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ANALYTICAL MODELS FOR THE SIMULTANEOUS INFLATION AND EXTENSION OF A POLYMERIC TUBE

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Elongation flows occur in many industrial processing operations and particulary in the injection stretch/blow molding process of P.E.T. bottles (1). In a previous paper (2), numerical simulations of this process were presented using the finite element method in the case of Oldroyd B constitutive equations. In addition, the capabiliy of setting up analytic models for the inflation and extension of a viscoelastic tube is of prime interest.The development of such analytical models allows us to validate finite element simulations, to demonstrate the influence of the process and rheological parameters, and to compare the solutions calculated using a volumic approach and the thin shell assumption.

The simplified geometry of stretch/blown bottles is presented in fig. 1.There is a perfect sliding contact between the tube and the two planes which means that the part will always remain a tube. A constant elongation velocity v_0 is prescribed on the lower plane and the *upper one has no displacement in the vertical direction. A differential inflation pressure* ΔP is applied to the inner surface of the tube.The tube is assumed sufficiently long so that end effects may be neglected.

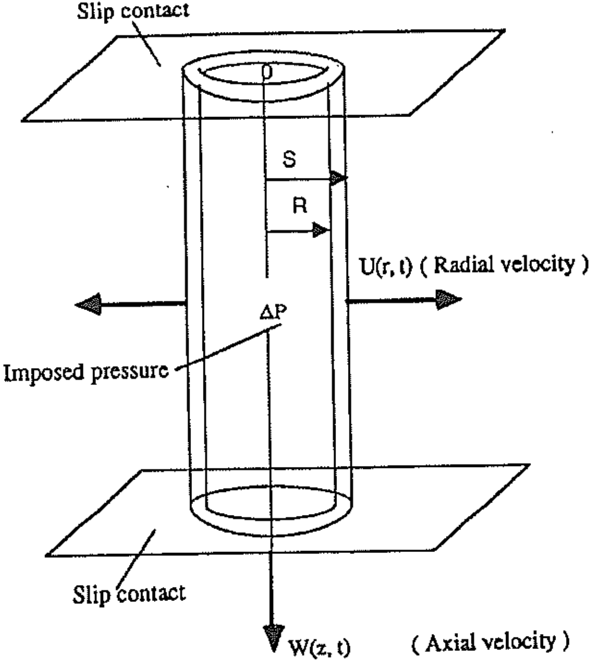

Fig. 1: Simultaneous inflation and extension of a tube

The simplest integral model that integrates both viscous and elastic phenomenon is Lodge's model (3), which is mathematically equivalent to Maxwell's differential model. Using a volumic approach, this model permits only a "quasi-analytical" solution for the inner radius R(t). Fig. 2 shows that the agreement is particulary fair between finite

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element simulation and "quasi-analytical" computed adimentionnal radii, this for three values of elongation velocity v_0.

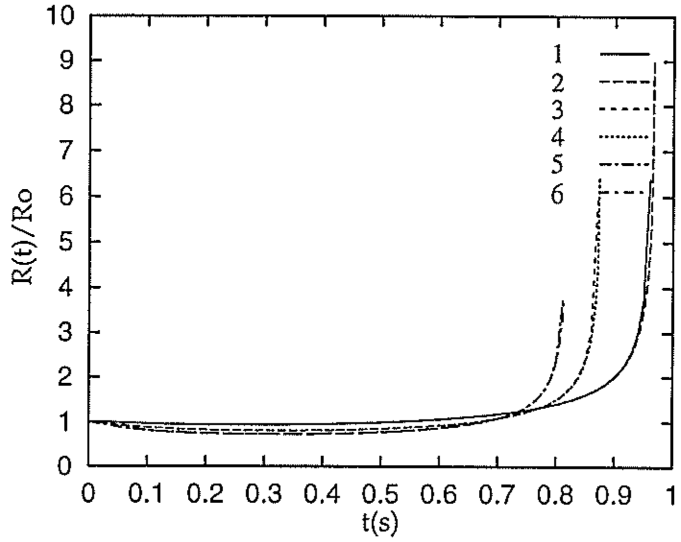

Fig. 2: Dimensionless radii as a function of time
(v_0 = 0.4 m/s - 1:Analytical Solution ; 2:Computed) ; (v_0=0.8 m/s - 3:A.S. ; 4:C.)
(v_0=1.2 m/s - 5:A.S. ; 6:C.)

In fig. 3 the adimensionnal radius is plotted for different values of the relaxation time λ. Note that for high values of λ, the kinematic of blowing is no more influenced. Further results have been obtained with thin shell assumption which allows to elaborate an analytical solution.

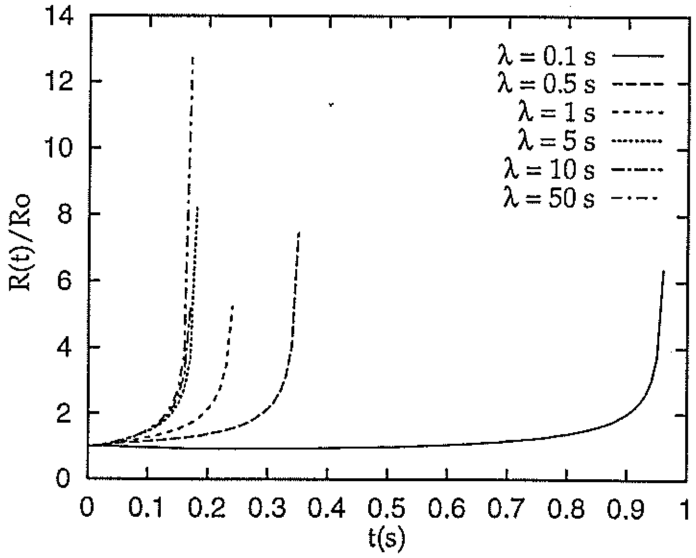

Fig. 3: Dimensionless radius as a function of time

REFERENCES

(1) Rosato D. V., Blow Molding Handbook, Ed. Carl Hauser, New-York, 1989
(2) F. M. Schmidt, J. F. Agassant, M. Bellet and L. Desoutter, "Viscoelastic Simulation of P.E.T Stretch/Blow Molding", accepted in J. of Non-New. Fluid Mech., December 1995
(3) Lodge A. S., Elastic Liquids, Academic Press, New York, 1964