Multiscale CFD simulation of impregnation die for unidirectional composites production: Impregnation rate and permeability with moving tow

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The permeability of a porous bundle of carbon fiber filaments and the impregnation rate of resin are important factors of impregnation process of uni-directional carbon fiber composites (UD-CFC). Although the permeability of a porous medium can be theoretically determined by Darcy's law, it is lack of knowledge for the permeability of a moving porous medium which happens in UD-CFC impregnation process. In this study, effects of the microscale structure and moving speed of the carbon fiber bundle on the permeability and impregnation rate were investigated in the presence of initial volatile and polymer matrix by using computation fluid dynamics (CFD). A representative element volume (REV) including the microscale CF filaments structure was constructed to measure the permeability of resin to the CF filaments. The average permeability calculated in the microscale CFD was used in the macroscale CFD for the porous media impregnation of resin. A linear relationship between the average permeability and the tow moving speed was found in the microscale CFD.