S2.3.1 Computing Flow Properties of Nonwovens using a 3D Novel Parametric Model in Compression and Stress Free State

Emrah Sozumert[1]¸ Emrah Demirci[1], Martin J Lehmann[2], Memis Acar[1], Behnam Pourdeyhimi[3], Vadim V. Silberschmidt[1]
[1]Wolfson School, Loughborough University, [2]MANN+HUMMEL, [3]The Nonwoven Institute, North Carolina State University

Design process of nonwoven materials in the light of their ultimate use is troublesome and challenging due to their complex microstructure composed of randomly distributed and curved fibres. Within the design process, numerical tools, such as, Finite Element Analysis and Computational Fluid Dynamics, are facilitated to predict their mechanical performance under service conditions before manufacturing them. This paper presents a computational and experimental framework to compute flow properties of various nonwovens with various microstructural control parameters in compression and free stress state, i.e., no compression.

Randomly distributed fibre-networks with microscopic properties, such as, fibre curvature were generated through a novel parametric 3d finite element model. This novel model was implemented for through-air bonded nonwovens in this research and fibre-to-fibre interactions were incorporated. In order to compute the effect of microstructural changes due to compression on flow properties such as pressure drop and air permeability, the nonwoven networks were compressed within the framework of finite element. Subsequently, their compressed and stress free forms were converted to cad formats to be utilized in the preparations of CFD simulations. Computational model was validated through permeability test results in good correlations. Furthermore, the novel parametric model enabled to investigate the influence of isotropic/anisotropic fibre diameter distributions and imperfections on fibre cross-sections.