

CLL728

Biomass conversion and Utilisation

Major Exam

Date & Time : 09/01/2021 , 10am-12 :00 MM 40

ONLINE EXAM (Answer sheets to be uploaded at : 727CLL@GMAIL.COM), Use pdf.

File name: Name – Entry number

Open book and Notes (There are four questions. State assumptions made if any and source of data taken.)

1. Calculate the gallon gasoline equivalent (gge) of methane gas compressed at 200 atm pressure. Assume that gasoline has heating value of 40 MJ/kg and methane has a heating value of 55 MJ/kg. If this methane gas is converted to H₂ (120MJ/kg), Calculate the energy efficiency of the process. (8)
2. It is propose to estimate the area of land for cultivation of energy crops. The rating of this biomass based power station is 30 MW. During the course of a year, it operates at full load for 6000 hours with an efficiency of 40%. It is assumed that the biomass of the crops and forests has an energy value of approximately 4 MWh per dry tonne, after allowing for the influence of moisture content on energy value. Suppose it is to be supplied from dedicated energy crops that produce on average 10 dry tonnes of biomass per hectare per year, calculate the area of land required. (1 hectare = 10 000 m²). (8)
3. Suggest a suitable mechanism for conversion of cellulose to ethyl levulinate. The conversion of pyrolysis vapours via acid-catalysed reactions leads to the breaking of C-O and C-C bonds among guaiacyl, syringyl and p-hydroxyphenyl and produces intermediates that cause for the coke formation on the zeolite surface . Suggest the role of catalysts for conversion to ethyl levulinate and formation of other products. (6)
4. It is planned to design a downdraft gasifier for the gasification of sugar cane bagasse. In the gasifier the biomass material undergoes several different reaction processes including drying, distillation, oxidation, and reduction reaction processes. These reactions are as follows :

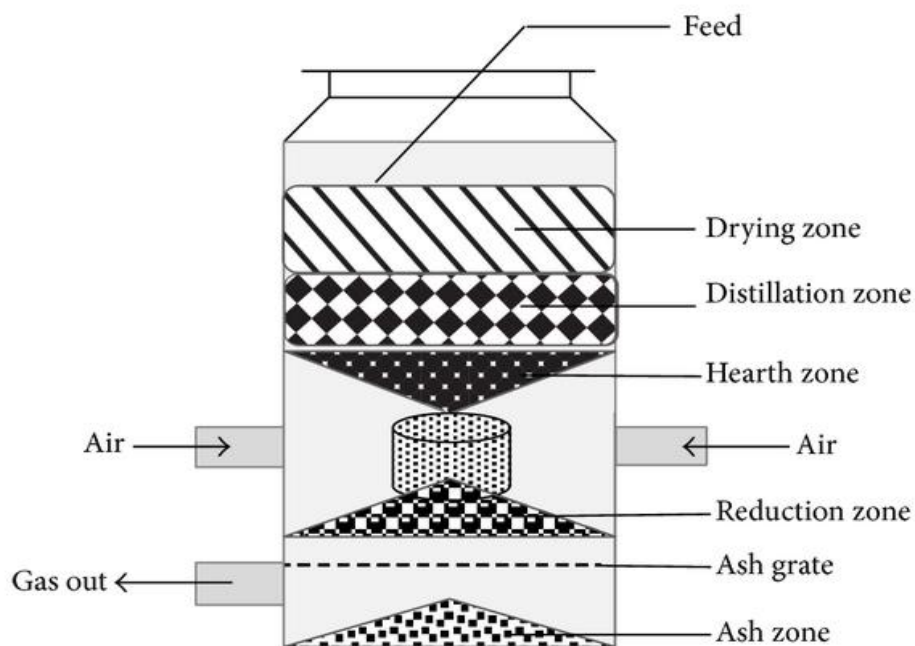
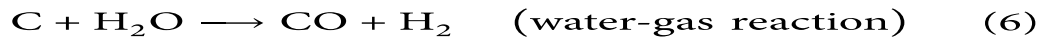
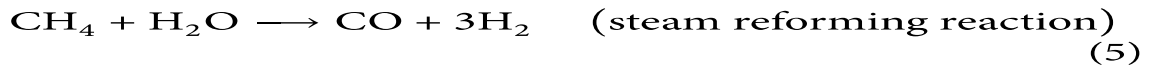
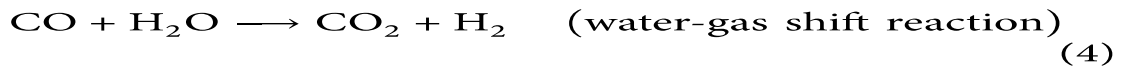


Figure 1: Fixed-bed downdraft gasifier or cocurrent gasifier [Adopted from FAO Corporate Document Repository, 1986] FAO Corporate Document Repository, “Wood gas and engine fuel,” 1986, <http://www.fao.org/docrep/t0512e/t0512e0a.htm>.

The heating value of sugarcane bagasse was found to be 17.8 MJ/kg.

- (i) Calculate the conversion efficiency of the gasification process. (5)
- (ii) For a 100MW gasifier, prepare a complete mass and energy balance for the entire unit. State all the assumptions and source of data taken. (8)
- (iii) Comment on effect of most critical operating parameters that affect gasifier performance and are useful empirical tools for scale-up designs of gasifiers. (5)