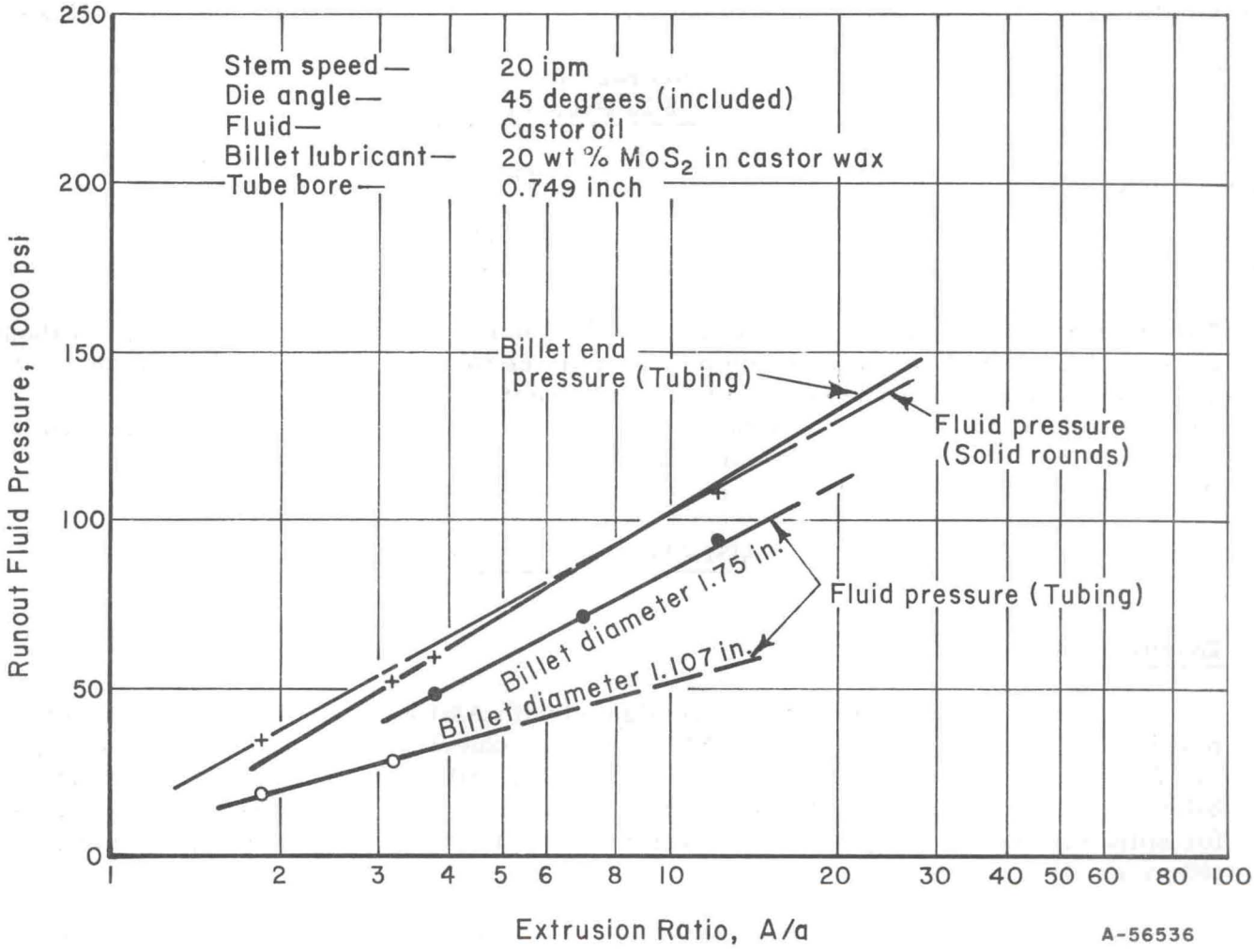

FIGURE 28. EFFECT OF EXTRUSION RATIO ON PRESSURE FOR COLD HYDROSTATIC EXTRUSION OF 7075-O ALUMINUM TUBING AND ROUNDS

Effect of Stem Speed

At a ratio of 12.2:1, where severe stick-slip was found to occur on runout, stem speeds over a range of 1-80 ipm were investigated with the aim of obtaining smooth runouts. In the extrusion of 7075-O solid rounds it was found that stick-slip on runout could be eliminated by increasing stem speed. The data in Table XXIX for Trials 332, 334, 335, and 350 indicate that stick-slip occurred even at the highest stem speed of 80 ipm. That stem speed produced an extrusion exit speed of 173 fpm. However, the amplitude of stick-slip was found to decrease with increases in stem speed as follows:

Stem Speed, ipm	Average Amplitude of Stick-Slip Pressure Cycles, psi
1	49,000
6	42,000
20	33,000
80	15,000

This indicated that a higher stem speed resulted in more efficient lubrication. Perhaps the techniques and lubricants developed later in the program, such as the compound angle nose and the stearyl-stearate based lubricants, which were so successful with 7075-O solid rounds, would eliminate the stick-slip tendency and perhaps even permit higher ratios to be achieved without billet upsetting.

AISI 4340 Steel Tubing

Extrusion Ratio

The range in extrusion ratio investigated with AISI 4340 steel tubing at room temperature was 2.6 to 5.7:1. Table XXIX gives the experimental data obtained and Figure 29 compares pressure requirements for tubing with those for solid rounds. The billet-end-pressures for tubing were about six percent higher than the fluid pressures for solid rounds. The higher pressure requirements for extruding tubing were attributed to mandrel friction.

Again, the advantage of the floating-mandrel arrangement is seen in the lower fluid pressures required for a given ratio compared with those required for solid rounds. Within the 250,000 fluid pressure capacity of the tooling, it is estimated from Figure 29 that a ratio of 8:1 should be possible, assuming adequate lubrication can be maintained. (This represents a single-pass tube wall reduction from 0.500 inch to 0.17 inch for a tube with a 3/4-inch bore tube.) In a single attempt to extrude tubing at a ratio of 7:1 (Trial 357), however, breakthrough was not achieved at a fluid pressure of 250,000 psi. Probably the billet lubrication broke down in this case since, even at the lower ratio of 5.7:1, some lubrication breakdown occurred on runout causing stick-slip to occur.

Lubrication

Two billet lubricants were evaluated for tubing, L17 and L48. Both lubricants provided good lubrication at a ratio of 3.8:1. The products obtained at this extrusion