Extended Physics Modeling of the Resin Flow During Vacuum Infusion Processes

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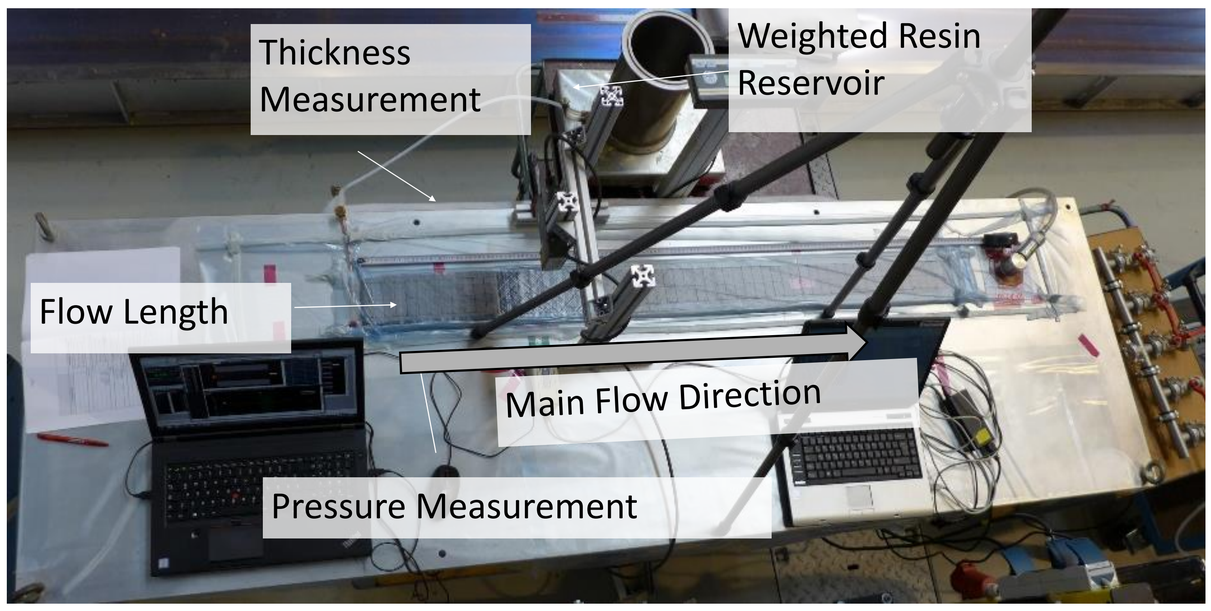

Figure 1. Experimental setup

Introduction: At the resin infusion process a dry preform is impregnated by a pressure gradient driven flow front. This process is used for production of structural composite parts, e.g. for aerospace industry. COMSOL Multiphysics® is used for simulation of the resin flow. Figure 2 shows the setup of flow experiments for process data generation and comparison with simulations.

Results: With the implementation of pressure gradient depending on flow front, simulation of flow behavior can be predicted precisely. Figure 2 and 4 show the results

Computational Methods: The pressure gradient is calculated by Darcy's law which is extended by a storage model. The position of saturated and dry areas is tracked by a level set model.

Coupling of the storage factor with the fluid saturation determined by the level set model allows calculation of pressure field depending on resin front position. Figure 3 shows the resulting flow front. Expression for fluid compressibility is 1E-3[1/Pa]*ls.Vf1.

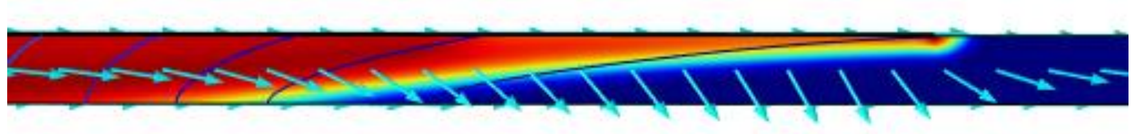

Figure 3. Flow front, pressure gradient and normalized direction of velocity at flow front

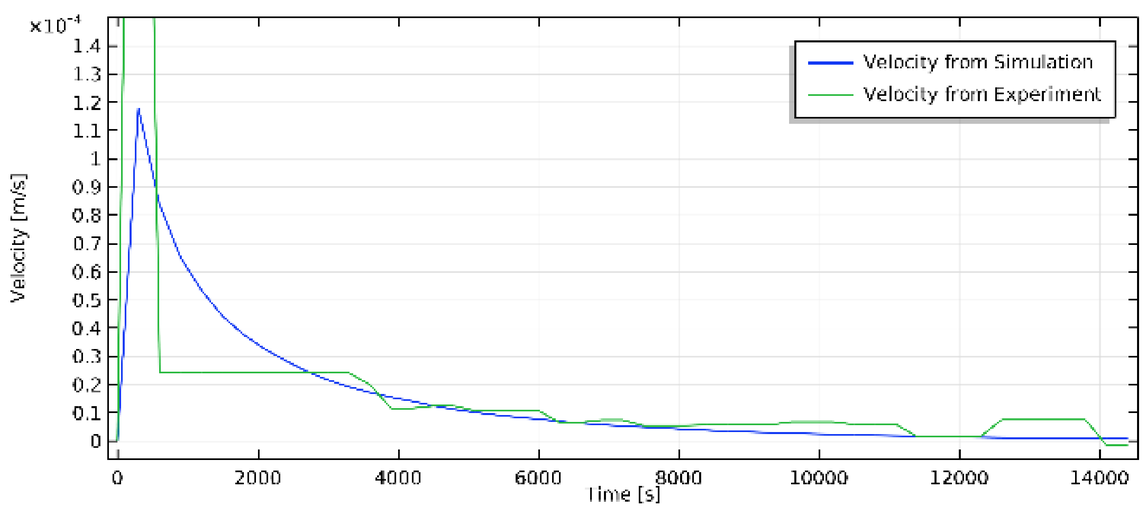

Figure 4. Flow velocities from experiment and simulation

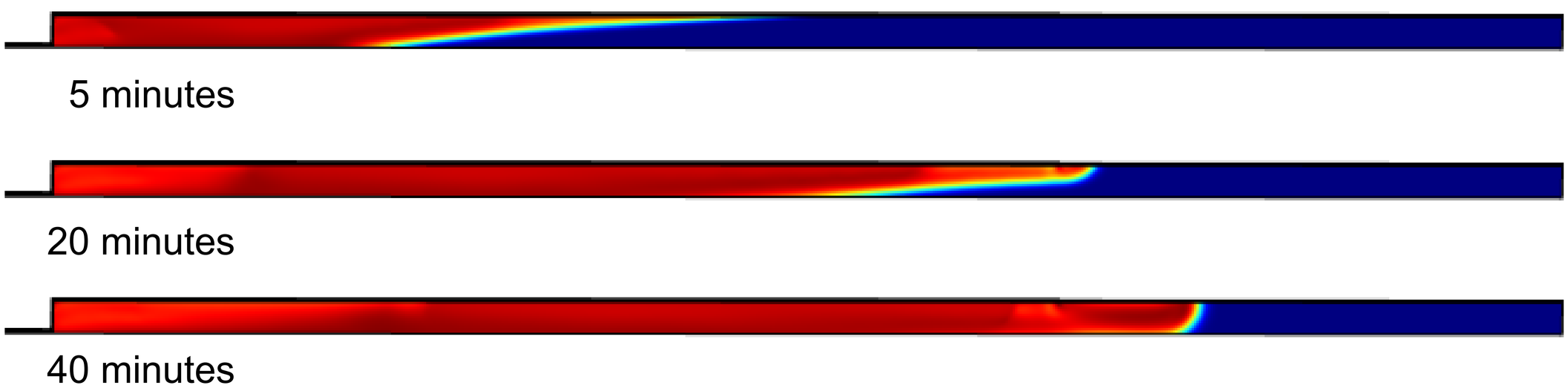

Figure 2. Flow front at different time steps

Conclusions: It could be demonstrated that combination of Subsurface Flow and Level Set interface allow to reproduce the practical experiments of the vacuum assisted process. For robust simulation of resin filling process of larger and complex parts a more stable level set function or alternative flow front tracking method has to be implemented.