HYDROSTATIC EXTRUSION OF AISI 4340 STEEL ROUNDS

Billet Surface Finish: 60-120 μin., rms

1000, psi Runout		Length of Extrusion,	
Stem	Fluid	in.	Comments
197	194	13-1/4	Slight P_b peak; uniform P_r
233	206	8	Moderate P_b peak; apparent stick-slip followed by die-seal failure
222	197	14-3/4	Slight P_b peak; uniform P_r followed by stem-seal failure
--	--	13/16	P_b not reached; stopped at indicated pressure
185	197	14-1/4	Very slight P_b peak; uniform P_r
190	186	11-3/4	Slight P_b peak; uniform P_r
197	203	5	Slight P_b peak; uniform P_r followed by die seal failure
189	197	12-3/4	Slight P_b peak; uniform P_r
186	183	9-3/4	Slight P_b peak; slight stick-slip followed by uniform P_r
199	194	10	Slight P_b peak; mostly uniform P_r
198	191	9-3/8	Very slight P_b peak; very slight stick-slip
200	185	11-1/2	Very slight P_b peak; uniform P_r
201	191	11-7/8	Very slight P_b peak; uniform P_r
191	181	10-1/8	Moderate P_b peak; uniform P_r
189	180	10-1/4	Slight P_b peak; uniform P_r
192	170	12-1/2	Slight P_b peak; uniform P_r
--	--	2-3/4	Stopped because of stem-seal failure at 216,000 psi fluid pressure
214	193	13-1/8	Slight P_b peak; uniform P_r

Effect of Fluid

Before fluids could be evaluated, preliminary trials were necessary to select an effective billet lubricant. A polyphenyl ether (PPE) fluid was selected because of its reported good high-temperature stability. Based on these trials a "best" billet lubricant was selected (L31), and the other fluids were evaluated. Data listed in Table 7 summarize the results obtained with the various fluids.

At a ratio of 4:1, the data suggest that the silicate ester (SE) fluid requires the least pressure. This is particularly significant, since the extrusion temperature (400 F) in this case was lower than in the other trials. However, at an extrusion ratio of 5:1 there appears to be only a marginal difference between the pressures for SE and PPE. (PPE fluid, at a ratio of 4:1, required the highest pressures.) Such results at higher ratios are not unexpected, however, because of the more severe conditions at the billet-die interface.

TABLE 7. EFFECT OF FLUID ON PRESSURES FOR WARM HYDROSTATIC EXTRUSION OF AISI 4340 STEEL

Die angle: 45 deg Lubricant: L31

Trial	Extrusion Ratio	Extrusion Temperature, F	Fluid[a]	Type of Stem Seal[b]	Extrusion Pressure, 1000 psi			
					Breakthrough		Runout	
					Stem	Fluid	Stem	Fluid
394	4.0	500	PPE	1t	198	196	197	194
410	4.0	500	TCP	2t	200	187	200	185
411	4.0	500	TAP	2t	202	192	201	191
412	4.0	500	CBP	2t	196	186	191	181
413	4.0	400	SE	2t	189	182	189	180
418	5.0	500	PPE	2t	243	213	233	206
420	5.0	500	PPE	2t	230	200	222	197
422	5.0	400	SE	2t	223	196	214	193

(a) PPE – Polyphenyl ether
TCP – Tricresyl phosphate
TAP – Triaryl phosphate
CBP – Chlorinated biphenyl
SE – Silicate ester

(b) 1t = one Teflon O-ring used on stem seal; 2t = two Teflon O-rings used on stem seal.

Apart from their effects on pressure requirements, it is worthy of note that all of the fluids evaluated performed satisfactorily as pressure media in the 400 to 500 F range range.