Coupling fluid-solid-porous mechanics in transient regimes

R. Mezher*, N. Moulin, J. Bruchon, and S. Drapier

SMS Division & LGF UMR CNRS 5307
Mines Saint-Etienne - Université de Lyon
158, Cours Fauriel, CS 62362, 42023 Saint-Etienne cedex 2, France
e-mail: *rabih.mezher@emse.fr, nmoulin@emse.fr bruchon@emse.fr and drapier@emse.fr

ABSTRACT

Composite materials have become a growing need in aeronautic industry. Infusion-based processes are considered for manufacturing composite structures [1]. This work is part of the *Hexcel-Mines Saint-Etienne Chair for Advanced Numerical Modelling of Infusion-based Processing for New Generation Composite Structures* aiming at modelling the infusion processes in a High Performance Computing framework.

Modeling these processes consist in coupling fluid, solid, and porous mechanics in isothermal conditions as depicted in Figure 1. First, two fluid flow regimes are coupled (1), representing the resin flow in both a highly permeable distribution medium (Stokes) and low permeability ($\propto 1E^{-15}m^2$) fibrous orthotropic preforms (Darcy). This coupling is achieved with efficient ASGS stabilized monolithic finite element formulations. Second, weak coupling algorithms are used along for coupling solid / fluid mechanics (2) in the wet preforms at both macro and micro scales, and for the fluid / level-set problems (3) - (4). The level-set aproach used to capture the flow front will rely on the physical velocity, computed from the Stokes-Darcy problem on a fixed grid, to evaluate the flow front motion. The level-set is also coupled with the nonlinear solid mechanics by updating the properties and receiving the corresponding displacement (5).

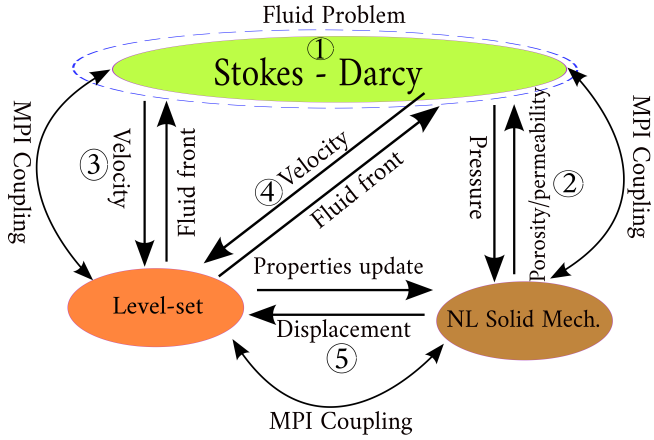

Figure 1: Coupling transient fluid-solid-porous mechanics

To minimise computation time, multi-core processors are used. To transfer the different parameters of the problem through the communicating processors, Message Passing Interface (MPI) environment is chosen [2]. MPI is a standardized and portable message-passing system designed to function on a wide variety of parallel computing architectures [3]. A first attempt is made to couple the fluid mechanics with a level set function, or with the solid mechanics. Compared with other classical methods, the calculation time is found to be the most reduced with MPI.

REFERENCES

[1] Blais, M. and Moulin, N. and Liotier, P. J. and Drapier, S., Resin infusion-based processes simulation : coupled Stokes-Darcy flows in orthotropic preforms undergoing finite strain, *Int. J. Mater. Form.* (2015) 1-12.

[2] J. D. Garaud, Développement de méthodes de couplage aéro-thermo-mécanique pour la prédiction d'instabilités dans les structures aérospatiales, PhD Thesis, UPMC, (2008).

[3] Open MPI: Open Source High Performance Computing, www.open-mpi.org.