EXTRUSION OF 7075-O ALUMINUM AND AISI 4340 STEEL TUBING

Billet Surface Finish: 25-100 μin.
Diameter of Mandrel: 0.7485 in. at top
0.7395 in. at bottom

Extrusion Pressure, 1000 psi				Length of Extrusion, in.	Comments
Breakthrough		Runout			
Stem	Fluid	Stem	Fluid		
Aluminum					
49	48	50	48	12-7/8	No P_b peak; uniform P_r
51	49	48	47	11	Very slight P_b peak followed by uniform P_r
33	30	32	29	6-7/8	Slight P_b peak followed by slight stick-slip
178	161	--	--	4	P_b not reached; stopped at indicated pressure
4340					
162	151	160	149	12-3/4	Slight P_b peak followed by uniform runout
240	209	232	202	5-1/2	Slight P_b peak followed by severe stick-slip
163	149	--	--	1-1/2	P_b not reached; stopped at pressure indicated
164	149	146	129	4-3/4	Moderate P_b peak followed by severe stick-slip

Two extrusion ratios were attempted in re-extruding tubing--3.2:1 and 12.9:1. At the lower ratio (Trial 385), approximately 7 inches of 0.056-inch-thick-wall tubing with excellent surface finish was produced. The cumulative reduction (Trials 351 and 385) in producing the tubing is 91 percent.

In Trial 384, re-extrusion at a ratio of 12.9:1 was attempted. A short length of high-quality 0.22-inch-wall tubing was produced. Here, the cumulative area reduction (Trials 351 and 384) was 97.6 percent. While the fluid-pressure versus ram-travel curve for this trial did not indicate a sharply defined extrusion breakthrough, it did show that a significant displacement of the billet had occurred. Upon removal of the extrusion from the container, it was found that the billet had not only extruded, but had also uniformly upset from about 1.1 to 1.5 inches in diameter. Upsetting apparently occurred because of an additional end load on the billet resulting from the unsupported area of the floating mandrel (see Figure 1). This caused an end pressure on the billet that exceeded the fluid pressure by roughly the compressive flow strength of the billet material. Other factors such as mandrel friction would probably influence the end pressure at which billet upsetting would occur. It can be seen from Figure 1 that the billet-end pressure exceeds the fluid pressure, p, by

$$\frac{p A_m}{A} ,$$

where

A_m = the mandrel cross-sectional area

A = the billet cross-sectional area.

The influence of extrusion ratio on the extrusion runout pressure for 7075-0 aluminum tubing is shown in Figure 2. Two curves are shown. One gives the measured fluid pressure, and the other shows the billet-end pressure, which, in fact, is the "effective" extrusion pressure. Extrapolation of the fluid-pressure curve shown indicates that 7075-0 aluminum tubing can be produced with the present tooling at extrusion ratios up to about 100:1, provided (1) lubrication is adequate at the higher ratios or (2) the unbalanced pressure, $\frac{p A_m}{A}$, is not greater than about the compressive yield strength of the material.

AISI 4340 STEEL

Table 3 lists the extrusion data obtained in the hydrostatic extrusion of tubing from AISI 4340 steel. In two trials, extrusion ratio and stem speed were investigated.

At an extrusion ratio of 3.8:1, 0.18-inch-thick wall tubing was produced at an exit speed of 140 ipm (Trial 389). At a higher extrusion ratio of 5.7:1 (Trial 391), 0.125-inch-wall tubing was produced at an exit speed of 63 ipm. Further trials will be made in this case, however, in an attempt to eliminate stick-slip during runout.