INTRODUCTION

The flow through a two-dimensional orifice, i.e., a slit plate, in a two parallel plate channel involves two flow geometries of conversion and diversion. Both of them are widespread and important in the polymer processing of extrusion and injection mouldings. Therefore, there has been much discussion. Giesekus\textsuperscript{1,2} paid attention to the remarkable difference in the flow pattern between the converging flow and the diverging flow although the corresponding, creeping flow of a Newtonian fluid has a symmetric flow pattern on both the sides of the orifice plane. That asymmetry is one of the characteristic features of viscoelastic behaviors, as is also seen in the flow past a sphere.\textsuperscript{3} Most existing studies have been directed to the converging, entry flow in connection with the elongational flow, but the diverging, exit flow is also important. Thus, it would be interesting to correlate the pressure drop with the related flow pattern in each flow region, or, at least, to divide the additional pressure drop due to the existence of the orifice plate into the entrance and exit portions, if possible. Further points to be made clear are the difference in the pressure drop between the 2-dimensional, plane flow through a slit plate and the 3-dimensional, axisymmetric flow through an orifice, the critical condition for the onset of the steady oscillating flow, its period, and the change in the pressure drop with the onset of viscoelastic flow disturbances. The present work will be more or less concerned with these points.

AN EXPERIMENTAL STUDY ON FLOW PATTERNS

The flow visualization experiments were performed in a vertical
channel of a 10×15 cm² rectangular cross-section and 230 cm height. It was equipped with a head tank of a 30×30 cm² cross-section at the top and a bulb controlling the flow rate at the bottom. The duct in the test section had a slit plate of 1 cm thickness with a slit of 15 cm in length and six different width (h₀=0.043, 0.065, 0.108, 0.211, 0.494 and 1.00 cm), which is illustrated in Fig. 1. Sodium polyacrylate aqueous solutions of 0.3, 0.5, and 0.75 wt% were used. The flow was visualized by fine aluminium dust.

One example of the photographs, which were taken at the vertical center plane, is shown in Fig. 2. The flow patterns are similar to those reported by others. There is an elongational flow with secondary vortices in front of the slit plate and a radial flow behind it. The vortex length data are presented in Fig. 3. Here, the characteristic quantities are defined at the slit and designated by the

\[ \begin{align*}
\epsilon &= \frac{h_0}{H} = \frac{A_0}{A} \\
X &= \frac{L}{H} \\
W_s &= \lambda \bar{u}_0 / h_0 \\
R_e &= h_0 \bar{u}_0 \rho / \eta \left( \dot{\gamma}_w \right)
\end{align*} \]

\[ \lambda = (\tau_{11} - \tau_{22}) / 2 \dot{\gamma}_w \]  \[ \dot{\gamma}_w = \left( 2 \bar{u}_0 / h_0 \right) (2n+1) / n \]

\[ Q = \bar{w} \bar{u}_0 h_0 = \bar{W} H \]

Fig. 1. Test Section with a Slit Plate.

Fig. 2. Steam Pattern of Stable Flow

Fig. 3. Vortex Length