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Modeling of pneumatic melt spinning processes

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Computer simulation of pneumatic processes of fiber formation from crystallizing polymer melts will be presented. Dynamics of air drawing of thin polymer streams in the "melt blown" technology, as well as in a supersonic air jet in the Laval nozzle will be discussed. In the melt blowing processes, two convergent high-velocity jets of hot air are blown from rectangular air slots on both sides of a longitudinal spinning beam onto a single row of polymer filaments. In the supersonic process, cold air is compressed to the Laval nozzle where it is strongly accelerated to a supersonic velocity and the row of the polymer streams undergoes fast air drawing, coaxially with the air jet, to super-thin fibers [1].

The air flow field is simulated with the aid of k-ε turbulence model for the "melt blown" method and the distribution of the air velocity, temperature and pressure along the axis of the pneumatic melt spinning are determined [2]. For the process with the Laval nozzle, the air flow takes place with a high Reynolds number and the k-ω model is used which considers kinetic energy of the turbulent flow and a specific dissipation rate of the air kinetic energy. The air fields are determined for several values of the initial air velocity, or of the initial air pressure in the Laval nozzle, at the absence of the polymer streams. The fields are considered as predetermined air conditions for the air-drawing process.

A single-, thin-filament model of stationary melt spinning is used for simulation of the pneumatic processes where the dynamics of air-drawing of the polymer filament is controlled by the axial distribution of the air velocity, temperature and pressure [3-5]. In the pneumatic processes of non-woven formation usually a single row of thin polymer streams is extruded from a longitudinal spinning beam. In such processes each filament can be considered as an individual stream non-interacting with the neighboring filaments, and the air jet – as undisturbed by the presence of the row of polymer streams.

Effects of non-linear viscoelasticity, important for fast flow deformations of polymer melts is accounted for, as well as non-linear stress-orientation relationship and fast on-line stress-induced crystallization of the filament. Example computations and the discussion concern formation of polypropylene non-wovens.

References

[1] Gerking, L. *Chemical Fibers Internat.*, **2002**, *6*, 424.
[2] Zachara, A.; Lewandowski, Z. *Fibers Textiles Eastern Europe*, **2008**, *16(4)*, 17.
[3] Ziabicki, A.,; Jarecki, L.; Wasiak, A. *Comput. Theoret. Polymer Sci.*, **1998**, *8*, 143.
[4] Jarecki, L.; Ziabicki, A. *Fibers Textiles Eastern Europe*, **2008**, *16(5)*, 17.
[5] Jarecki, L.; Ziabicki, A.; Lewandowski, Z.; Blim, A. *J. Appl. Polymer Sci. (in press).*