TABLE 2. EXPERIMENTAL DATA FOR COLD HYDROSTATIC EXTRUSION OF 7075-0 ALUMINUM AND DISPERSION-HARDENED ALUMINUM

Die angle – 45 degrees (included) Billet surface finish – 60-100 microinches, rms
Fluid – Castor oil

Trial	Objective or Variable	Extrusion Ratio	Stem Speed, ipm	Billet Nose Design[a]	Billet Lubricant	Extrusion Pressure, 1000 psi: Breakthrough Stem	Breakthrough Fluid	Runout Stem	Runout Fluid	Type of Curve, p 25	Length of Extrusion, inch	Comments
					7075-0 Aluminum Rounds							
472	Stop-start investigation	20	20	S	L53	156	135	138	121	B2	65	Stopped after partial extrusion. Restarted extrusion after 10 sec
						211	172	--	--	D2		
470	Reference trial	40	20	C, A = 0.75 in.	L53	168	150	154	137	C2	140	Interim Report VIII
473	Lubricant	40	20	C, A = 0.75 in.	L52	177	157	149	143	B2	120	
474	Ratio	60	20	C, A = 0.70 in.	L52	192	178	175	153	B2	200	
504[b]	Ratio	200	6	C, A = 0.3 in.	L53	210	189	--	--	C4	49	
					7075-0 Aluminum T-Sections							
488	T-Die design	7.3	20	S	L53	120	105	108	99	D1	25	
					Re-extrusion of 7075-0 T-Sections							
482	Re-extrusion	2	20	S	L17	--	34.5	--	--	--	1-1/2	Leaked
507	Re-extrusion	2	6	S	L17	42	40.5	--	--	--	14	Woods metal aided sealing
489	Re-extrusion	4	20	S	L53	75	73.5	55	52.5	D2	24	Woods metal aided sealing
					Dispersion-Hardened Aluminum							
475	Ratio	10	20	S	L53	104	99	99	92	B2	20	
476	Ratio	20	20	S	L53	156	139	135	117	B2	20	
490	Ratio	40	20	C, A = 0.75 in.	L53	221	202	--	--	C4	1/2	

(a) S - Standard nose. C - compound-angle nose, 45 degrees at apex, 30 degrees beyond diameter A in.
(b) Billet diameter 1.414 in., die orifice 0.10 in diameter.

to the sandwich-billet and to the joint interfaces. The extrusion data are contained in Table 2.

At ratios of 10 and 20:1, the whole billet was extruded in one piece. While the extruded products were craze cracked at the beginning, the remainder appeared to be sound. The extruded products were returned to ORNL for further evaluation. At 40:1, the lubricant film apparently broke down resulting in seizure at the die-billet interface after extruding about 1/2 inch of product. The 7075-0 aluminum nose had extruded satisfactorily. The discontinuity at the joint may have contributed to the failure of the lubricant film.

The runout pressure levels obtained at 10 and 20:1 ratios were marginally lower than those obtained with 7075-0 aluminum. The breakthrough pressures were probably influenced by the joint with the leading 7075 aluminum billet. It is noteworthy that at both these ratios, the rear part of the sandwich billet failed to extrude and seized at the die interface. This is believed to be due to compaction of the sintered aluminum which was initially 85 percent dense. The compaction probably left a protruding edge of 7075 aluminum on the rear billet which caused metal-metal contact and hence seizure.

HYDROSTATIC EXTRUSION AND COMPACTION OF Ti-6Al-4V TITANIUM ALLOY

The experimental data for hydrostatic extrusion of Ti-6Al-4V rounds and tubes are given in Table 3. Data previously reported are also presented for comparison purposes. In addition to the hydrostatic extrusion trials, several hydrostatic compacts of Ti-6Al-4V alloy powder were produced.

Rounds

In previous hydrostatic extrusions of Ti-6Al-4V at a ratio of 4:1 (Trial 193[1] and Trial 376[7]), severe stick-slip occurred and, in one instance, transverse cracking occurred in the areas of sticking during stick-slip. In Trial 487, stick-slip was completely eliminated and an excellent surface finish without surface cracks was obtained. This improvement is attributed partly to increasing the stem speed from 6 to 20 ipm and partly to using a compound-angle nose on the billet. Both of these factors apparently also contributed to a 6-7 percent lowering of breakthrough and runout pressures.

The pressures obtained at room temperature were further reduced by about 10 percent by extruding at 400 F, where the only difference in conditions was, of necessity, the billet lubricant and fluid. At this temperature, the anodized coating (C3) was used for the first time (Trial 496). The data for Trial 416 conducted previously at 400 F is given for comparison. The pressures for Trial 496 were only marginally lower than for Trial 416 (by about 3 percent), and there was no difference in the surface finish of the products, both being excellent. The coating, higher stem speed, and compound nose in Trial 496 appeared to have had only marginal effect on pressure levels. It is believed that Lubricant L33 (55 wt% MoS_2 and 6 wt% graphite in sodium silicate) was largely responsible for the good surface finish and smooth runout conditions obtained at 400 F.