VIII

HYDROSTATIC EXTRUSION OF AISI 4340 STEEL ROUNDS

A good foundation was laid in an earlier research program[1] for the study of the critical process variables for AISI 4340 steel.

AISI 4340 proved to be the least difficult of the materials in this program to lubricate and, consequently, extrusions of excellent quality were obtained at ratios of up to 6:1. Extrusion pressure requirements for ratios above 6:1 were beyond the capacity of the tooling. Lubrication systems were thoroughly evaluated at both room temperature and temperatures up to 500 F in terms of:

(1) hydrostatic fluids

(2) billet coatings

(3) billet lubricants

(4) billet surface finish (in a few cases).

Table IX gives data obtained in the evaluation of lubrication systems at room temperature and under constant extrusion conditions.

Data obtained in the investigation of the effect of other process variables such as extrusion ratio, stem speed, and die angle on extrusion pressures are given in Table X. For reasons of clarity, some duplication of data occurs in Tables IX and X.

Several lubrication systems were evaluated at three elevated temperature levels. Details are given in Table XI. Here also, AISI 4340 steel was satisfactorily lubricated by most of the systems evaluated. The choice of a lubrication system in a production operation would appear to depend on the relative costs of these lubricants and their ease of application.

Extrusion Ratio

The range in extrusion ratio covered in the hydrostatic extrusion of AISI 4340 steel in this program was from 3.3:1 to 6.0:1. Figure 17 shows the pressure requirements within this extrusion ratio range for both room temperature (80 F) and 400 F. Extrapolation of each line enables an estimate to be made of the extrusion ratios possible with containers having various pressure capabilities. A container design with a pressure capacity of 450,000 psi is currently being considered at Battelle. With such a container, the limiting reduction ratios would be about 35:1 at 80 F and 50:1 at 400 F. In view of the advancements made in lubrication for AISI 4340 in this program, those predicted ratios are a realistic possibility and would represent sizable reductions not hitherto possible with steel at these low temperatures.

The runout pressure levels shown in Figure 17 are only slightly lower than those obtained in the previous program[1].

IX. INVESTIGATION OF LUBRICATION SYSTEMS UNDER CONSTANT EXTRUSION CONDITIONS FOR 80 F HYDROSTATIC EXTRUSION OF AISI 4340 R

Die angle - 45 degrees (included)
Billet diameter - 1-3/4 inches
Stem speed - 20 ipm
Billet surface finish - 60 to 120 microinches

Trial	Fluid	Billet Lubrication[a]		Extrusion Pressure, 1000 psi				Type of Curve (Fig. 26)	Length of Extrusion, inches	Com
				Breakthrough		Runout				
		Coating	Lubricant	Stem	Fluid	Stem	Fluid			
				Extrusion Ratio 5:1						
215	Castor oil	C1	L11	249	212	248	212	A1	17	
216	Ditto	C1	L11	253	214	251	214	A2	17	
230	"	None	L11	248	209	248	235	B4	13	Die scored
209	"	C1	L17	256	217	253	212	B1	11	
210	"	C1	L17	254	215	252	212	B1	16	
211	"	C1	L17	253	214	252	212	B1	18	
212	"	C1	L17	256	216	254	213	B1	17	
217	"	None	L17	254	218	252	215	B1	17	
218	"	None	L17	255	216	254	215	B1	17	
219	"	C1	None	272	228	259	216	B1	16	
220	"	C1	"	272	230	261	215	C1	17	
221	"	None	"	265	225	256	229	D3	14	
222	Castor oil	C1	L18	245	213	244	213	A1	17	
223	Ditto	C1	L18	250	214	250	214	A1	17	
231	"	C1	L19	254	215	248	209	B1	17	
232	"	C1	L19	252	212	246	207	B1	18	
233	"	C1	L20	245	208	245	209	A1	18	
234	"	C1	L20	245	206	245	207	A1	17	
235	"	C1	L21	262	218	249	208	B1	17	
236	"	C1	L21	262	219	250	208	B1	19	
277	Castor oil	None	L17	240	223	240	216	B1	13	
257	Ditto	"	L17	255	218	251	215	B1	17	
258	"	"	L17	296	238	--	--	--	--	P_b not achi
315[b]	"	"	L17	240	221	241	217	B1	15	
429	"	"	L38	267	230	264	218	B1	13	
430	"	"	L31	266	230	262	217	B1	10	
462	"	"	L53	260	225	255	221	B3	11	