TA 3330 course

Written examination on 22.03.2004

1. A new plant was built for manufacturing 500 000 pumps/year. The total capital investment has been 12 million €. The proportional cost are 20 €/pump. The fixed operating cost (excl. depreciation and interest) are 1.32 million €/year. Capital charges: Linear depreciation is over 10 years, interest rate is 8 %/years (both refer to total capital investment).
   What is the break-even sales price of manufactured pumps to cover total fixed cost, incl. capital charges?

2. What are the fundamental differences in recycling metals and plastics?

3. A copper ore contains in average 0.75 % Cu as CuO (atomic weight of Cu = 63.57 g/atom).
   Melt this ore directly (for material balance neglect carbon as a reductant) with 20 % silicon addition (referred to ore mass) as a flux for proper slag forming. The slag will dissolve 0.3 % Cu. What is the copper recovery?
   The ore is upgraded to a concentrate with 12 % Cu. The copper recovery from ore to concentrate is 82 %. Melt this Cu-concentrate under conditions above. What is now the copper recovery referred to the original Cu-content in the ore?

4. Small spherical balls consisting of limestone have a density of 3 t/m^3. The balls are covered by a 75 μm thick layer of moisture (water). The laboratory determined a moisture content of 20 wt.%. What is the diameter of the dry limestone balls? (volume of a spherical ball = $4/3\ \pi\ r^3$).

5. You have to transport Magnesium scrap to the new plant at Delfzijl. The bulk density of the scrap is 0.2 t/m^3. The trucks to be used can carry 20 m^3/trip. Due to safety aspects the transportation cost are as high as 80 €/truck*hour. The average speed of the trucks is 70 km/h. According to your own

profitability analysis you cannot afford to pay more than 100 €/t Mg-scrap. What is the max. distance from where you can purchase Mg-scrap?

6. (a)Steel sheets are hot dip galvanized with a layer of 30 μm of zinc metal (densities: Fe = 7.85, Zn = 7.14 t/m^3). In Europe 58.5 million t of steel sheets with a width of 3 m and a thickness of 2.5 mm are produced. What is the total demand in t zinc/y for hot dip galvanizing in Europe?

   (b) Assume that 50 % of the steel sheets are recycled to electric arc furnace smelters, where the zinc evaporates and is bound into a dust with 26 % zinc content. What is the specific dust generation in [kg EAF dust/t produced steel sheet] ?

7. At Nedstaal 10 m long steel billets are manufactured with a cross area of 125 x 125 mm. These billets are rolled to a wire of 5.5 mm diameter (circular cross area). The rolling starts with a speed of 0.2 m/s. What is the speed of the 5.5 mm wire at the end of the rolling mill?

8. A die-caster produces steering boxes from aluminium metal (density 2.7 t/m^3). The average wall thickness of the boxes is 5 mm. Various holes are drilled into the cast boxes producing turnings. Average length of turnings is 15 cm, average thickness is 1 mm. The turnings oxidise quickly and are finally covered by a Al_2O_3-layer of 100 μm (density of Al_2O_3 is 3 t/m^3). Neglect the change of volume during oxidation.
   (a) What is the average metal content of the oxidised turnings?
   (b) A sample of the oxidised turnings are melted in a crucible together with 90 % flux addition. During melting 0.5 % aluminium metal is burnt to oxide. Oxide plus flux forms a salt slag, which is skimmed but containing 0.75 wt.% entrapped liquid metal. No salt or oxide is lost. What is the metal recovery and metal yield of melting this sample of turnings?

Delft, February 2004
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