Rolling – Sheet 1

Q1. The strength coefficient = 550 MPa and strain hardening exponent = 0.22 for a certain metal. During a forming operation, the final true strain that the metal experiences = 0.85. Determine the flow stress at this strain and the average flow stress that the metal experienced during the operation.

Ans: Flow stress = 531 MPa, Average flow stress = 435 MPa

Q2. A metal has a flow curve with parameters: strength coefficient = 850 MPa and strain-hardening exponent = 0.30. A tensile specimen of the metal with gauge length = 100mm is stretched to a length = 157 mm. Determine the flow stress at the new length and the average flow stress that the metal has been subjected to during the deformation.

Ans: Flow stress = 669.4 MPa, Average flow stress = 514.9 MPa

Q3. A tensile test is performed to determine the parameters strength constant C and strain-rate sensitivity exponent m in Eq. $\sigma_f = C\epsilon^m$ for a certain metal. The temperature at which the test is performed = 500°C. At a strain rate = 12/s, the stress is measured at 160MPa; and at a strain rate = 250/s, the stress = 300 MPa. (a) Determine C and m. (b) If the temperature were 600°C, what changes would you expect in the values of C and m?

Ans: m = 0.207, C = 95.659

Q4. A 42.0-mm-thick plate made of low carbon steel is to be reduced to 34.0 mm in one pass in a rolling operation. As the thickness is reduced, the plate widens by 4%. The yield strength of the steel plate is 174MPa and the tensile strength is 290MPa.The entrance speed of the plate is 15.0 m/min. The roll radius is 325 mm and the rotational speed is 49.0 rev/min. Determine (a) the minimum required coefficient of friction that would make this rolling operation possible, (b) exit velocity of the plate, and (c) forward slip.

Ans: (a) 0.157 (b) 17.8 m/min (c) 0.0947

Q5. A series of cold rolling operations are to be used to reduce the thickness of a plate from 50mm down to 25 mm in a reversing two-high mill. Roll diameter=700 mm and coefficient of friction between rolls and work=0.15. The specification is that the draft is to be equal on each pass. Determine (a) minimum number of passes required, and (b) draft for each pass?

Ans: (a) 4 passes (b) 6.25mm

Q6. A continuous hot rolling mill has two stands. Thickness of the starting plate = 25 mm and width = 300mm. Final thickness is to be 13 mm. Roll radius at each stand = 250mm. Rotational speed at the first stand = 20 rev/min. Equal drafts of 6 mm are to be taken at each stand. The plate is wide enough relative to its thickness that no increase in width occurs. Under the assumption that the forward slip is equal at each stand, determine (a)speed v_r at each stand, and (b) forward slip s. (c) Also, determine the exiting speeds at each rolling stand, if the entering speed at the first stand= 26 m/min.

Ans: (a) 31.42 m/min and 47.1 m/min (b) 0.089 (c) 51.3 m/min

Q7. A plate that is 250 mm wide and 25 mm thick is to be reduced in a single pass in a two-high rolling mill to a thickness of 20mm. The roll has a radius = 500 mm, and its speed = 30 m/min. The

work material has a strength coefficient = 240 MPa and a strain hardening exponent = 0.2. Determine (a) roll force, (b) roll torque, and (c) power required to accomplish this operation.

Ans: (a) 1,851,829 N (b) 46,296 Nm (c) 92,591 W

Q8. A single-pass rolling operation reduces a 20 mm thick plate to 18 mm. The starting plate is 200 mm wide. Roll radius = 250mm and rotational speed = 12 rev/min. The work material has a strength coefficient = 600 MPa and a strength coefficient = 0.22. Determine (a) roll force, (b) roll torque, and (c) power required for this operation.

Ans: (a) 0.672 MN (b) 3720 Nm (c) 37.697 kW

Q9. A 4 mm thick sheet is rolled with 300 mm diameter rolls to reduce the thickness without any change in its width. The friction coefficient at the work-roll interface is 0.1. The minimum possible thickness of the sheet that can be produced in a single pass is

(a) 1.00 mm
(b) 1.5 mm
(c) 2.5 mm
(d) 3.7 mm

Ans: c