MODELLING OF SLIT DEVOILATILIZATION OF POLYMERS

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ABSTRACT

A new technique of polymer devolatilization, where the polymer-volatile solution simply flows through a heated slit, is modelled. We assume that the mass transfer is linear in the driving force, and that lubrication theory [1] can be applied to the gas phase; a strong hypothesis on the pressure gradient is also made. For some operating conditions a good agreement is found with experimental results. An initial tentative argument about cyclic behaviour, as observed experimentally, is presented.

INTRODUCTION

A new static devolatilization technique, which overcomes the problem of long residence times of the polymer at high temperature, is recently being developed. In this process the separation takes place during the passage of the polymer solution through a heated slit. Fig.1 shows the scheme of the system considered and the coordinates chosen.
A ZERO ORDER APPROACH TO MODELLING

The basic assumption of our model is that the evaporated gas forms two channels, of thickness $h(z)$, which separate the polymeric phase from the slit walls.

If the lubrication approximation holds for the gas phase, the momentum balance is:

$$-\frac{dp}{dz} = \frac{12\mu G}{\rho_g h^3}, \quad z=0 \quad p=p_0$$

where $p$ is pressure, $G$ the gas mass flow rate per unit width, $\rho_g$ the density and $\mu$ the viscosity of the gas.

Since the heat diffusion time in the polymer is significantly less than the residence time in the slit, at a zero order level of approximation it is reasonable to assume that the polymer temperature $T$ is, at the slit entrance itself, equal to the wall temperature $T_0$. Since heat transfer is by conduction through the gas layer, the heat balance is:

$$\frac{dT}{dz} = M \frac{(T_0 - T)}{h} - N \frac{dG}{dz}, \quad z=0, \quad T=T_0$$

where $M=K_g/(c_{pol}G_{pol})$ and $N=\lambda/(c_{pol}G_{pol})$ with $K_g$ the gas conductivity, $c_{pol}$ and $G_{pol}$ the polymer specific heat and mass flowrate per unit of slit width, respectively, and $\lambda$ the volatile latent heat.