Uka Tarsadia University(Diwaliba Polytechnic)
Diploma in Chemical Engineering
Objective Type Questions (Chemical Reaction Engineering)

Unit 1 Basics of Chemical Reactions

1. An autothermal reactor is
   A. Most suitable for a second order reaction.
   B. Most suitable for a reversible reaction.
   C. Completely self-supporting in its thermal energy requirements.
   D. Isothermal in nature.

2. The rate constant of a first order reaction depends on the
   A. Concentration of the reactant.
   B. Temperature.
   C. Concentration of the product.
   D. Time.

3. Which of the following will favour the reverse reaction in a chemical equilibrium reaction ?
   A. Increasing the concentration of one of the reactants.
   B. Increasing the concentration of one or more of the products.
   C. Removal of at least one of the products at regular interval.
   D. None of these.

7. A reaction in which one of the products of reaction acts as a catalyst is called a/an _____ reaction.
   A. Catalytic
   B. Autocatalytic
   C. Photochemical
   D. None of these

4. A photochemical reaction is _____ light.
   A. Initiated by

B. Accompanied with emission of

C. Catalysed by

D. Used to convert heat energy into

5. In a/an _____ reactor, there is exchange of heat with the surroundings with sizeable temperature variation.

A. Adiabatic

B. Isothermal

C. Non-adiabatic

D. None of these.

6. From among the following, choose one which is not an exothermic process.

A. Methanol synthesis

B. Catalytic cracking

C. Ammonia synthesis

D. Oxidation of sulphur

6. A catalyst

A. Initiates a reaction.

B. Lowers the activation energy of reacting molecules.

C. Is capable of reacting with any one of the reactants.

D. Can not be recovered chemically unchanged at the end of a chemical reaction.

7. For every 10°C rise in temperature, the rate of chemical reaction doubles. When the temperature is increased from 30 to 70°C, the rate of reaction increases _____ times.

A. 8

B. 12

C. 16

D. 32

8. Reaction rate equation for the reaction, $R + 2S \rightarrow X + Y$ is $-\frac{dCR}{dt} = K \cdot C_R \cdot C_s^2$. If S at is present in large excess, what is the order of this reaction?

A. Zero

B. One

C. Two

D. Three

9. Rate of a gaseous phase reaction is given by, $-\frac{dpA}{dt} = K.p^2A$. The unit of rate constant is

A. $(atm)^{-1}$

B. $(hr)^{-1}$

C. $(atm)^{-1}.(hr)^{-1}$

D. $Atm.(hr)^{-1}$

10. The reaction between oxygen and organic material is a/an _____ reaction.

A. Exothermic

B. Endothermic

C. Biochemical

D. Photochemical

11. The rate constant of a chemical reaction increases by 100 times when the temperature is increased from 400 °K to 500 °K. Assuming transition state theory is valid, the value of E/R is

A. 8987°K

B. 9210°K

C. 8764°K

D. 8621°K

12. For a heterogeneous catalytic reaction

A. Free energy of activation is lowered in the presence of catalyst, which remains unchanged at the end of reaction.

B. A relatively small amount of catalyst can cause the conversion of large amount of reactants which does not mean that catalyst concentration is important.

C. The catalyst does not form an intermediate complex with the reactant.

D. The surface of the catalyst does not play an important role during reaction.

13. The increase in the rate of reaction with temperature is due to
    A. Increase in the number of effective collisions.
    B. Decrease in activation energy.
    C. Increase in the average kinetic energy of the reacting molecules.
    D. None of these.

14. A catalyst loses its activity due to
    A. Loss in surface area of the active component.
    B. Agglomeration of metal particles caused by thermal sintering of the solid surface.
    C. Covering of the catalytic active sites by a foregin substance.
    D. All (a), (b) and (c).

15. Pick out the correct statement.
    A. In catalytic reactions, the catalyst reacts with the reactants.
    B. A catalyst initiates a chemical reaction.
    C. A catalyst lowers the activation energy of the reacting molecules.
    D. A catalyst can not be recovered chemi cally unchanged at the end of the chemical reaction.

16. Sulphuric acid is used as a catalyst in the
    A. Hydrogenation of oils.
    B. Gas phase oxidation of SO_2 in chamber process.
    C. Alkylation of hydrocarbons.
    D. None of these.

17. The reason why a catalyst increases the rate of reaction is that, it
    A. Decreases the energy barrier for reaction.
    B. Increases the activation energy.
    C. Decreases the molecular collision diameter.
    D. None of these.

18. The reaction in which one of the products of reaction acts as a catalyst is called a/an

_____ reaction.

A. Biochemical

B. Photochemical

C. Catalytic

D. Autocatalytic

19. A typical example of an exothermic reversible reaction conducted at high pressure in industry is

A. Dehydration of ethanol.

B. Methanol synthesis.

C. Reformation of methane.

D. Polymerisation of ethylene.

20. Study of chemical kinetics is the easiest in the case of _____ reactions.

A. Irreversible

B. Reversible

C. Surface

D. Side

21. In autocatalytic reactions,

A. One of the reactants acts as a catalyst.

B. One of the products acts as a catalyst.

C. Catalysts have very high selectivity.

D. No catalyst is used.

22. Exposure of a photographic plate to produce a latent image is an example of _____ reaction.

A. Very slow

B. Very fast

C. Photochemical

D. Both (b) and (c)

23. Helium-mercury method is used for the measurement of the _____ of the catalyst.

A. Surface area

B. Porosity

C. Pore volume

D. Both (b) & (c).

24. A catalyst inhibitor

A. Lessens its selectivity.

B. May be useful for suppressing undesirable side reactions.

C. Is added in small quantity during the catalyst manufacture itself.

D. All(a), (b) and (c).

25. In chamber process of sulphuric acid manufacture in industry, the gas phase oxidation of SO_2 to SO_3 is accomplished by a _____ reaction.

A. Non-catalytic homogeneous

B. Non-catalytic heterogeneous

C. Catalytic homogenous

D. Catalytic heterogeneous

26. If the rate of a chemical reaction becomes slower at a given temperature, then the

A. Initial concentration of the reactants remains constant.

B. Free energy of activation is lower.

C. Entropy changes.

D. Free energy of activation is higher.

27 _____ catalytic reaction is involved in the thermal cracking of gas oil.

A. Homogeneous

B. Homogeneous non

C. Heterogeneous

D. Heterogeneous non

28. Variables affecting the rate of homogeneous reactions are

A. Pressure and temperature only.

B. Temperature and composition only.

C. Pressure and composition only.

D. Pressure, temperature and composition.

29. A chemical reaction occurs when the energy of the reacting molecules is _____ the activation energy of the reaction.

A. Less than

B. Equal to

C. More than

D. Equal to or more than

30 In a reversible chemical reaction having two reactants in equilibrium, if the concentration of the reactants are doubled, then the equilibrium constant will

A. Remain the same

B. Be halved

C. C be halved

D. Become one fourth

31. The equilibrium constant of a catalytic chemical reaction _____ due to the presence of a catalyst.

A. Increases

B. Decreases

C. Remains unaffected

D. Unpredictable from the data

32. A photochemical reaction is

A. Accompanied with emission of light.

B. Catalysed by light.

C. Initiated by light.

D. All (a), (b) & (c).

33. A catalyst is said to be a negative catalyst, if it

A. Retards the rate of reaction.

B. Reduces the value of equilibrium constant.

C. Does not initiate the reaction.

D. All (a), (b) and (c).

34 Rate of a chemical reaction is not influenced by the

A. Catalyst

B. Temperature

C. Reactants concentration

D. Number of molecules of reactants taking part in a reaction

35 Enzymes are destroyed, when the

A. Temperature is very high,

B. Reactant's concentration is very high.

C. Reactant's concentration is very low.

D. Reaction rate is independent of the reactant's concentration.

36 In the gaseous phase ammonia formation reaction ($N_2 + 3H_2 \rightleftharpoons 2NH_3$), the value of the equilibrium constant depends on the↔

A. Total pressure of the system.

B. Volume of the reactor.

C. Temperature.

D. Initial concentration of N_2 and H_2.

37 Photochemical reaction rate does not depend significantly on temperature, because

A. It is a reversible reaction.

B. It is an exothermic reaction.

C. The energy of reacting molecules exceeds the activation energy by absorption of light.

D. None of these.

38 For an ideal gas mixture undergoing a reversible gaseous phase chemical reaction, the equilibrium constant

A. Is independent of pressure.

B. Increases with pressure.

C. Decreases with pressure.

D. Increases /decreases with pressure depending on the stoichiometric co-efficients of the reaction.

39. In the reversible reaction of the type, $A + B \rightleftharpoons AB$, in general

A. Both forward and backward reactions will be exothermic.

B. Neither of the reactions will be en-dothermic.

C. The combination reaction will be exothermic, while the dissociation reaction will be endothermic.

D. The combination reaction will be endothermic, while the dissociation reaction will be exothermic.

40. Velocity of a reaction depends upon the

A. Nature of the reactants.

B. Concentration of the reactants.

C. Temperature at which the reaction is carried.

D. All (a), (b) and (c).

41. The rate of forward reaction, at chemical equilibrium is____the rate of backward reaction.

A. More than

B. Less than

C. Equal to

D. Either (b) or (c)

42. Enzymes (a protein) are catalysts found in organisms. Its efficiency of catalysing a reaction is due to its capacity to lower the activation energy of the reaction. The enzyme *ptyalin* used for food digestion is present in

A. Blood

B. Saliva

C. Intestine

D. Gland

43. An exothermic reaction takes place in an adiabatic reactor. The product temperature _____ reactor feed temperature.

    A. Is always equal to

    B. Is always greater than

    C. Is always less than

    D. May be greater or less than

44. The role of a catalyst in a chemical reaction is to change the

    A. Equilibrium constant

    B. Activation energy

    C. Final products

    D. Heat of reaction

45. The rate of a homogeneous reaction is a function of

    A. Temperature and pressure only.

    B. Temperature and composition only.

    C. Pressure and composition only.

    D. All temperature, pressure and composition.

46. In the fluid catalytic cracker (FCC), the cracking reaction is _____ (A) and the regeneration is___(B) _____

    A. (A) exothermic (B) endothermic

    B. (A) exothermic (B) exothermic

    C. (A) endothermic (B) enodthermic

    D. (A) endothermic (B) exothermic

47. In an exothermic reaction, the energy of the reacting substances as compared to that of products is

    A. More

    B. Less

    C. Same

    D. Either (a) or (b), depends on order of reaction.

48 Which of the following is not endothermic in nature ?

A. Combustion of sulphur.

B. Gasification of carbon.

C. Thermal cracking of fuel oil.

D. Steam reforming of naphtha.

49. Pick out the wrong statement.

A. Autocatalytic reactions are exemplified by microbial fermentation reactions.

B. The slowest step has the greatest influence on the overall reaction rate in case of an irreversible series reaction.

C. The fractional conversion at any time is same for both the constant as well as the variable volume system in case of an irreversible unimolecular type first order reaction.

D. Hydrolysis of ester in presence of alkali or acid is a zero order reaction.

50. Chemical kinetics can predict the _____ of a chemical reaction.

A. Rate

B. Feasibility

C. Both (a) & (b)

D. Neither (a) nor (b)

51. Thermodynamics can predict the _____ of a chemical reaction.

A. Rate

B. Feasibility

C. Both (a) & (b)

D. Neither (a) nor (b)

52. The reaction which occure in single phase is known as

A. Hetrogeneous reaction

B. Homogeneous reaction

C. Elementary

D. Non elementary

53. The reaction which occure in two or more than two phase is known as
    A. Hetrogeneous reaction

    B. Homogeneous reaction

    C. Elementary

    D. Non elementary

54. The reaction which occur in presence of catalyst is
    A. Catalytic reaction

    B. Non catalytic reaction

    C. Multiphase reaction

    D. Elementary Reaction

54. The reaction which occur without catalyst is
    A. Catalytic reaction

    B. Non catalytic reaction

    C. Multiphase reaction

    D. Elementary Reaction

Unit 2 Kinetics of Homogeneous Reactions

1. The rate constant of a chemical reaction increases by increasing the
   A. Temperature
   B. Pressure
   C. Reactant's concentration
   D. None of these

2 The catalytic activity of enzymes is due to their capacity to lower the _____ energy.
   A. Activation
   B. Potential
   C. Kinetic
   D. None of these

3. When a catalyst increases the rate of forward reaction, the value of rate constant
   A. Increases
   B. Decreases
   C. Remain same
   D. Becomes infinite

4. The rate of a chemical reaction is almost doubled for every 10°C rise in temperature. The rate will increase _____ times, if the temperature rises form 10 to 100°C.
   A. 256
   B. 512
   C. 112
   D. 612

5 A catalyst in a chemical reaction _____ free energy change in the reaction.
   A. Increases
   B. Decreases
   C. Either (a) or (b); depends on the type of catalyst
   D. Neither (a) nor (b).

6. Pick out the wrong statement:
   A. Chemical reactions with high activation energy are very temperature sensitive.
   B. A flat velocity profile exists in a plug flow reactor.
   C. The residence time for all the elements of fluid in case of a P.F.R. need not be same.
   D. Half life of a reaction increases with increased initial concentration for reaction orders more than one.

7. Which of the following is not a theory of homogeneous reaction?
   A. Collision theory and activated complex theory
   B. Chain reaction theory
   C. Radiation hypothesis
   D. None of these

8. Transition state theory relates the above quantities as
   A. $K \propto e^{-E/RT}$
   B. $K \propto T.e^{e/RT}$
   C. $K \propto T$
   D. $K \propto T^{1.5}$

9. In a chemical reaction, _____ are conserved.
   A. Ions
   B. Masses
   C. Atoms
   D. Both(b) & (c)

10. There is no correspondence between stoichiometry and the rate equation in case of a/an _____ reaction.
   A. Elementary
   B. Multiple
   C. Autocatalytic
   D. Non-elementary

11. Threshold energy in a reaction is equal to the

A. Activation energy

B. Normal energy of reactants

C. Sum of (a) & (b)

D. Neither (a) nor (b)

12. The rate at which a chemical substance reacts is proportional to its

A. Active mass

B. Molecular weight

C. Equivalent weight

D. Atomic weight

13. From Arhenius law, a plot of $\log_e K$ versus $1/T$ gives a straight line with a slope of $(-E/R)$. The unit of E/R is

A. K cal

B. K cal/°*K*

C. °*K*

D. K cal. °*K*

14. Sum of the powers of the concentration terms in the rate equation is called the _____ of the reaction.

A. Order

B. Overall order

C. Molecularity

D. None of these

15. Molecularity of a reaction

A. Is always equal to the overall order of reaction.

B. May not be equal to the order of reaction.

C. Can't have a fractional value.

D. Both (b) and (c).

42. According to Arhenious equation of temperature dependency of rate constant for an elementary reaction

A. $K \propto T$

B. $K \propto e^{-E/RT}$

C. $K \propto T\, e^{-E/RT}$

D. None of these

16. The reactions of high molecularity are rare, because

A. Of very large activation energy of many bodies.

B. Of low probability of many body collisions.

C. Many body collisions are not favoured energetically.

D. Of requirement of very large concentration for such reactions.

17. For a first order chemical reaction, the rate constant

A. Changes on changing the concentration units.

B. Is not a function of the unit of time.

C. Has unit of $time^{-1}$.

D. None ofthese.

. 18Arhenious equation shows the variation of _____ with temperature.

A. Reaction rate

B. Rate constant

C. Energy of activation

D. Frequency factor

19 When a catalyst increases the rate of chemical reaction, the rate constant

A. Decreases

B. Increases

C. Remains constant

D. Becomes infinite

20. Higher free energy of activation of a chemical reaction (at a given temperature) implies

A. Slower rate of reaction.

B. Higher rate of reaction.

C. Higher equilibrium conversion.

D. Both (b) and (c).

21. The energy of activation of a chemical reaction

A. Is same as heat of reaction at constant pressure.

B. Is the minimum energy which the molecules must have before the reaction can take place.

C. Varies as fifth power of the temperature.

D. Both (b) and (c).

22. The experimentally determined overall order of the reaction, $A + B \rightarrow C + D$, is two. Then the

A. Reaction is elementary with a molecularity of 2.

B. Molecularity of the reaction is 2, but the reaction may not be elementary.

C. Reaction may be elementary with molecularity of 2.

D. Reaction is elementary but the molecularity may not be 2.

23. Transition state theory gives the rate constant as

A. $K \alpha e^{-E/RT}$

B. $K \alpha e^{e/RT}$

C. $K \alpha T . E^{-E/RT}$

D. $K \alpha T . E^{-E/RT}$

24. For the reaction, $A + B \rightarrow 2B + C$, $\leftrightarrow \rightarrow$

A. $R_a = r_b$

B. $R_a = -r_b$

C. $R_a = 2r_b$

D. $R_a = r_b/2$

24. The order of a chemical reaction is

A. An experimentally determined quantity.

B. Always equal to the total stoichiometric number of reactants.

C. Never fractional.

D. None of these.

25. The molecularity and the order of reaction respectively, for the hydrolysis of methyl acetate in presence of acids are

A. 2 & 1

B. 11 & 2

C. 2 && 2

D. 1 & 1

26. Pick out the wrong statement.

A. Visible radiation provides the necessary activation energy in photochemical reactions.

B. The order and molecularity of a complex reaction may not be the same.

C. For a second order reaction, the slope of the graph/plot between rate and (concentration) is equal to the rate constant (k).

D. Molecularity of the reaction is always a whole number greater than zero.

27. The units of frequency factor in Arhenious equation

A. Are the same as those of the rate constant.

B. Depend on the order of the reaction.

C. Depend on temperature, pressure etc. Of the reaction.

D. Are cycles per unit time.

28. The rate at which a chemical substance reacts is proportional to its

A. Active mass

B. Equivalent weight

C. Molecular weight

D. None of these

29. What is the order of a chemical reaction whose rate is deter-mined by the variation of one concentration term only ?

A. Zero

B. First

C. Second

D. Third

30 _____ explains the mechanism of catalysis.

A. Activated complex theory

B. Collision theory

C. Thermodynamics

D. None of these

31

$$A + 2B \xrightarrow{K} C$$

What is the order of a chemical reaction, , if the rate of formation of '*C*', increases by a factor of 2.82 on doubling the concentration of '*A*' and increases by a factor of 9 on trebling the concentration of '*B*'?

A + 2B → C

A. 7/2

B. 7/4

C. 5/2

D. 5/4

32. The rate constant of a chemical reaction decreases by decreasing the

A. Pressure

B. Concentration of reactant

C. Temperature

D. Duration of reaction

33. '*N*' plug flow reactors in series with a total volume '*V*' gives the same conversion as a single plug flow reactor of volume '*V*' for _____ order reactions.

A. First

B. Second

C. Third

D. Any

34. Specific rate constant for a second order reaction

A. Is independent of temperature.

B. Varies with temperature.

C. Depends on the nature of the reactants.

D. Both (b) and (c).

35. Radioactive decay follows _____ order kinetics.

A. First

B. Second

C. Third

D. Zero.

36. The excess energy of reactants in a chemical reaction required to dissociate into products is termed as the _____ energy.

A. Activation

B. Potential

C. Binding

D. Threshold

37. For a solid catalysed chemical reaction, the effectiveness of solid catalyst depends upon the _____ adsorption.

A. Physical

B. Chemical

C. Both (a) and (b)

D. Neither (a) nor (b)

38. The dimensions of rate constant for reaction $3A \rightarrow B$ are (l/gm mole)/min. Therefore the reaction order is

A. 0

B. 1

C. 2

D. 3

39. Pick out the correct statement

A. Reactions with high activation energies are very temperature sensitive.

B. Chemical equilibrium is a static state.

C. A photochemical reaction is catalysed by light.

D. A chemical reaction occurs when the energy of the reacting molecule is less than the activation energy of the reaction.

40 The rate of the chemical reaction $A \rightarrow B$ doubles as the concentration of *A i.e..*, C_A is doubled. If rate of reaction is proportional to c_a^n, then what is the value of *n* for this reaction ? →

A. 0.5

B. 1

C. 0

D. 2

41. For a homogeneous reaction of nth order, the dimension of the rate constant is given by

A. $L/(time)^n$

B. $(concentration)^{1-n}/(time)$

C. $(concentration)^{n-1}/(time)$

D. None of these

42. The reaction in which the rate equation corresponds to a stoichiometric equation, is called a/an _____ reaction.

A. Elementary

B. Non-elementary

C. Parallel

D. Autokinetic

43. Arrhenious equation represents graphically the variation between the _____ and temperature.

A. Rate of reaction

B. Frequency factor

C. Rate constant

D. Activation energy

44. At a given value of E/R (ratio of activation energy and gas constant), the ratio of the rate

constants at 500°K and 400°K is 2, if Arrhenious law is used. What will be this ratio, if transition state theory is used with the same value of E/R?

A. 1.6

B. 2

C. 2.24

D. 2.5

45. The reaction rate is defined as the rate at which the concentration of the reactants _____ with time or the concentration of products _____ with time.

A. Increase, increase

B. Decrease, decrease

C. Decrease, increase

D. Increase, decrease

46. The unit of rate of reaction is _____

A. Mol L^{-1} s^{-1}

B. Mol L s^{-1}

C. Mol L^{-1} s

D. Mol L s

47. The unit s^{-1} is the unit of rate constant for the reaction of the order is?

A. 1

B. 2

C. 0.5

D. 0

48.. The molecularity of a multi-step reaction does not make any sense.

A. True

B. False

49. The elementary processes with molecularity greater than _____ are not known.

A. View 1

B. 2

C. 3

D. 0

50. Which of the following statement is incorrect about the molecularity of a reaction?

A. It is a theoretical concept
B. Each step of a multi-step reaction has a unique molecularity
C. It is equal to the total number of reactants taking part in elementary step
D. It can be zero, fractional or integer

Unit 3 Interpretation of Batch Reactor Data

1. The half life period of a first order reaction is
   A. Always the same irrespective of the reaction.
   B. Independent on initial concentration of the reactants.
   C. Proportional to the initial concentration of reactants.
   D. Half the specific rate constant.

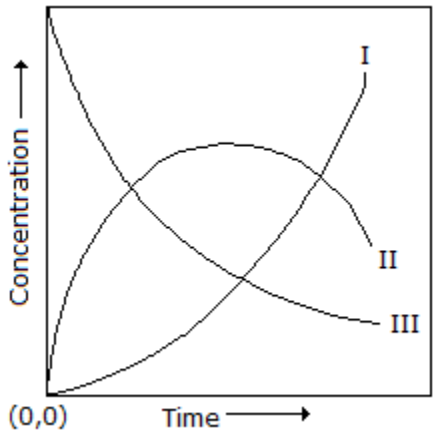
2. If the time required to change the concentration of reactant to half its original value is independent of the initial concentration, the order of reaction is
   A. Zero
   B. One
   C. Two
   D. Three

3. A batch adiabatic reactor at an initial temperature of 373°K is being used for the reaction, $A \rightarrow B$. Assume the heat of reaction is - 1kj/mole at 373°K and heat capacity of both *A* and *B* to be constant and equal to 50J/mole.K. The temperature rise after a conversion of 0.5 will be
   A. 5°C
   B. 10°C
   C. 20°C
   D. 100°C

4. If C_A is the quantity of reactants initially present, the quantity left after '*n*' half periods will be equal to
   A. $\left(\frac{C_A}{2}\right)^n$
   B. $\left(\frac{1}{2}\right)^n . C_A$
   C. $\left(\frac{C_A}{2}\right)^{1/n}$
   D. $(C_A)^{1/2n}$

5. Pick out the wrong statement.
   A. The integral method of analysing kinetic data is used when the data is scattered.
   B. The differential method of analysing kinetic data requires more accurate or larger amounts of data.
   C. When the reaction rate is independent of temperature, the reaction is said to be of zero order.
   D. The ratio of volumes of plug flow reactor to that of mixed reactor is always less than one for identical feed composition, flow rate, conversion and for all positive reaction orders.

6. A first order homogeneous reaction of the type $X \rightarrow Y \rightarrow Z$ (consecutive reaction) is carried out in a CSTR. Which of the following curves respectively show the variation of the concentration of X, Y and Z with time?



   A. I, II, III
   B. III, II, I
   C. III, I, II
   D. II, III, i

7. The half life period of a first order reaction is given by (where, K = rate constant.)
   A. 1.5 K
   B. 2.5 K
   C. 0.693/K
   D. 6.93 K

8. Half life period of a chemical reaction is
   A. The time required to reduce the concentration of the reacting substance to half its

initial value.

B. Half of the space time of a reaction.

C. Half of the residence time of a reaction.

D. None of these

9. According to the 'law of mass action', the rate of reaction is directly proportional to the
   A. Equilibrium constant.
   B. Volume of the reaction vessel.
   C. Nature of the reactants.
   D. Molar concentration of the reactants.

10. A chemical reaction is of zero order, when the reaction rate is (where, C_A = concentration of reactant)
   A. $\propto C_A$.
   B. $\propto 1/C_A$.
   C. Independent of temperature.
   D. None of these.

11. Limiting reactant in a chemical reaction decides the
   A. Rate constant
   B. Conversion
   C. Reaction speed
   D. Equilibrium constant.

12. Consider the 'n' th order irreversible liquid phase reaction $A \rightarrow B$. Which one of the following plots involving half life of the reaction ($t_{1/2}$) and the initial reactant concentration (C_{A0}) gives a straight line plot ?
   A. C_{A0} *Vs* $t_{1/2}$
   B. Ln C_{A0} *Vs* $t_{1/2}$
   C. C_{A0} *Vs* ln $t_{1/2}$
   D. Ln C_{A0} *Vs* ln $t_{1/2}$

13 Reaction rate of a first order reaction, which is half completed in 23 minutes will be

A. 0.03 sec^{-1}

B. 0.03 min^{-1}

C. 0.03 hr^{-1}

D. 0.05 min^{-1}

14

The half life period 't' of a zero order reaction, $A \xrightarrow{K} \text{Products}$, is equal to

A. $C_{A0}/2K$

B. C_{A0}/K

C. $0.693/K$

D. $1/K$

15 Half life period of a first order irreversible reaction $A \rightarrow B$ is

A. $K/2$

B. Ln $k/2$

C. Ln $2/k$

D. Ln $0.5/k$

16. Which of the following fixes the volume of a batch reactor for a particular conversion and production rate ?

A. Operating conditions (e.g. Pressure and temperature)

B. Rate constant

C. Density of mixture

D. None of these

17.

Volume change for unimolecular type first order reaction $A \xrightarrow{K} 4R$, increases _____ with time.

A. Linearly

B. Exponentially

C. Parabolically

D. Logarithmically

18. Integral method for analysing the kinetic data is used

A. When the data are scattered.

B. For testing specific mechanisms with simple rate expressions.

C. Both (a) and (b)

D. None of these.

19. The fractional volume change of the system for the isothermal gas phase reaction, $A \rightarrow 3B$, between no conversion and complete conversion is

A. 0.5

B. 1

C. 2

D. 3

20. For a reaction of the type, $V \xrightarrow{K_1} X \xrightarrow{K_2} Y \xrightarrow{K_3} Z$, the rate of reaction ($-r_x$) is given by

A. $(K_1+K_1)C_X$

B. $(K_1+K_2+K_3)C_X$

C. $K_1C_V - K_2C_X$

D. $(K_1-K_2)C_X$

21. For the irreversible elementary reactions in parallel *viz* $X \xrightarrow{k_2} Y \; ; \; X \xrightarrow{k_1} Z$, the rate of disappearance of 'X' is equal to

A. $C_A(K_1+K_2)$

B. $C_A(K_1 + K_2)/2$

C. $C_A \,.\, K_1/2$

D. $C_A \,.\, K_2/2$

22. For a zero order chemical reaction, the

A. Half life period is directly proportion to the initial concentration of the reac-tants.

B. Plot of products concentration with time is a straight line through the origin.

C. Products concentration increases linerarly with time.

D. All (a), (b) and (c).

23. If the time required to complete a definite fraction of reaction varies inversely as the concentration of the reactants, then the order of reaction is

A. 0

B. 1

C. 2

D. 3

24. Fractional conversion _____ with increase in pressure for ammonia synthesis reaction *i.e.*, $N_2 + 3H_2 \rightleftharpoons 2NH_3$.

A. Increases

B. Decreases

C. Remains unchanged

D. Unpredictable from the data

25. A first order irreversible reaction, $A \rightarrow B$ is carried out separately in a constant volume as well as in a variable volume reactor for a particular period. It signifies that _____ in the two reactors.

A. Both conversion as well as concentration are same

B. Conversion in both will be the same but concentrations will be different

C. Both the conversion as well as concentrations will be different

D. None of these.

26. The fractional volume change between no conversion and complete conversion, for the isothermal gas phase reaction, $2A \rightarrow R$, is

A. 0.5

B. -0.5

C. 1

D. 1.5

27. The reaction $A \rightarrow B$ is conducted in an isothermal batch reactor. If the conversion of A increases linearly with holding time, then the order of the reaction is

A. 0

B. 1

C. 1.5

D. 2

28. For identical flow rate, feed composition and for elementary first order reactions, '*N*' equal sized mixed reactors in series with a total volume '*V*' gives the same conversion as a single plug flow reactor of volume '*V*' for constant density systems. This is true, when the value of '*N*' is

A. 1

B. >1

C. ∞

D. ≥ 1

29. A chemical reaction, $A \rightarrow 3B$, is conducted in a constant pressure vessel. Starting with pure *A*, the volume of the reaction mixture increases 3 times in 6 minutes. The fractional conversion is

A. 0.33

B. 0.5

C. 1

D. Data insufficient, can't be predicted

30. The conversion X_A and residence time data are collected for zero order liquid phase reaction in a stirred tank reactor. Which of the following will be a straight line ?

A. X_A *Vs* . T

B. X_A *Vs* ln τ

C. $X_A/(1 - X_A)$*Vs* τ

D. $X_A(1 - X_A)$*Vs* τ

31. The rate of the reaction, $X \rightarrow Y$, quadruples when the concentration of '*X*' is doubled. The rate expression for the reaction is, $r = K C_x^n$, the value of '*n*' in this case will be

A. 0

B. 1

C. 2

D. 3

32 For a zero order reaction, the concentration of product increases with the

A. Increase of reaction time.

B. Increase in initial concentration.

C. Total pressure.

D. Decrease in total pressure.

33. Differential method for analysing the kinetic data is used

A. For testing complicated mechanisms.

B. When the data are scattered.

C. When rate expressions are very simple.

D. None of these.

34. In case of the irreversible unimolecular type, first order reaction, the fractional conversion at any time for constant volume system as compared to variable volume system is

A. More

B. Less

C. Same

D. Either (a) or (b), depends on other factors

35. Integral method for analysing the kinetic data is used

A. When the data are scattered.

B. For testing specific mechanisms with simple rate expressions.

C. Both (a) and (b).

D. None of these.

Unit 4 Ideal Reactors

1. A plug-flow reactor is characterised by
   A. High capacity.
   B. Presence of axial mixing.
   C. Presence of lateral mixing.
   D. Constant composition and temperature of reaction mixture.

2. Pick out the wrong statement.
   A. 'Hold back' is defined as the fraction of material that stays longer than the mean residence time.
   B. Study of non-ideal flow reactor is done experimentally by stimulus-response technique.
   C. For studying a chemical reaction, it is desirable to monitor the reactants during initial stages and the products during the final stages of reaction.
   D. A batch reactor can not be used to study the kinetics of catalytic reaction.

3. Pick out the wrong statement.
   A. In a batch reactor, which is exclusively used for liquid phase reactions; temperature pressure and composition may vary with time.
   B. In a semi-batch reactor, one reactant is charged batchwise, while the other reactant is fed continuously.
   C. In a continuous flow reactor, uniform concentration can not be maintained throughout the vessel even in a well agitated system.
   D. In a continuous flow reactor, both the reactants and the products flow out continuously.

4. Which of the following will give maximum gas conversion ?
   A. Fixed bed reactor.
   B. Fluidised bed reactor.
   C. Semi-fluidised bed reactor.
   D. Plug-flow catalytic reactor.

5. The most unsuitable reactor for carrying out reactions in which high reactant concentration favours high yields is

A. Backmix reactor

B. Plug flow reactor

C. Series of CSTR

D. PFR in series

6. A reactor is generally termed as an autoclave, when it is a
   A. High pressure batch reactor.
   B. Atmospheric pressure tank reactor.
   C. High pressure tubular reactor.
   D. Atmospheric pressure CSTR.

7. 6 gm of carbon is burnt with an amount of air containing 18 gm oxygen. The product contains 16.5 gms CO_2 and 2.8 gms CO besides other constituents. What is the degree of conversion on the basis of disappearance of limiting reactant ?
   A. 100%
   B. 95%
   C. 75%
   D. 20%

8. Which of the following is the most suitable for very high pressure gas phase reaction ?
   A. Batch reactor
   B. Tubular flow reactor
   C. Stirred tank reactor
   D. Fluidised bed reactor

9. A batch reactor is suitable for
   A. Achieving cent percent conversion of reactants into products.
   B. Large scale gaseous phase reactions.
   C. Liquid phase reactions.
   D. Obtaining uniform polymerisation products in highly exothermic reactions.

10. Semibatch reactor is preferred, when a/an

A. A highly exothermic reaction is to be controlled.

B. Undersirable side reaction (at high concentration of one of the reactants) is to be avoided.

C. A gas is to be reacted with liquid (e.g. Hydrogenation of fat).

D. All (a), (b), and (c).

11. A stirred tank reactor compared to tubular-flow reactor provides

A. More uniform operating conditions.

B. Permits operation at the optimum temperature for a long reaction time.

C. Higher overall selectivity for a first order consecutive reaction.

D. All (a), (b) and (c)

12. In an ideal tubular-flow reactor

A. There is no mixing in longitudinal direction.

B. Mixing takes place in radial direction.

C. There is a uniform velocity across the radius.

D. All (a), (b) and (c).

13. In case of _____ reactions, the reaction rate does not decrease appreciably as the reaction proceeds.

A. Catalytic

B. Parallel

C. Series

D. Auto catalytic

14. For nearly isothermal operation involving large reaction time in a liquid-phase reaction, the most suitable reactor is a _____ reactor.

A. Stirred tank

B. Tubular flow

C. Batch

D. Fixed bed

15. A batch reactor is characterised by

A. Constant residence time.

B. Variation in extent of reaction and properties of the reaction mixture with time.

C. Variation in reactor volume.

D. Very low conversion.

15. A backmix reactor

A. Is same as plug-flow reactor.

B. Is same as ideal stirred tank reactor.

C. Employs mixing in axial direction only.

D. Is most suitable for gas phase reaction.

16. In a semi-batch reactor,

A. Mixing takes place in axial direction only.

B. Velocity of reaction can be controlled.

C. Condition similar to plug flow reactor exists.

D. Residence time is constant.

17. Sometimes, batch process is preferred over continuous process, when the product

A. Quality & yield can not be achieved in continuous processes, because of long residence time.

B. Sales demand is fluctuating.

C. Both (a) & (b).

D. Neither (a) nor (b).

18. A batch reactor is

A. Suitable for gas-phase reactions on commercial scale.

B. Suitable for liquid phase reactions involving small production rate.

C. Least expensive to operate for a given rate.

D. Most suitable for very large production rate.

19. Which of the following is used for calcination of limestone and dolomite in industrial practice ?

A. Fluidised bed reactor

B. Moving bed reactor

C. Fixed bed reactor

D. None of these

20. Which of the following is a characteristic of an ideal plug flow reactor ?

A. Axial dispersion

B. Flat velocity profile

C. Uniform mixing

D. None of these

21 For a fluidised bed reactor, the most suitable/relevant model is a _____ model.

A. Tank in series

B. Bubbling bed

C. Plug flow

D. None of these

22. The most suitable reactor for carrying out an auto-thermal reaction is a

A. Batch reactor

B. CSTR

C. Semi-batch reactor

D. Plug-flow reactor

. 23Slurry reactors are characterised by the

A. Lack of intraparticle diffusion resistance.

B. Presence of two mobile phases.

C. Both (a) and (b).

D. Neither (a) nor (b).

24. Which of the following is the most suitable for isothermal operation ?

A. Batch reactor

B. Back-mix reactor

C. Plug-flow reactor

D. Fixed bed reactor

25 Oil is hydrogenated using nickel catalyst in a _____ reactor.

A. Batch

B. Slurry

C. Fluidised bed

D. Fixed bed

26 Which of the following is the optimum operating condition for an exothermic reversible reaction taking place in a plug-flow reactor ?

A. Temperature should be high in the beginning and decreased towards the end of the reaction.

B. Very low temperature should be used throughout the reaction.

C. Very high temperature should be used throughout the reaction.

D. None of these.

27. When a high liquid hold up is required in a reactor for gas liquid reaction, use _____ coloumn.

A. Packed

B. Spray

C. Tray

D. Bubble

28. In case of a P.F.R., there

A. May be lateral mixing of fluid.

B. Should not be any mixing along the flow path.

C. Both (a) and (b).

D. Neither (a) nor (b).

29. In a continuous flow stirred tank reactor, the composition of the exit stream

A. Is same as that in the reactor.

B. Is different than that in the reactor.

C. Depends upon the flow rate of inlet stream.

D. None of these.

30. In a semi-batch reactor

A. Velocity of reaction can be controlled.

B. Maximum conversion can be controlled.

C. Both the reactants flow counter-currently.

D. Residence time is constant.

31. A trickle bed reactor is the one, which

A. Has altogether three streams either entering or leaving.

B. Processes three reactants at different flow rates.

C. Processes three reactants with same flow rate.

D. Employs all the three phases (i.e.. .solid, liquid and gas).

32. The preferred reacting system for oxidation of o-xylene to phthalic anhydride is

A. Jacketted liquid phase CSTR.

B. Jacketted steam heated multitubular reactor.

C. Multitubular reactor with cooling.

D. Multistage multitubular reactor with interstage cooling.

33. For a packed bed reactor; the presence of a long tail in the residence time distribution curve is an indication of

A. Ideal plug flow

B. Bypass

C. Dead zone

D. Chanelling

34. An example of autothermal reactor operation is

A. Sulphur dioxide oxidation

B. Ethylene oxidation

C. Benzene oxidation

D. Ammonia synthesis

35. In an ideal P.F.R. at steady state conditions

A. The composition of reactants remains constant along a flow path.

B. The conversion of the reactant varies from point to point along a flow path.

C. There is no lateral mixing of fluid.

D. There may be diffusion along the flow path.

36. In an ideal mixed reactor (at steady state), the

A. Space time is equivalent to holding time for constant density systems.

B. Composition throughout the reactor remains same.

C. Exit stream has the same composition as the fluid within the reactor.

D. All (a), (b) and (c).

37. In case of a _____ reactor, the composition in the reactor and at the exit of the reactor is the same.

A. Semi-batch

B. Tubular

C. Batch

D. Back-mix

38. Backmixing is most predominant in

A. A well stirred batch reactor.

B. A plug-flow reactor.

C. A single CSTR.

D. CSTR's connected in series.

39. Fluidised bed reactor is characterised by

A. Uniformity of temperature.

B. Comparatively smaller equipment.

C. Very small pressure drop.

D. Absence of continuous catalyst regeneration facility.

40. Vegetable oils are hydrogenated in a _____ reactor.

A. Slurry

B. Plug flow

C. Homogeneous catalytic

D. None of these

41. In a CSTR _____ varies with time.

A. Reaction rate

B. Concentration

C. Both (a) & (b)

D. Neither (a) nor (b)

42. Autocatalytic reactions are best carried out in a

A. CSTR

B. CSTR in series

C. Plug flow reactor

D. Recycle reactor

43. A batch reactor suffers from following disadvantage.

A. Poor product quality control.

B. High labour and handling cost.

C. High shutdown time requirement for emptying, cleaning and refilling.

D. All (a), (b)and(c).

44. Basic Purposes of Reactors is

A. Mixing of substrates, contacting catalyst

B. Mass transfer (G/L, L/L, G/S, L/S)

C. Heat transfer

D. All of above

45.Batch operation has the following characteristics

A. Time variant conditions

B. Discontinuous production

C. Downtime for cleaning and filling

D. Flexibility

E. All of above

46. Which one is correct for batch reactor.

A. Batch operation is most flexible.

B. Reactors can be used for multiple purposes.

C. This is particularly important for the fine chemical industry where multiple products are produced in one plant.

D. All of above

47. Continuous Operation has the following characteristics:

A. Time variant conditions

B. Discontinuous production

C. No variation of concentrations with time

D. All of above

48. In Continuous Operation, reaction rate remains constant.

A. True

B. False

49. Advantaged of Continuous flow reactor

A. Provides high production;

B. Better product quality due to constant conditions;

C. Good for kinetic studies

D. All of above

50. In a bubble column reactor, the mass transfer depends on the size of the bubble.

A. True

B. False

51. Bubble column reactor provides better mixing than airlift reactors.

A. True

B. False

52. Bubble column reactor is used in the production of Bakers' yeast, Beer, and Vinegar. It is also used in aeration and treatment of wastewater.

A. True

B. False

Unit 5 Design of Single Ideal Reactor

1. Which of the following is an independent variable for a batch tank reactor with uniform concentration and temperature ?
   A. Time
   B. Useful volume of the tank
   C. Diameter of the reactor
   D. None of these

2. A high space velocity means that a given
   A. Reaction can be accomplished with small reactor.
   B. Conversion can be obtained with a high feed rate.
   C. Both (a) and (b).
   D. None of these.

3. In flow reactors, the performance equations interrelate the rate of reaction to the
   A. Feed rate.
   B. Reactor volume,
   C. Extent of reaction.
   D. All (a), (b) and (c).

4. For a first order reaction carried out in a plug flow reactor, the space time is
   A. $\frac{1}{K} \ln \frac{C_0}{C}$
   B. $\frac{1}{K} \ln \frac{C}{C_0}$
   C. $K \ln \frac{C_0}{C}$
   D. $K \ln \frac{C}{C_0}$

5. For an isothermal second order aqueous phase reaction, $A \rightarrow B$, the ratio of the time required for 90% conversion to the time required for 45% conversion is
   A. 2

B. 4

C. 11

D. 22

6. An imbalanced chemical reaction equation is against the law of

A. Multiple proportion

B. Conservation of mass

C. Constant proportion

D. None of these

7 $A \xrightarrow{K_1} R \xrightarrow{K_2} S$

In case of a consecutive unimolecular type first order reaction , the concentration of component _____ increases continuously with time.

A. *S*

B. *R*

C. *A*

D. None of these

8. $A \xrightarrow{k} 2B$

An elementary liquid phase decomposition reaction is to be carried out in a CSTR. The design equation is

A. $K\tau = X_A/(1 - X_A)$

B. $K\tau = X_A(1 + X_A)/(1 + X_A)$

C. $K\tau = X_A/(1 - X_A)^2$

D. $k\tau C_{A_0} = \frac{X_A/(1 + X_A)^2}{(1 - X_A)^2}$

9. Which of the following is an autocatalytic reaction ?

A. Photochemical reactions

B. Microbial fermentation reaction

C. Enzyme fermentation reaction

D. Ammonia synthesis reaction

11. Holding time for flow reactors is _____ the space time, for constant fluid density
    A. Double
    B. Triple
    C. Equal to
    D. None of these.

12. The performance equations for constant density systems are identical for
    A. P.F.R. and backmix reactor.
    B. P.F.R. and batch reactor.
    C. P.F.R, batch reactor and backmix reactor.
    D. Batch reactor and backmix reactor.

13. For a tubular flow reactor with uniform concentration and temperature, the independent variable is
    A. Time
    B. Length
    C. Diameter
    D. None of these

14. The space time is equivalent to the holding time in a steady state mixed reactor for
    A. Non-isothermal gas reaction.
    B. Variable fluid density systems.
    C. Constant fluid density systems.
    D. Gas reactions with changing no. Of moles.

15. With increase in the space time of an irreversible isothermal reaction being carried out in a P.F. reactor, the conversion will
    A. Increase
    B. Decrease
    C. Remain same
    D. Data in insufficient; can't be predicted

16 For a mixed flow reactor operating at steady state, the rate of reaction is given by

A. $\frac{F_{A_0}}{V} - \frac{dC_A}{dt}$

B. $\frac{F_{A_0}}{V} + \frac{dC_A}{dt}$

C. $\frac{F_{A_0}}{V} . X_A$

D. $- \frac{dC_A}{dt}$

17. A space time of 3 hours for a flow reactor means that

A. The time required to process one reactor volume of feed (measured at specified conditions) is 3 hours.

B. Three reactor volumes of feed can be processed every hour.

C. It takes three hours to dump the entire volume of the reactor with feed.

D. Conversion is cent per cent after three hours.

18. An irreversible first order reaction is being carried out in a CSTR and PFR of same volume. The liquid flow rates are same. The relative conversion will

A. Be more in CSTR than in PFR

B. Be more in PFR than in CSTR

C. Be same in both cases

D. Depend on the temperature

20. In case of staged packed bed reactors carrying out exothermic reaction, use

A. High recycle for pure gas

B. Plug flow for dilute liquid requiring no large preheating of feed

C. Cold shot operations for a dilute solution requiring large preheating to bring the stream upto the reaction temperature

D. All (a), (b) and (c)

21. The performance equations for constant density systems are identical for

A. P.F.R. and backmix reactor

B. P.F.R. and batch reactor

C. P.F.R. batch reactor and backmix reactor

D. Batch reactor and backmix reactor

22. Space velocity

A. Describes the extensive operating characteristics of a tubular flow reactor.

B. Is the maximum feed rate pre unit volume of reactor for a given conversion.

C. Is a measure of the ease of the reaction.

D. All (a), (b) and (c)

---

23 A first order reaction requires two equal sized CSTR. The conversion is

A. Less when they are connected in series.

B. More when they are connected in series.

C. More when they are connected in parallel.

D. Same whether they are connected in series or in parallel.

24 The ratio of volume of mixed reactor to the volume of P.F.R. (for identical flow rate, feed composition and conversion) for zero order reaction is

A. ∞

B. 0

C. 1

D. > 1

25 A reactor is generally termed as an autoclave, when it is a

A. High pressure batch reactor.

B. Atmospheric pressure tank reactor.

C. High pressure tubular reactor.

D. Atmospheric pressure CSTR.

26. Space Time

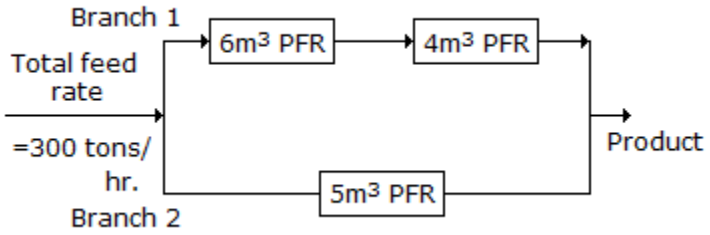
A. Describes the time required to react one reactor volume.

B. Is the maximum feed rate pre unit volume of reactor for a given conversion.

C. Is a measure of the ease of the reaction.

D. All (a), (b) and (c)

27. Three plug flow reactors (PFR's) of 4, 5 & 6 m^3 volumes are arranged in two branches as shown below in the figure.



If the total feed rate is 300 tons/hr, then for the same conversion in each branch, the feed rate through branch II should be _____ tons/hr.

A. 100

B. 150

C. 200

D. 225

28. For a tubular reactor with space time 'τ' and residence time 'θ', the following statement holds good.

A. T and θ are always equal.

B. $T = \theta$, when the fluid density changes in the reactor.

C. $T = \theta$, for an isothermic tubular reactor in which the density of the process fluid is constant.

D. $T = \theta$, for a non-isothermal reactor.

29. When the density of the reaction mixture is constant in a chemical reaction, the ratio of the mean residence time to space time is

A. > 1

B. < 1

C. 1

D. 0

30. Conversion increases with increase in temperature in case of a an _____ reaction.

A. Autocatalytic

B. Irreversible

C. Reversible endothermic

D. Reversible exothermic

31. The conversion for a first order liquid phase reaction. $A \rightarrow B$ in a CSTR is 50%. If another CSTR of the same volume is connected in series, then the % conversion at the exit of the second reactor will be

A. 60

B. 75

C. 90

D. 100

32. Exothermic reactions are best carried out in

A. A CSTR.

B. CSTR in series.

C. A plug flow reactor followed by CSTR.

D. CSTR followed by a plug flow reactor.

33. A space velocity of 5 hr^{-1} means that

A. Five reactor volumes of feed (at specified conditions) are being fed into the reactor per hour.

B. After every 5 hours, reactor is being filled with the feed.

C. Cent per cent conversion can be achieved in at least 5 hours.

D. Fixed conversion of a given batch of feed takes 5 hours.

34 For the same residence time, which one will give the maximum conversion ?

A. Single stirred tank (v = 5 litres).

B. Two stirred tank (each of 2.5 litres) in series.

C. Stirred tank followed by tubular flow reactor (each of 2.5 litres).

D. Single tubular flow reactor (v = 5 litres).

35. For identical flow rate and feed composition, X plug flow reactors (PER) in series with a total volume V gives the same conversion as single

A. CSTR of volume V

B. PFR of volume V

C. CSTR of volume V/X

D. PFR of volume V/X

36. With the same reaction time, initial concentration and feed rate, the reaction $2A \rightarrow B$ is carried out separately in CSTR and P.F. reactor of equal volumes. The conversion will be

A. Higher in P.F. reactor

B. Higher in CSTR

C. Same in both the reactors

D. Data insufficient; can't be predicted

37. The use of space time is preferred over the mean residence time in the design of a/an

A. Batch reactor

B. Ideal tubular-flow reactor

C. Slurry reactor

D. CSTR

38. A first order reaction is to be treated in a series of two mixed reactors. The total volume of the two reactors is minimum, when the reactors are

A. Equal in size.

B. Of different sizes.

C. Of such size that the ratio of their volumes is < 5.

D. None of these.

39. A space velocity of 9 hr^{-1} means that

A. After every 9 hours, reactor is being filled with the feed.

B. Nine reactor volumes of feed (at specified conditions) are being fed into the reactor per hour.

C. A fixed conversion of a given batch of feed takes 9 hours.

D. None of above

40. The Damkohler numbers (Da) are dimensionless numbers used in chemical engineering to relate the chemical reaction timescale (reaction rate) to the transport phenomena rate occurring in a system.

A. True

B. False

41. For a first order reaction Damkohler numbers is the product of time space and reaction rate constant.

A. True

B. False

42. Low value of Damkohler numbers indicates high conversion.

A. True

B. False

43. The space velocity is the proper performance measure of flow reactors having the units of

A. Time

B. $(\text{Time})^{-1}$

C. Velocity

D. $(\text{velocity})^{-1}$

44. Units of the space time is

A. Time

B. $(\text{Time})^{-1}$

C. Velocity

D. $(\text{velocity})^{-1}$

45.A space-time of 2 hour means that

A. After every 2 hours, reactor is being filled with the feed.

B. A fixed conversion of a given batch of feed takes 2 hours.

C. Both of above

D. Two reactor volumes of feed (at specified conditions) are being fed into the reactor per hour.

46. Performance equation for PFR

A. $t = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

B. $\mathrm{T} = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

C. $\mathrm{T} = \frac{C_{A0} X_A}{-r_A}$

D. None

47. Performance equation for CSTR

A. $t = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

B. $\mathrm{T} = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

C. $\mathrm{T} = \frac{C_{A0} X_A}{-r_A}$

D. None

48. Performance equation for Batch Reactor

A. $t = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

B. $\mathrm{T} = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A}$

C. $\mathrm{T} = \frac{C_{A0} X_A}{-r_A}$

D. None

49. Time required to process one reactor volume of feed measured at specified conditions in known as Space time.

A. True

B. False

50. Number of reactor volumes of feed at specified conditions which can be treated in unit time is known as Space velocity.

A. True

B. False

Unit 6 Design for Single Reactions

1. For reactions in parallel viz $A \rightarrow P$ (desired product) and $A \rightarrow Q$ (unwanted product), if the order of the desired reaction is higher than that of the undesired reaction, a
   A. Batch reactor is preferred over a single CSTR for high yield.
   B. Tubular reactor is preferred over a single CSTR for high yield.
   C. Both (a) and (b).
   D. Single CSTR is the most suitable.

2. A first order reaction requires two unequal sized CSTR. Which of the following gives higher yield ?
   A. Large reactor followed by smaller one.
   B. Smaller reactor followed by larger one.
   C. Either of the arrangement (a) or (b) will give the same yield.
   D. Data insufficient, can't be predicted.

3. When all the limiting reactant is consumed in the reaction, the operational yield _____ the relative yield.
   A. Is greater than
   B. Is smaller than
   C. Equals
   D. Can be either greater or smaller than (depends on the type of reaction)

4. The optimum performance for reactors operating in parallel is obtained when the feed stream is distributed in such a way, that the
   A. Space time for each parallel line is same.
   B. Space time for parallel lines is different.
   C. Larger reactors have more space time compared to smaller ones.
   D. None of these.

5. Which of the following is a controlling factor in very fast heterogeneous reaction ?
   A. Heat and mass transfer effects
   B. Pressure
   C. Temperature

D. Composition of reactant

6. For an autocatalytic reactor, the suitable reactor set up is
   A. P.F. reactors in series.
   B. CSTR in series.
   C. CSTR followed by P.F. reactor.
   D. P.F. reactor followed by CSTR.

7. Pick the WRONG design guideline for a reactor in which the reactions, $A \rightarrow R$ (desired) and $A \rightarrow S$ (undesired) are to take place. The ratio of the reaction rates is $\frac{r_R}{r_S} = (k_1/k_2).C_A^{a-b}$.
   A. Use high pressure and eliminate inerts, when a > b.
   B. Avoid recycle, when a > b.
   C. Use batch reactor or plug flow reactor, when a > b.
   D. Use CSTR with a high conversion, when a > b.

8. With increase in temperature, the equilibrium _____ rises in case of endothermic reaction.
   A. Constant
   B. Conversion
   C. Both (a) & (b)
   D. Neither (a) nor (b)

9 Considering the endotheomic dissociation of $caco_3$ in a closed vessel ($caco_3 \rightleftharpoons cao + CO_2$), the pressure of CO_2 increases, if
   A. A catalyst is added.
   B. The temperature is increased.
   C. An inert gas is pumped keeping the temperature constant.
   D. None of these.

10 Reverse reaction in a chemical equilibrium is favoured by the
   A. Removal of one of the products regularly.
   B. Increase in the concentration of oneof the products.

C. Increase in the concentration of one of the reactants.

D. None of these.

11. A multiple reaction may be classified as a _____ reaction.

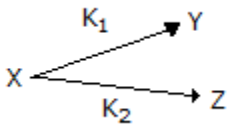
A. Consecutive or side

B. Parallel or side

C. Mixed

D. All (a), (b) and (c)

12. The point selectivity of the product '*Y*' in the reaction,



is equal to

A. K_1/K_2

B. K_2/K_1

C. K_1-K_2

D. K_2-K_1

13. An irreversible first order reaction is being carried out in a CSTR and PFR of same volume. The liquid flow rates are same. The relative conversion will

A. Be more in CSTR than in PFR.

B. Be more in PFR than in CSTR.

C. Be same in both cases.

D. Depend on the temperature.

14 Pick out the wrong statement.

A. For a first order consecutive reaction, a tubular flow reactor as compared to a stirred tank reactor provides higher overall selectivity.

B. For an ideal mixed reactor at steady state, the exit stream has the same composition as fluid within the reactor and the space time is equivalent to holding time for constant density system.

C. Plug flow reactor (PFR) is always smaller than mixed reactor for all positive reaction orders for a particular duty.

D. Reaction rate does not decrease appreciably as the reaction proceeds in case of an autocatalytic reaction.

15 The size of plug flow reactor (PFR) for all positive reaction orders and for any given duty, is _____ that of mixed reactor.

A. Greater than

B. Equal to

C. Smaller than

D. Unpredictable from the data

16. With decrease in temperature, the equilibrium conversion of a reversible endother-mic reaction

A. Decreases

B. Increases

C. Remains unaffected

D. Increases linearly with temperature

17. In an exothermic chemical reaction, the reactants compared to the products have

A. Higher temperature

B. More energy

C. Less energy

D. Same energy.

18. $A \xrightarrow{E_1} B \xrightarrow{E_2} C$

In a consecutive reaction system when E_1 is much greater than E_2, the yield of B increases with the

A. Increase of temperature.

B. Decrease of temperature.

C. Increase in initial concentration of A.

D. Decrease in initial concentration of A.

19 A reversible liquid phase endothermic reaction is to be carried out in a plug flow reactor. For minimum reactor volume, it should be operated such that the temperature along the length

A. Decreases.

B. Increases.

C. Is at the highest allowable temperature throughout.

D. First increases and then decreases.

20. Rate of an autocatalytic chemical reaction is a function of

A. Temperature only.

B. Pressure only.

C. Composition only.

D. All (a), (b) and (c).

21. For series reaction, the relative yield

A. Is always greater for plug-flow reactor than for the single CSTR of the same volume.

B. Statement in (a) is wrong.

C. Decreases with increasing conversion.

D. Both (a) and (c) hold good.

22.Following factor is consider during selection of reactor system

A. Type of reaction

B. Scale of production

C. Cost of equipment and operation

D. All of above

23. Following factor is consider during selection of reactor system

A. Flexibility of operation

B. Equipment life

C. Safety

D. All of above

24. For a given duty the ratio of the size of a CSTR and PFR depends upon

A. Extent of reaction

B. Stoichiometry

C. From of rate expression

D. All o above

25. For a given duty and for all positive reaction order of size of CSTR is always larger than PFR.

A. True

B. False

26. Size of reactor is independent of type of flow for zero order reaction.

A. True

B. False

27. The volume ratio of V_{CSTR}/V_{PFR} decreased with reaction order.

A. True

B. False

28. For low value of conversion, the reactor size is slightly affected by the type of flow.

A. True

B. False

29. As the conversion approach zero, the volume/size ratio of CSTR and PFR approach_____.

A. 0

B. 1

C. 2

D. 3

30. Size ratio increase very rapidly at high value of conversions.

A. True

B. False

31. If density increase during reaction, the effectiveness of CSTR is better as compared to PFR.

A. True

B. False

32. A plug flow reactor is more efficient than a mixed flow reactor for reactions whose rates increase with reactant concentration, such as nth-order irreversible reactions, $n > 0$.

A. True

B. False

33. In Recycle reactor the recycle ratio is zero. This means the reactor is basically a

A. PFR

B. CSTR

C. PFR with zero radial mixing

D. PFR with substantial axial dispersion

34. In Recycle reactor the recycle ratio is infinity. This means the reactor is basically a

A. PFR

B. CSTR

C. PFR with zero radial mixing

D. PFR with substantial axial dispersion

35. Multiple reaction may be classified as

A. Consecutive or side reaction

B. Parallel reaction

C. Mixed reaction

D. All of above

36. In order to realize a specifed conversion for a zero order reaction ,volume of a CSTR is

A. More than the volume of a PFR

B. Less than the volume of a PFR

C. Equal than the volume of a PFR

D. Twice than the volume of a PFR

37. A first order reaction is to be conducted in a series of two mixed reactors .Total volume of two reactors is minimum when

A. The reactor are equal in size

B. The ratio of volume of the first and second reactor is 2:1

C. The ratio of volume of the first and second reactor is 1:2

D. None of above

38.The disadvantage (s) of batch reactor is

A. High labour and handling cost

B. Poorer quality control of the product

C. Considerable shutdowm time of empty,clean out and refill

D. All of above

39.For identical feed composition and flow rate ,N plug flow reactor in series with a total volume V gives the same conversion as single

A. Plug-flow reactor of volume V

B. CSTR of volume V

C. Plug-flow reactor of volume V/N

D. Plug-flow reactor of volume NV

40.For a state mixed reactor,the space-time is equivalent to the holding time for

A. Constant fluid density system
B. Variable fluid density system
C. Non-isothermal gas reactions
D. Gas reactions with changing number of moles

41.Independent variable for a batch reactor with uniform concentration and temperature is

A. Time
B. Useful volume of tank
C. Diameter of reactor
D. None of above

42. For a tubular flow reactor with uniform concentration and temperature ,the independent variable is

A. Time
B. Length
C. Diameter
D. None of above

44.A homogeneous liquid phase reaction is conducted in a batch strirred reactor at a certain speed of agitation .If the speed of agitation is doubled,

A. The reaction rate will double
B. The reaction rate will be halved
C. The reaction rate will remain unaffected
D. The reaction rate will decrease b y a factor less than two

45. Batch reactors are industrially used

A. For production of fine chemicals
B. For production of heavy chemicals
C. When relatively small amount of material are to treated
D. For conducting fermentation

46.An ideal plug flow reactor should have the following characteristics

A. No back mixing of the reaction and products
B. Complete back mixing of the reactants and products
C. Uniform temperature ,pressure and composition across any section normal to fluid motin

D. Uniform temperature ,pressure and composition at any location in the longitudinal direction

47.In an ideal mixed reactor at steady stae,

A. Composition throughout the reactor remains same
B. Exits stream has the same composition as the fluid within reactor
C. Space-time is equivalent to holding time for constant density systems
D. All of above

48. Total Volume of CSTR in series in is _____than the volume of single CSTR to achive same conversion.

A. Less
B. Greater
C. Equal
D. None

49. Optimum size ratio of two CSTR in series is found to be dependent on

A. Reaction kinetics
B. Level of conversion
C. Both of above
D. None of above

50. For first order reaction _____CSTR in series are best.

A. Equal size
B. Small size CSTR followed by large size CSTR
C. Large size CSTR followed by small size CSTR
D. None of above

51. Recycle reactor are used in following situation

A. When reaction is autocatalytic
B. To maintain isothermal operation of the reactor
C. To promote certain selectivity
D. All of above