

February 7, 2006
SCO (Shirai Consulting Office)
T. Shirai
E-mail: t_shirai@mvf.biglobe.ne.jp

Abstracts of Fiber Formation Articles^{*}

Chapter 18. Melt Spinning

[Simulation Analysis for Polymer Processing by PC (11), Japan Plastics, Vol.50, No.8, P.95 (1999)]

Melt spinning, which is the fiber formation process of PET, Nylon, PP etc., sometimes does not categorized as polymer processing, but analogous concepts of the melt spinning theory can be applied when analyzing some kinds of polymer processing too.

Many Japanese researchers have been contributing to the melt spinning theory from many phases.

Kase and Matsuo did pioneering works of melt spinning theory [1], [2], [3], and Hamana et al. [4], [5] refined the theory. They paved the way of applying the theory for practical uses.

These theories were developed for steady-state single-filament spinning. In succession to these theories, many extended theories, e.g. steady-state multi-filament theory by Yasuda et al. [6], were published.

In this chapter, steady-state single-filament theory for PET spinning by George [7], which is said to be applicable to a fairly wide range of spinning speed, is brought up and the theory, its simulation program and calculation example are described in detail. Furthermore, modified theory for PP spinning based on George's is mentioned.

[1] Kase,S. & Matsuo,T., J. Polym. Sci., Part A3, 2541 ('65)

[2] Kase,S. & Matsuo,T., Sen-i Gakkaishi, 18, 188 ('65)

[3] Kase,S. & Matsuo,T., J. Appl. Polym. Sci., 11, 251 ('67)

[4] Hamana, I. et al., Malliand Text., 50, 382 ('69)

[5] Hamana, I. et al., Malliand Text., 50, 499 ('69)

[6] Yasuda, H. et al., Sen-i Gakkaishi, 40 (7), T-227 ('84),

* This collection of abstracts is written in English, but original articles are written in Japanese.

[7] George, H. H., Polym. Eng. Sci., 22 (5), 292 ('82)

Dry Spinning Simulation

[Computer Simulation of Dry Spinning, Japan Plastics, Vol.57, No.2, P.87 (2006)]

Dry spinning has long been used for producing acetate, acrylic, spandex filaments etc., along with melt spinning and wet spinning,

When filaments are dry-spun, viscous solution from polymer and solvent is extruded through fine holes into hot gas to evaporate the solvent, and solidified into filaments.

To analyze the dry spinning process, it is necessary to consider heat balance, mass balance and momentum balance at the same time. It can be said that dry spinning is a sophisticated and complicated phenomenon to simulate.

Dry spinning theory by Ohzawa et al. [8], [9], [10], [11] was epoch-making one, and ensuing researches seem to be done based on this theory.

Theory and simulation in this article are based on the theory of Ohzawa, but the present writer makes some refinements in preciseness. Points of the refinements are the introduction of solvent content distribution and elongational viscosity distribution inside a filament, and the introduction of heat balance and mass balance of drying gas as most dry spinning processes adopt parallel gas flow to the yarn path in spinning tubes.

This article explains the refined theory, its simulation program, calculation example etc. in detail.

[8] Ohzawa, Y., Nagano, Y. and Matsumoto, T., J. Appl. Polym. Sci., 13, 257 ('69)

[9] Ohzawa, Y. and Nagano, Y., J. Appl. Polym. Sci., 14, 1879 ('70)

[10] Ohzawa, Y., Macromolecule (Japan), 19 (222), 790 ('70)

[11] Ono H. and Ohzawa, Y., 'Sen-i no Keisei to Kouzo no Hatsugen (written in Japanese; 'Fiber Formation and Structure Generation of Fibers') (III), P.157, Kagakudojin ('71)