Prediction of Deformation Behavior of Film during Transverse Stretching with Consideration of Heated Air Flow in a Tenter

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The deformation behavior of polypropylene (PP) film during transverse direction (TD) stretching with a tenter was newly predicted under consideration of heated air flow in a tenter in order to obtain the more realistic heat transfer coefficient than that in the previous works based on an impinging jet model or a wall jet model. The heated air flow in a tenter was analyzed with a finite volume method in order to calculate the distribution of heat transfer coefficient on film. The distribution obtained has been confirmed to be more realistic than that in the previous works. The film thickness and the bowing distortion after stretching were analyzed by applying the distribution of heat transfer coefficient based on air flow analysis under the assumption that the deformation of film obeys an elastic-plastic rule. The film deformation behavior such as film thickness distribution, the bowing distortion and the successive distortion patterns of the drawn line on film both machine direction (MD) and TD was experimentally measured with a pilot plant. It has been shown that the experimental results with a pilot plant agree better with the calculated results in this work based on the distribution of heat transfer coefficient obtained from air flow analysis than the previous works based on that obtained from an impinging jet model or a wall jet model, especially under higher line speed. It is revealed that the distribution of heat transfer coefficient has a strong influence on the difference of film temperature and the difference of longitudinal force, and results in the difference of uniformity of film thickness and the bowing distortion.