Solutions of ME 355 Home Work No. 5

1. 8A-12

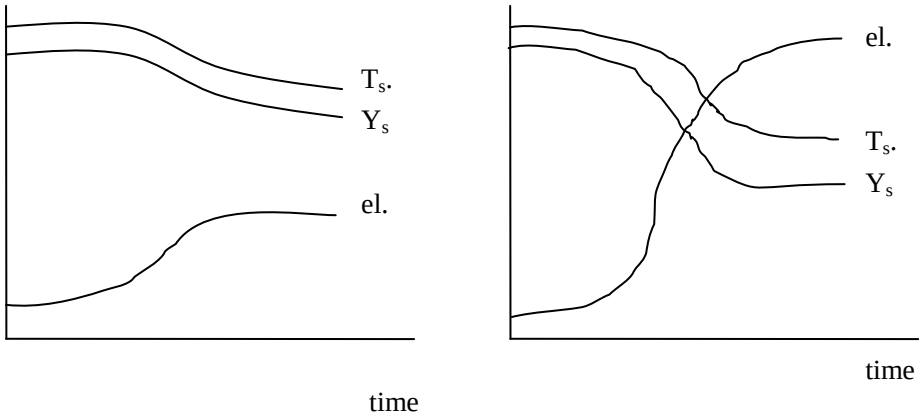
(a) The condition in which metals deform at a very low stress and are capable of very large tensile deformation.

(b) *m* becomes very high (at some low strain rates).

(c) Very fine grain size (or microduplex structure).

2. 8A-15

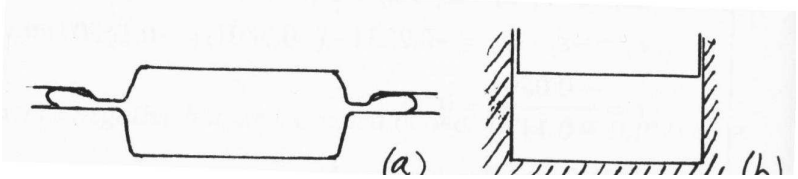
(a) Recovery: rearrangement of dislocations in minimum-energy configuration.
Recrystallization: Growth of new, dislocation-free grains



3. 9A-1

	Cold	*Warm*	*Hot*
Strain-rate sensitivity	Low	Medium	High
Flow stress	High	Medium	Low
Die pressure	High	Medium	Low
Dimensional tolerance	High	Medium	Low
Surface finish	High	Medium	Low
Ease of lubrication	High	Medium	Low
Healing of defects	Low	Medium	High

4. 9A-6



Essential: (a) Excess material runs out into flash; (b) Part is trapped, flash is axial.

5. 9C-2

(a) and (b): Follow steps given in Sec. 9-21. Adapt spreadsheet of Ex. 9-2.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Cold	Cartridge brass					d0 =	6	mm	h0 =	5	mm	V=	141	mm^3	
Flow stress		K =	500	MPa		n =	0.41								
Point	mu	v	h	d1	A1	ec	epsilon	eps dot	sigma f	d/h	Qa	pa		Pa	Pa
No		mm/s	mm	mm	mm^2			1/s	N/mm^2			N/mm^2	kpsi	kN	tonf
				Eq (9-2c)	Eq (9-2b)	Eq (9-3)	Eq (8-5b)	Eq. (8-10)	Eq (8-4)		Fig 9-6	Eq (9-7)		Eq. (9-4)	
0	0.1	80	5	6.0	28.3	0.00	0.000	16.00	0	1.2	1.00	0	0	0	0
1	0.1	80	0.8	15.0	176.7	0.84	1.833	100.00	641	19	2.00	1282	186	227	25
1	st	80	0.8	15.0	176.7	0.84	1.833	100.00	641	19	4.70	3012	437	532	60

(c) To judge feasibility, consider the shape of the tooling. Most likely, the wire will be held in a split die and with h/d < 1, buckling is no problem.

(d) Most likely, the head will be formed by a short punch, as in Fig. 9-34b. According to Sec. 9-5-1, Case 2, well-lubricated upsetting generates just permissible pressure for lubrication is maintained. If the punch were made to a larger diameter (at least of 3*15 =45 mm), it would be loaded in indentation, Case 3, Fig. 9-34c, and even a less expensive steel punch would be suitable. To be on the safe side, the maximum die pressure would have to be calculated too.

6. 9C-8

Set up a spreadsheet like that in Ex. 9-3.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Hot	2017	T =	500	C		d0 =	50	mm	h0 =	70	mm	V =	137445	mm^3
Flow stress			C =	36	MPa	m =	0.12							
Point	u	v	h	d1	A1	ec	epsilon	eps dot	sigma f	d/h	Qa	pa	Pa	Pa
No		mm/s	mm	mm	mm^2			1/s	N/mm^2			N/mm^2	kN	tonf
				Eq (9-2c)	Eq (9-2b)	Eq (9-3)	Eq (8-5b)	Eq (8-10)	Eq (8-11)		Fig 9-6	Eq (9-7)	Eq (9-4)	
0	st	100	70	50.0	1963.5	0.00	0.000	1.43	37.574	0.71	1.00	38	74	8.29
1	st	100	20	93.5	6872.2	0.71	1.253	5.00	43.67	4.68	1.40	61	420	47.2
Hot	2017	T =	400	C		d0 =	50	mm	h0 =	70	mm	V =	137445	mm^3
Flow stress			C =	90	MPa	m =	0.12							
Point	mu	v	h	d1	A1	ec	epsilon	eps dot	sigma f	d/h	Qa	pa	Pa	Pa
No		mm/s	mm	mm	mm^2			1/s	N/mm^2			N/mm^2	kN	tonf
				Eq (9-2c)	Eq (9-2b)	Eq (9-3)	Eq (8-5b)	Eq (8-10)	Eq (8-11)		Fig 9-6	Eq (9-7)	Eq (9-4)	
0	st	100	70	50.0	1963.5	0.00	0.000	1.43	93.936	0.71	1.00	94	184	20.7
1	st	100	20	93.5	6872.2	0.71	1.253	5.00	109.17	4.68	1.40	153	1050	118

Calculation steps:

$$\text{cold working: } h_0, h_1 \xrightarrow{\ln(\frac{h_0}{h_1})} \varepsilon \xrightarrow{K\cdot\varepsilon^n} \sigma_f \xrightarrow{\sigma_f \cdot Q_a} P_a \xrightarrow{P_a \cdot A_1} F$$

$$\text{hot working: } h_0 \xrightarrow{\frac{v}{h}} \dot{\varepsilon} \xrightarrow{C\cdot\dot{\varepsilon}^m} \sigma_f \xrightarrow{\sigma_f \cdot Q_a} P_a \xrightarrow{P_a \cdot A_1} F$$