

WASTE MANAGEMENT (KBT135)

Exam in Waste Management 2013-12-16

Examiner: Professor Britt-Marie Steenari

Contact person: Professor Britt-Marie Steenari, ext. 2890 (0730794201)

Grading: Total points: 50 + points from project work (max 6 p)

Points	Grading
<25	Failed
25-32	3
32.5-39.5	4
40-56	5

Closed book exam, a non-technical language dictionary is permitted. A calculator with emptied memory is permitted.

Please note: Each question must be answered on separate paper.

1. Ashes (6 p)

- a) What parts of the trees are most commonly used as a fuel in large scale biomass combustors? (1p)
- b) Explain why it can be beneficial to use ash from such a combustor as forest fertilizer (1p)
- c) What type of ash would you chose as a material to put in a road base? Explain why you would choose that ash. (2p)
- d) What method is generally used at a combustor firing municipal solid waste to stop mercury in the combustion gases from being emitted into the air? Where does the mercury end up? (2p)

2. Waste flows in society (6 p)

- a) Based on the following data, what would you say would be typical major differences between municipal solid waste flows in those two countries with regard to the amounts per capita and the composition? Data: Sweden had a GDP per capita in 2012 of 55 245 USD and Cambodia had a GDP per capita in 2012 of 946 USD (2p)
- b) When doing a material flow balance over all material flows related to the consumption taking place in a country, also hidden waste flows would sometimes be mapped. What is a large part of these hidden waste flows made up of and what type of activities do they originate from? (2p)
- c) The waste management hierarchy tells us that it is better to recycle a material than to recover energy from the material. However, for some materials, this makes more sense than for others. Which material is more important to recycle? Paper or aluminium? You have to provide two different good arguments that support your answer. (2p)

3. Hydrothermal waste treatment (4 p)

- a) At wastewater treatment plants (WWTPs), hydrothermal processes are sometimes used for different purposes. What is a common reason for using a thermal hydrolysis and what is a common reason for using a wet oxidation process in a WWTP? (2p)
- b) In a transpiring wall reactor, a typical problem in supercritical water oxidation of waste is handled in a special way. Which problem and how is this handled? (2p)

4. Thermal Waste Treatment (5p)

- a) What does the abbreviation POP stand for? (1p)
- b) To reduce emissions of particulates from waste incineration, what is the best technology? (1 p)
- c) Syngas (synthetic gas), is a raw material for production of many polymers and methanol is a mixture of two gases that could be produced from waste. What two gases are called syngas as a mixture? (1 p)
- d) What is the difference between waste gasification and waste pyrolysis? (2 p)

5. Recycling of plastics (6p)

- a) Mention three driving forces for polymer recycling (2p)
- b) Mention at least three drawbacks and difficulties when you want to use recycled polymers. (2p)
- c) Mention two ways except landfill to handle mixed polymers and reinforced polymers. (2p)

6. Metal recovery methods (8p)

- a) Describe how an eddy current separator works and what materials can be separated by it. (2p)
- b) Describe the processes involved in the recycling of different grades of circuit boards. (3p)
- c) Describe how solvent extraction works, which types of chemicals are needed and why it is used in metallurgy. (3p)

7. Management of nuclear waste (4p)

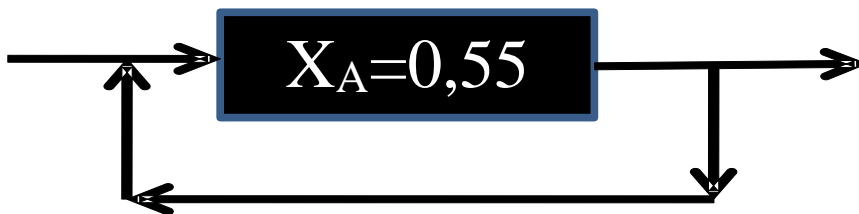
Describe the different flows of material in a reprocessing /(separation and transmutation) process (4p)

8. Biological treatment (5p)

The possibility to design a reactor concept for the degradation of a toxic compound must be examined. We know that the maximum concentration of the toxic compound should be less than 0,5 g/l in the outlet flow. We know that the concentrations of the compound in the incoming waste flow (fresh) is 10,0 g/l. The conversion of the compound A over the reactor is 0,55 (independent of the inflow).

The toxic compound reacts according to $A \rightarrow 3B$

- What will the concentration of the toxic compound be in the outlet if no recirculation occurs?
- How much of the reactor outflow (of the toxic compound) must be recirculated to the reactor inlet (and mixed with the fresh flow) to reach the wanted concentration of the toxic compound.



9. Sludge treatment (6p)

- What is sludge stabilization? Describe briefly three different methods. (2p)
- What are the main advantages of using anaerobic digestion compared to aerobic digestion for sludge treatment? (2p)
- Describe what sludge incineration is and mention some of the main advantages and disadvantages compared to for example sludge disposal on farmland as fertilizer or as soil improvement. (2p)