Conversion Costs to Produce Rounds by Hydrostatic Extrusion and by Conventional Hot Extrusion

It was assumed that essentially the same press facilities would be used for both the hydrostatic extrusion and hot extrusion operations. The labor costs were assumed to be equal in both operations.

Hydrostatic Extrusion of Rounds

The production output of the hydrostatic extrusion process measured in pounds per extrusion will depend on the extrusion rate, billet size, and on the density of the particular material extruded.

A production rate of 20 billets per hour was used to determine a press cost of \$2.35 per extrusion. (\$46.96/hr ÷ 20 extrusions/hr.) This rate reflects the use of only simple materials handling equipment and is certainly not a maximum value. Hydrostatic fluids and seals which are required in the hydrostatic extrusion process are generally reuseable, while lubricants are expendable. The life of the seals and the amount of fluid unrecovered from each extrusion cycle would have to be precisely determined to obtain an accurate cost for these items. A conservative estimate of these costs of \$0.50 per extrusion was used in this analysis, thereby obtaining net extrusion cost of \$2.85 per extrusion, exclusive of die costs.

A simple round production hydrostatic extrusion die would cost approximately \$100. It is apparent if a short die life is assumed, the die cost can exceed the press and fluid costs. The estimated die life is wholly dependent on the effectiveness of the lubrication system.

The hydrostatic extrusion chamber described in the previous section would accommodate a billet 2-inches in diameter x 30 inches long with allowance for fluid compression and tooling. The conversion costs were determined for five materials which are listed along with their billet weights in Table XXXVII.

The conversions costs per pound of extrusion were calculated to show the influence of both die life and billet material. Conversion costs were determined from the following formula:

$$\text{Conversion Cost Per lb} = \frac{\text{(Extrusion Costs)} + \text{(Die Costs)}}{\text{Billet Weight}}$$

For example:

Using a beryllium billet weighing 6.296 lb and a die life of five extrusions

$$\frac{\$2.85 + (\$100 \div 5)}{6.296\ \text{lb}} = \$3.63/\text{lb} \ .$$

These conversion costs are shown on Table XXXVIII.

TABLE XXXVII. BILLET WEIGHTS FOR HYDROSTATIC EXTRUSION AND HOT EXTRUSION AS A FUNCTION OF BILLET MATERIAL

Billet Material	Density, lb/in.^{3}	Hydrostatic Extrusion (Billet Size 2-inch diam x 30 inches) Billet Weight, pounds	Hot Extrusion (Billet Size 3-1/8 inch diam x 9-3/8 inches) Billet Weight, pounds
Beryllium	0.0668	6.296	4.80
7075 Aluminium	0.101	9.519	7.26
Titanium alloy	0.160	15.08	11.50
Steel	0.283	26.67	20.35
Molybdenum	0.369	34.78	26.53

TABLE XXXVIII. CONVERSION COSTS PER POUND OF EXTRUSION FOR HYDROSTATIC EXTRUSION AND HOT EXTRUSION AS A FUNCTION OF DIE LIFE AND A VARIETY OF MATERIALS

Die Life (Number of Extrusion per die)	Hydrostatic Extrusion						Hot Extrusion					
	Cost(a) per Extrusion, $	Conversion Cost(a) per Pound of Extrusion for Various Materials, $					Cost(a) per Extrusion, $	Conversion Cost(a) per Pound of Extrusion for Various Materials, $				
		Be	Al	Ti	Steel	Mo		Be	Al	Ti	Steel	Mo
1	102.85	16.33	10.80	6.82	3.85	2.95	100.59	20.96	13.85	8.75	4.94	3.79
2	52.85	8.39	5.55	3.50	1.98	1.52	50.59	10.54	6.97	4.40	2.49	1.91
3	36.18	5.75	3.80	2.40	1.36	1.04	33.92	7.07	4.67	2.95	1.67	1.28
4	27.85	4.42	2.93	1.85	1.04	0.80	25.59	5.33	3.52	2.23	1.26	0.96
5	22.85	3.63	2.40	1.52	0.86	0.66	20.59	4.29	2.84	1.79	1.01	0.78
10	12.85	2.04	1.35	0.85	0.48	0.37	10.59	2.21	1.46	0.92	0.52	0.40
15	9.52	1.51	1.00	0.63	0.36	0.37	7.26	1.51	1.00	0.63	0.36	0.27
20	7.85	1.25	0.82	0.52	0.29	0.23	5.59	1.16	0.77	0.49	0.27	0.21
25	6.85	1.09	0.72	0.45	0.26	0.20	4.59	0.96	0.63	0.40	0.23	0.17
50	4.85	0.77	0.51	0.32	0.18	0.14	2.59	0.54	0.36	0.23	0.13	0.10
100	3.85	0.61	0.40	0.26	0.14	0.11	1.59	0.33	0.22	0.14	0.08	0.06
200	3.35	0.53	0.35	0.22	0.13	0.10	1.09	0.23	0.15	0.09	0.05	0.04
500	3.05	0.48	0.32	0.20	0.11	0.09	0.79	0.16	0.14	0.07	0.04	0.03

(a) All values rounded off to the nearest $0.01.