

NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR

DEPARTMENT OF CHEMICAL ENGINEERING

Subject: Fuel Cells and Hydrogen Energy

End Semester Theory Examination Dec, 2020

Class: B.Tech (VII Semester)

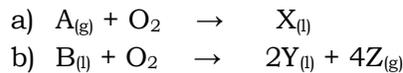
Code: CH-450

Total Marks: 50

Time: 2 hours

- Note:- The figures in the margin indicate full marks for the question.
- Assume the missing data/information (if any) and state it clearly.
 - Answer all questions.

1. a) Predict the sign of ΔS for the following reactions with reason (3)



Both reactions are exothermic and spontaneous.

- b) What are the different types of fuel cell? Explain the Molten Carbonate Fuel Cell with its merits and demerits and the reactions involved. (5)
2. a) Discuss the hydrogen emission NO_x control techniques and strategies. (5)
- b) Explain the I-V curve. How to calculate the real fuel cell efficiency. (5)
3. a) A H₂-O₂ fuel cell stack might operate at a voltage of 0.7 V per cell with 90% fuel utilization efficiency. (8)

- i) calculate efficiency at STP
standard bond formation enthalpies
H-H : -432 KJ/mol; O-O : -494 KJ/mol; H-O: -460 KJ/mol

- ii) The above stack is used for powering a vehicle which draws 10 KW of power at 60 km/h. Calculate the minimum volume required for the fuel cell system (fuel cell stack + fuel tank) so that a driver can go at least 300 km before refuelling.

Stack power density: 1KW/L, Fuel tank energy density (compressed H₂): 9MJ/L

- b) Derive the Nernst equation which shows the dependency of reversible cell potential on the partial pressures of H₂ and O₂. (4)
4. (a) (i) Write half-cell reaction for direct methanol fuel cell for both acid and alkali medium (ii) Calculate half-cell potential and compare anode, cathode and total thermodynamic potential for both medium. ΔG_f values CH₃OH= -174 KJ/Mol, CO₂ = -394 KJ/Mol, H₂O = -237 KJ/mol, OH⁻ = -157 KJ/Mol. From thermodynamic point of view, tell which reaction is more favorable and why? (6)
- (b) What are the main sources for ohmic polarization and define Nernst-Einstein relation. (4)

- 5 (a) What are the major hydrogen storage techniques and write the advantages (5) and disadvantages with composite tanks?
- (b) Discuss the hydrogen generation through electrolysis and write the (5) electrolysis reaction in the cationic electrolyte