

Puu-23.4020 Modelling and simulation of pulp washing and chemical cycle
Examination 16.09.2008

The exam questions are only in English but you may answer in Finnish or Swedish.

1. The effective alkali of white liquor is $EA = 115.0 \text{ gNaOH/l}$. The sulfidity is 38%, causticizing degree is 82% and reduction degree is 95%. Calculate active alkali AA concentration (use unit gNaOH/l). Calculate NaOH , Na_2S , Na_2SO_4 and Na_2CO_3 concentrations (use unit gNaOH/l).
2. The feed consistency of the unwashed pulp to a washer is 10% and the discharge consistency of the washer is 12%. The dilution factor of the washer is 2.5 t/BDt and the washing efficiency of the washer is $E = 7.0$. The unwashed pulp flow contains 126 kgCOD/BDt . The wash liquid has the COD-concentration 440 mg/l . Calculate the washing loss in the washed pulp (use unit kgCOD/BDt). Calculate COD-concentration in the filtrate, which leaves from the washer (use unit mg/l). Assume that density of liquids is 1000 kg/m^3 .
3. A pulp mill is operated at the production rate 1500 BDt/d. The washing line between continuous digester and oxygen delignification contains a pressure diffuser and a vacuum filter. The discharge consistency of the vacuum filter is 12% and the wash loss 100 kgCOD/BDt . The wash liquid flow to the vacuum filter is 176 liters/s and the COD-concentration 12 g/l . The discharge consistency of the continuous digester is 10% and the wash loss 600 kgCOD/BDt . Assume liquid densities 1000 kg/m^3 .
 - a) What is the dilution factor of the washing line?
 - b) Calculate the washing efficiency of the washing line (E_{10} -value and DR-value)
 - c) What is the COD-concentration (mg/l) in the filtrate leaving from the pressure diffuser?
4. A kraft pulp mill has chemical losses as follows
 - Liquid losses 9 kg Na/BDt + 2 kg S/BDt
 - Dust losses 2 kg Na/BDt + 1,2 kg S/BDt
 - Sulphurous gases 3 kg S/BDt

} 11 kg Na/BDt 6,2 S/BDt

$2, -0,2 = 0,8$

The mill chlorine dioxide manufacturing plant produces spent acid which contains 3 kg Na/BDt and 7 kg S/BDt. The mill uses fuel oil in the lime kiln. This adds 3 kg S/BDt to the chemical cycle. The mill can use Na_2SO_4 and Na_2CO_3 as make-up chemicals. Show with a vector diagram how chemicals are added or discharged to maintain chemical balance. The mill decides to replace the fuel oil with sulphur free natural gas. How does the make-up chemical balance change due to this modification?

5. Tell about factors which affects to the production capacity of a washer.
6. Both the feed consistency and the discharge consistency of a pressure diffuser is 10%. The dilution factor $DF = 3.0 \text{ t/BDt}$ and the displacement ratio $DR = 0.93$. What is the E-value of the pressure diffuser? What is the E_{10} -value?