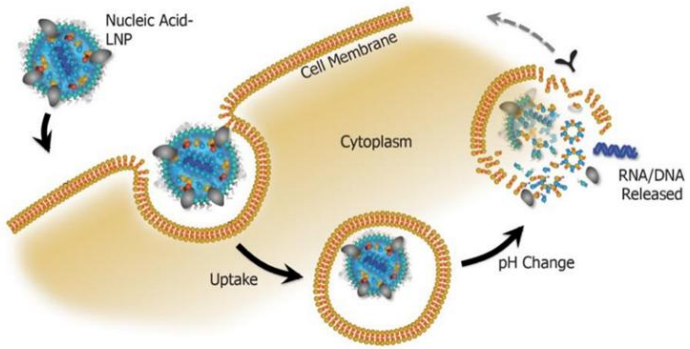
Solvent Extraction for Heat Sensitive Mixtures

Some mixtures require more sophisticated methods for solvent extraction;

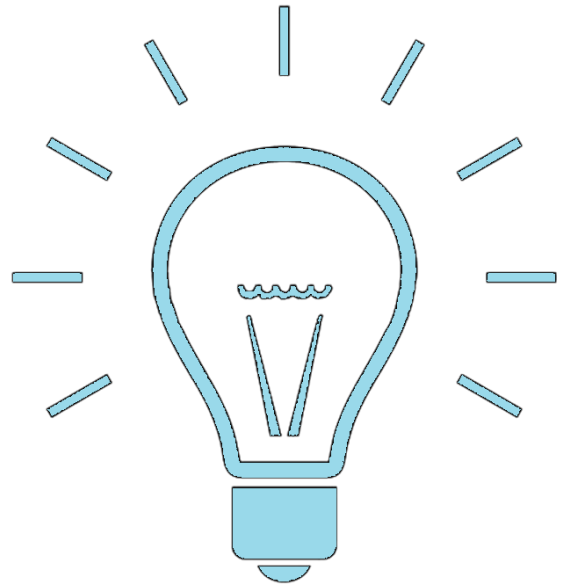
Need to utilize techniques that do not compromise the final products;

Pharmaceutical and food industries constitutes such cases;

In specific, a pharmaceutical formulation for LNPs/PNPs containing RNA

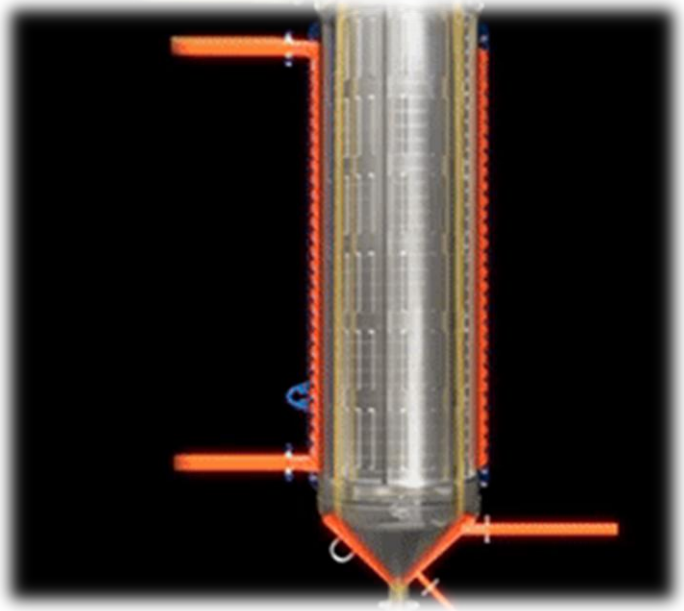


The Answer



Wiped Film Evaporator

WFE is a solvent removal equipment that provides a high heat transfer area, through a helix flow provided by the rotating blades;



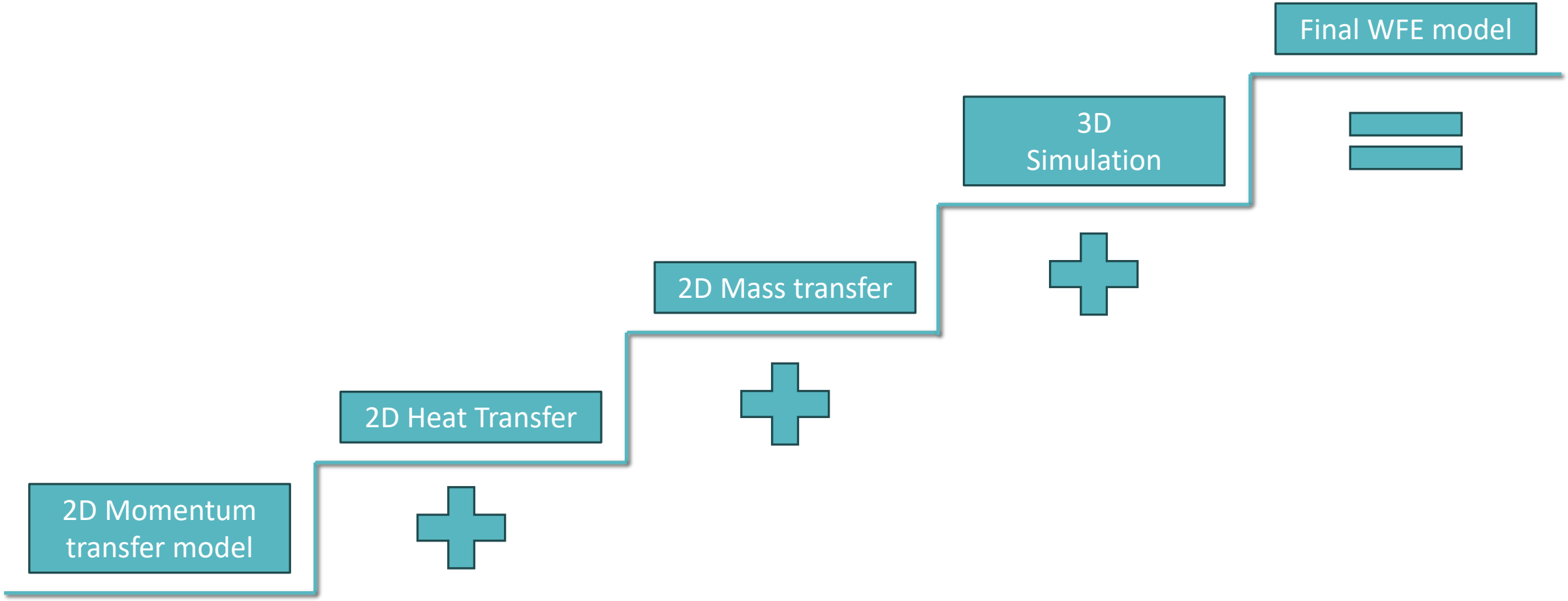
Continuous operation, with a recovered solvent in a high degree of purity;

Varying degrees of operation:

- Temperature, Rotation speed, design of blades;

Lack of rigorous models of the flow inside this equipment;

Modeling Steps



Pre-Processing

The geometry was based on the laboratorial scale WFE:

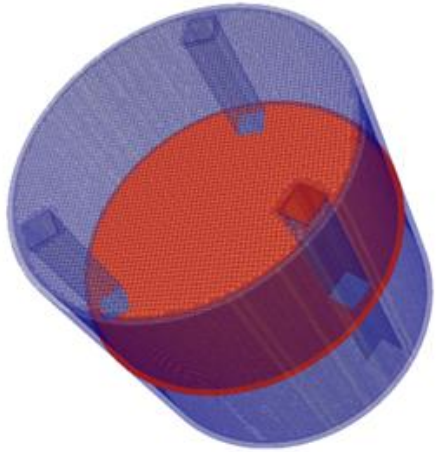
- Perfect Cylindrical body, 5.8 cm radius, 30 cm height;
- 3 rotating blades;

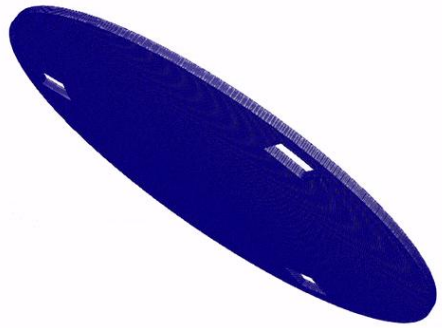
Recurring to BlockMesh to define the main frame, and then snappyHexMesh and .STL files to shape the final geometry;

For the first 2D tests, a cross section was selected, containing 60k cells;

The 2D cross section was considered an isolated system;

- Boundary conditions “empty” on the upper and lower face
- NoSlip condition for the inner wall and the blades;





Pre-Processing

To describe the interface between the liquid and gaseous phases, a VoF method was applied.

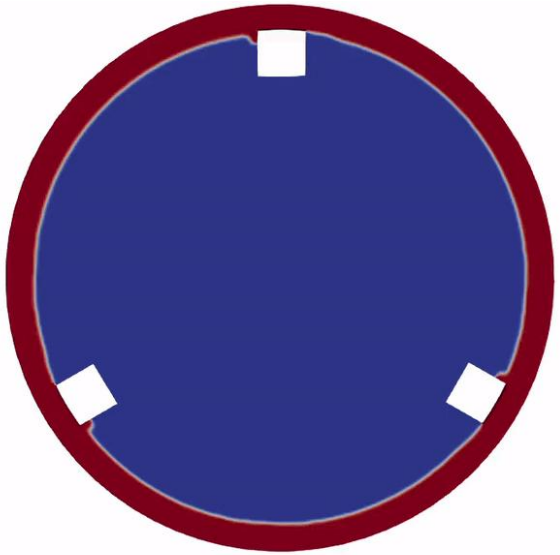
The liquid film was initialized as a 5mm thick film;

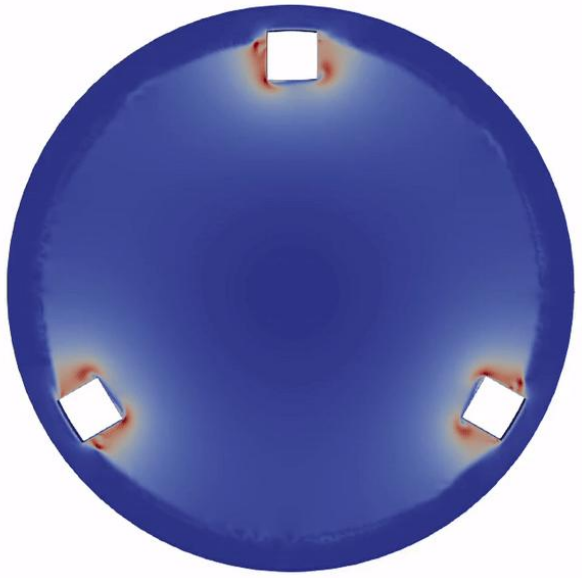
There are multiple possibilities to describe the rotational movement of the blades inside the WFE; Two were studied, a **dynamicMesh** approach and a **MRF** approach. The MRF was ultimately chosen:

- A single cell group was defined has the rotating zone, while the outer wall was excluded from the cell group;
- Rotation velocity was constant and defined as 60 rpm;

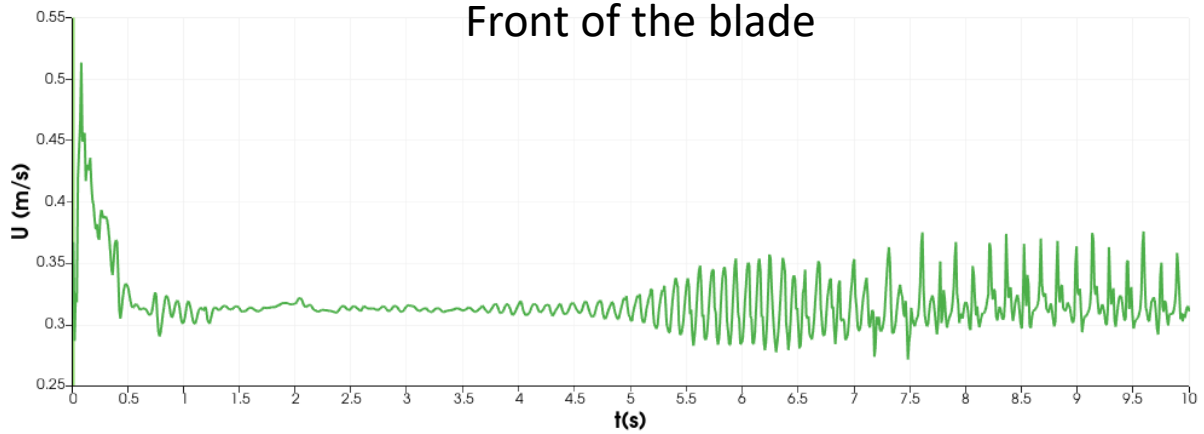
The turbulence model chosen was the *k*-*ω* SST;

Post Processing

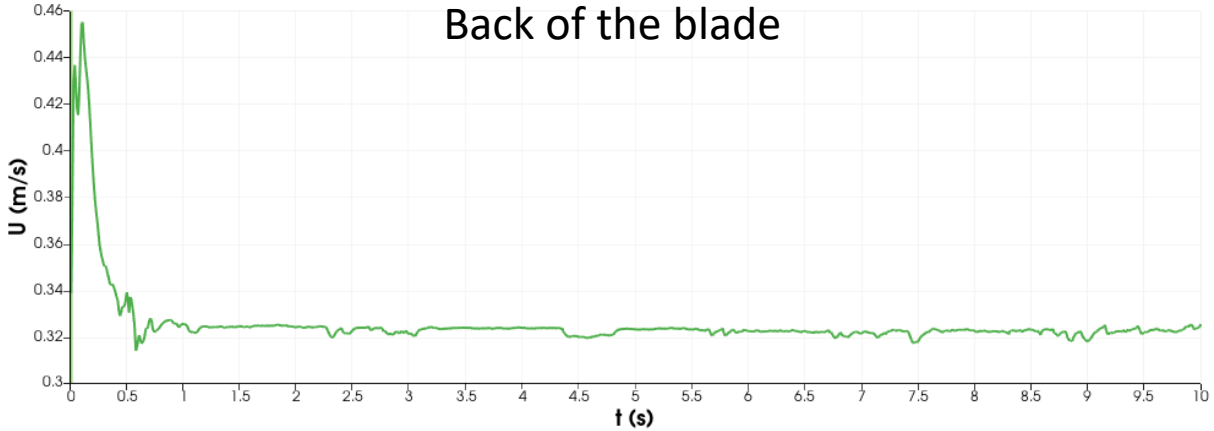




Front of the blade



Back of the blade



Future Works

Refine the geometry so that it better resembles the lab scale evaporator;

Fulfil the remaining steps towards the final model;

Develop a multiphase SRF solver, and compare with the results obtained from MRF using interFoam;

Gather experimental data to consolidate the CFD model;

Formulate a scale up procedure;

Thank you for your time !

Acknowledgements

The authors thank financial support from Project “CiNTech - Technological Hub for Innovation, Translation and Industrialization of Complex Injectable Drugs” (reference: 7131), in the scope of PRR - Recovery and Resilience Plan and by the Next Generation EU European Funds, following NOTICE No. 02/C05-i01/2022, Component 5 - Capitalization and Business Innovation - Mobilizing Agendas for Business Innovation.