

National Exams December 2005
98-Chem-B5
Pulp and Paper Technology

3 hour duration

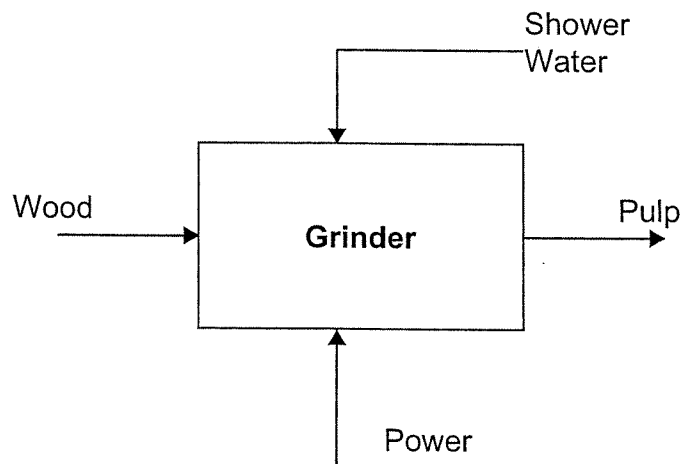
Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a Closed Book exam.
3. Any 3 questions constitute a complete paper. Only the first three questions as they appear in your answer book will be marked.
4. All questions are of equal value. Marks for question parts are indicated under each question.

Question #1

Parts (a) – (d) are worth 5 marks each. Part (e) is worth 10 marks.

- (a) Sketch the elements of a pulp grinder. Describe the operation of a pulp grinder, including feeding arrangements and operating variables.
- (b) Describe the construction of a pulp stone and how it is prepared for service.
- (c) Describe the production cycle of a grinder in terms of how stone sharpness, production rate, and motor load vary over time.
- (d) What is the most common method used to bleach groundwood pulp? What conditions are recommended? What brightness gains may be expected?
- (e) A 35 metric tonne per day grinder consumes 1200 kWh/tonne. The wood enters the grinder at 20°C and 50% moisture (total mass basis). How much shower water (kg/s) supplied at 50°C, is required to keep the vat temperature at 70°C? For simplicity you may assume wood and water both have a heat capacity of 4.18kJ/kg°C. Also assume 100% pulp yield.



Question #2

Parts (a) – (d) are worth 5 marks each. Part (e) is worth 10 marks.

- (a) Sketch a block diagram of the kraft recovery cycle, writing any chemical reactions that take place in each unit/step of the cycle.
- (b) Sketch and describe the multiple effect evaporation system used in the recovery of kraft mill black liquor. Define steam economy and boiling point rise.
- (c) Give two by-products of kraft pulping. From where in the kraft mill are these byproducts recovered?
- (d) What are the advantages and disadvantages to a kraft mill if it decides to pulp aspen, compared to jack pine?
- (e) A white liquor has an active alkali concentration of 93 g/L. Calculate the individual chemical concentrations of NaOH, Na₂S, Na₂CO₃ and Na₂SO₄, in g/L of Na₂O, given a white liquor sulphidity of 27%, a causticizing efficiency of 75% and a reduction of 95%. How much white liquor (m³) must be added to a cook of 10 metric tonnes of chips at 17.5% active alkali?

Question #3

Parts (a) – (d) are worth 5 marks each. Part (e) is worth 10 marks.

- (a) Sketch the flow sheet of a first stage of kraft pulp delignification which uses chlorine dioxide (D₀). Include the washing arrangements. What are the typical operating conditions of this stage, and how much delignification can be accomplished?
- (b) Sketch a high consistency oxygen delignification stage that might be used in place of a chlorine dioxide delignification stage. What are the typical operating conditions for a high consistency oxygen stage, and how much delignification can be accomplished.
- (c) What are the potential environmental benefits in using an oxygen stage? What are the requirements for an oxygen stage to achieve maximum environmental benefits? What are the environmental measures that quantify the environmental impact?
- (d) Name two chemical tests that are used in the bleach plant to measure pulp quality and explain what each test tells about the pulp quality.
- (e) For a pulp production of 750 metric tonnes per day, calculate the flow of chlorine dioxide required to the D₀ stage, in L/min given a chlorine dioxide solution of 8.3 g/L and a dose rate of 6.5% equivalent chlorine on pulp. (Cl - 35.45; O - 16.0; H - 1.008)

Question #4

Parts (a) – (j) are worth 2 marks each. Parts (k) and (l) are worth 5 marks each.

- (a) Why is an air-padded headbox pressurized with air?
- (b) What is the purpose of slice lip adjusters?
- (c) What is a deaerator and where is it found in a papermill?
- (d) What are rectifier rolls?
- (e) What is a couch roll?
- (f) Give the typical percent consistency or percent dryness of the paper web as it leaves the fourdrinier, the press section and the dryer section.
- (g) What is paper sizing? What two types of sizing are used in papermaking?
- (h) Sketch a typical nip of the press section, pointing out any design aids for dewatering.
- (i) How is condensate removed from the dryer cylinders?
- (j) What are the purposes of a calender stack?
- (k) A fan pump delivers $1\text{m}^3/\text{s}$ of stock at 0.55% consistency to a headbox of a 5 m wide paper machine making 600 m/min of 60 g/m^2 paper, o.d. basis. What is the percent fibre retention on the fourdrinier?
- (l) A 5 m wide paper machine uses dryer cylinders that are 1.8 m in diameter. When the paper machine is running at 700m/min making 52 g/m^2 paper (o.d. basis), the paper is observed to increase from 70% to 80% dryness across a section of 10 cylinders. Calculate the moisture evaporated.