

Chemical Engineering

1. A substance existing as a gas at a temperature below its critical temperature is called a:

- A) Vapor
- B) Ideal gas
- C) Permanent gas
- D) Non-condensable gas

Answer: A) Vapor

Explanation: A vapor is a gas that can be liquefied by the application of pressure alone, without lowering its temperature, as long as it is below its critical temperature.

2. For flow over a sphere, the drag coefficient is lowest in which flow regime?

- A) Stokes' flow regime
- B) Newton's flow regime
- C) The transition regime just after the critical Reynolds number
- D) Highly turbulent regime

Answer: C) The transition regime just after the critical Reynolds number

Explanation: At a critical Reynolds number (around 3×10^5), the boundary layer on the sphere becomes turbulent, which delays separation and causes a sudden, sharp drop in the drag coefficient. This is known as the "drag crisis."

3. In a heat exchanger, if the hot and cold fluids flow in the same direction, the flow arrangement is called:

- A) Counter-current flow
- B) Cross flow
- C) Co-current or parallel flow
- D) Regenerative flow

Answer: C) Co-current or parallel flow

Explanation: In parallel flow, both fluids enter at one end and exit at the other, flowing in the same direction. This arrangement is less thermally efficient than counter-current flow.

4. 'Angle of repose' is a property of granular materials that is important for the design of:

- A) Pumps
- B) Heat exchangers

C) Hoppers and silos

D) Distillation columns

Answer: C) Hoppers and silos

Explanation: The angle of repose is the steepest angle at which a pile of granular material is stable. It is used to design the cone angle of hoppers to ensure reliable gravity flow (mass flow or funnel flow).

5. The Chilton-Colburn analogy relates the transfer coefficients for:

A) Heat, mass, and momentum.

B) Heat and mass only.

C) Mass and momentum only.

D) Heat and momentum only.

Answer: A) Heat, mass, and momentum.

Explanation: This is a powerful analogy that allows experimental data from one type of transport phenomenon (e.g., momentum transfer, which is related to friction factor) to be used to predict the coefficients for the other two.

6. The purpose of adding tetraethyllead (now phased out) to gasoline was to:

A) Increase its energy content.

B) Act as an anti-knock agent to increase the octane number.

C) Improve its viscosity.

D) Act as a lubricant.

Answer: B) Act as an anti-knock agent to increase the octane number.

Explanation: Tetraethyllead was a very effective octane booster, but it was phased out due to its toxicity and the environmental damage caused by lead emissions.

7. What is the primary function of a granulator in a fertiliser plant?

A) To dissolve raw materials.

B) To mix liquid fertilisers.

C) To agglomerate fine powders into larger, more uniform granules.

D) To dry the final product.

Answer: C) To agglomerate fine powders into larger, more uniform granules.

Explanation: Granulation improves the handling, storage, and application properties of fertilisers by reducing dust, preventing caking, and ensuring a uniform distribution of nutrients.

8. 'Crystallization' is a process used to separate a solute from a solution by:

- A) Changing its chemical structure.
- B) Adsorbing it onto a solid surface.
- C) Forming a solid phase with a highly ordered internal structure.
- D) Vaporizing the solvent.

Answer: C) Forming a solid phase with a highly ordered internal structure.

Explanation: Crystallization is a powerful purification technique because the regular structure of a crystal tends to exclude impurities, leading to a very pure solid product.

9. The 'gross heating value' (GHV) of a fuel is the same as its:

- A) Net heating value (NHV).
- B) Lower heating value (LHV).
- C) Higher heating value (HHV).
- D) Latent heat of combustion.

Answer: C) Higher heating value (HHV).

Explanation: The HHV, or GHV, is the heat of combustion calculated assuming that the water produced in the combustion is fully condensed back to a liquid, thus recovering its latent heat of vaporization.

10. A 'transducer' in an instrumentation system is a device that:

- A) Displays the measured value.
- B) Converts the measured physical quantity into a standardized signal (e.g., electrical).
- C) Transmits the signal over a long distance.
- D) Controls the final element.

Answer: B) Converts the measured physical quantity into a standardized signal (e.g., electrical).

Explanation: A transducer is the primary sensing element that interacts with the process and converts a physical variable like temperature, pressure, or flow into a more easily processed signal.

11. An 'isentropic' process is a thermodynamic process that is both:

- A) Adiabatic and reversible.
- B) Isothermal and reversible.
- C) Isobaric and adiabatic.
- D) Isochoric and isothermal.

Answer: A) Adiabatic and reversible.

Explanation: An isentropic process is an idealized process where there is no heat transfer and no entropy generation (due to irreversibilities like friction). The entropy of the system remains constant.

12. The 'Damköhler number' (Da) is a dimensionless group used in chemical reaction engineering to relate the:

- A) Reaction rate to the mass transfer rate.
- B) Reaction rate to the heat transfer rate.
- C) Reaction rate to the bulk transport (convective) rate.
- D) Reaction rate to the diffusion rate.

Answer: C) The reaction rate to the bulk transport (convective) rate.

Explanation: It provides an estimate of the degree of conversion that can be achieved in a continuous flow reactor. A large Da number suggests a high conversion.

13. 'Liquefied Petroleum Gas' (LPG) consists mainly of:

- A) Methane and ethane.
- B) Hydrogen and carbon monoxide.
- C) Propane and butane.
- D) Gasoline and kerosene.

Answer: C) Propane and butane.

Explanation: LPG is a byproduct of natural gas processing and petroleum refining. It is stored as a liquid under moderate pressure and vaporizes at room temperature.

14. 'Cathodic protection' is a technique used to control corrosion by:

- A) Applying a protective coating to a metal surface.
- B) Making the metal structure the cathode of an electrochemical cell.
- C) Removing oxygen from the environment.
- D) Using a corrosion inhibitor.

Answer: B) Making the metal structure the cathode of an electrochemical cell.

Explanation: This is achieved either by attaching a more reactive "sacrificial anode" or by impressing an external DC current. This forces the structure to be the cathode, where reduction occurs, thus preventing it from corroding (oxidizing).

15. A 'condenser' is a piece of equipment used with a distillation column to:

- A) Heat the liquid at the bottom of the column.

- B) Cool and condense the vapor leaving the top of the column into a liquid.
- C) Separate two immiscible liquids.
- D) Increase the pressure of the vapor.

Answer: B) Cool and condense the vapor leaving the top of the column into a liquid.

Explanation: The condensed liquid is then split into the reflux (which is returned to the column to enrich the vapor) and the distillate product.

16. The 'internal rate of return' (IRR) is a metric used in economic analysis which represents the:

- A) Rate of return when the net present value (NPV) of a project is zero.
- B) Total profit of a project.
- C) Time it takes to recover the initial investment.
- D) Annual interest rate on borrowed capital.

Answer: A) The rate of return when the net present value (NPV) of a project is zero.

Explanation: IRR is the discount rate at which the present value of all future cash flows from a project equals the initial investment. A project is generally considered acceptable if its IRR is greater than the company's required rate of return.

17. The 'half-life' of a radioactive isotope is the time required for:

- A) The isotope to decay completely.
- B) Half of the atoms in a sample to decay.
- C) The radioactivity of a sample to double.
- D) The isotope to become non-radioactive.

Answer: B) Half of the atoms in a sample to decay.

Explanation: Radioactive decay is a first-order process, meaning the half-life is a constant, characteristic property of each isotope, regardless of the amount present.

18. A 'rotary kiln' is a type of furnace used for:

- A) Heat treating small metal parts.
- B) Continuous processing of solids at high temperatures, such as in cement production.
- C) Melting glass.
- D) Baking food products.

Answer: B) Continuous processing of solids at high temperatures, such as in cement production.

Explanation: A rotary kiln is a long, rotating, slightly inclined cylinder. Material is fed into the high end and slowly moves to the low end as the kiln rotates, undergoing processes like drying, calcining, and sintering.

19. 'Creep resistance' is a critical property for refractories that will be:

- A) Subjected to rapid temperature changes.
- B) Used in a chemically corrosive environment.
- C) Required to bear a structural load at high temperatures.
- D) In contact with molten metal.

Answer: C) Required to bear a structural load at high temperatures.

Explanation: Creep is the slow deformation of a material under a sustained load at elevated temperatures. Refractories used in arches, walls, and piers must have good creep resistance to prevent sagging and failure over time.

20. A 'fabric filter' or 'baghouse' is an air pollution control device that removes particulate matter by:

- A) Using centrifugal force.
- B) Dissolving it in a liquid.
- C) Passing the gas stream through a large fabric bag which traps the particles.
- D) Using high voltage to charge the particles.

Answer: C) Passing the gas stream through a large fabric bag which traps the particles.

Explanation: Baghouses are highly efficient at removing even very fine dust particles from industrial exhaust streams.

21. The 'glass transition temperature' (T_g) of a polymer is the temperature below which the polymer is:

- A) In a molten, liquid state.
- B) In a hard, glassy, and often brittle state.
- C) In a rubbery, flexible state.
- D) Decomposing.

Answer: B) In a hard, glassy, and often brittle state.

Explanation: The glass transition is a reversible transition in amorphous polymers from a rigid state to a more flexible, rubbery state. It is a critical property that determines the useful temperature range of a polymer.

22. For an incompressible fluid, the 'continuity equation' is a statement of the:

- A) Conservation of energy.
- B) Conservation of momentum.
- C) Conservation of mass.

D) Second law of thermodynamics.

Answer: C) Conservation of mass.

Explanation: For steady, incompressible flow, the continuity equation simplifies to $A_1V_1 = A_2V_2$, meaning the product of the cross-sectional area and the average velocity is constant along a pipe, so the flow rate is constant.

23. A 'plate heat exchanger' consists of:

- A) A bundle of tubes inside a large cylindrical shell.
- B) Two concentric pipes.
- C) A series of thin, corrugated metal plates pressed together.
- D) A solid block of metal with holes drilled through it.

Answer: C) A series of thin, corrugated metal plates pressed together.

Explanation: The hot and cold fluids flow in alternate channels between the plates. Plate heat exchangers are known for their high thermal efficiency and compact size.

24. 'Kick's Law' of crushing states that the energy required for size reduction is proportional to the:

- A) New surface area created.
- B) Logarithm of the reduction ratio.
- C) Final particle size.
- D) Hardness of the material.

Answer: B) Logarithm of the reduction ratio.

Explanation: This law is generally considered most applicable for the coarse crushing of large particles.

25. The process of removing a dissolved gas from a liquid by bringing it into contact with an inert gas is called:

- A) Absorption
- B) Adsorption
- C) Stripping or desorption
- D) Leaching

Answer: C) Stripping or desorption

Explanation: In stripping, the concentration of the solute is higher in the liquid than the equilibrium concentration in the gas phase, providing the driving force for the mass transfer from the liquid to the gas.

26. 'Sweetening' of petroleum fractions refers to the process of:

- A) Removing wax.
- B) Removing sulfur compounds, especially mercaptans.
- C) Increasing the octane number.
- D) Adding oxygenates.

Answer: B) Removing sulfur compounds, especially mercaptans.

Explanation: Mercaptans (thiols) have a strong, foul odor. "Sour" fractions are high in these sulfur compounds, while "sweet" fractions have had them removed or converted into less odorous disulfides.

27. The most common source of potassium for the fertiliser industry is:

- A) The ocean.
- B) The atmosphere.
- C) Mined deposits of potassium salts, such as sylvinite.
- D) Industrial by-products.

Answer: C) Mined deposits of potassium salts, such as sylvinite.

Explanation: Sylvinite is a mechanical mixture of sylvite (potassium chloride, KCl) and halite (sodium chloride, NaCl), which is mined and then processed to produce potash fertilisers.

28. An 'equilibrium stage' in a separation process is a hypothetical stage where:

- A) The streams entering the stage are in equilibrium with each other.
- B) The streams leaving the stage are in equilibrium with each other.
- C) There is no mass transfer.
- D) The temperature is at a maximum.

Answer: B) The streams leaving the stage are in equilibrium with each other.

Explanation: The concept of an ideal or equilibrium stage is fundamental to the design of staged separation processes like distillation and absorption, providing a benchmark for stage efficiency.

29. 'Recycle' in a chemical process refers to the practice of:

- A) Discarding unreacted raw materials.
- B) Sending a portion of a process stream back to an earlier point in the process.
- C) Purifying the final product.
- D) Using waste heat to generate steam.

Answer: B) Sending a portion of a process stream back to an earlier point in the process.

Explanation: Recycling unreacted materials back to the reactor inlet is a common way to increase the overall conversion and efficiency of a process.

30. A 'Bourdon tube' is a mechanical element used in instruments to measure:

- A) Flow rate
- B) Temperature
- C) Pressure
- D) Level

Answer: C) Pressure

Explanation: A Bourdon tube is a C-shaped, sealed tube that is open to the pressure source at one end. As the pressure inside increases, the tube tends to straighten out. This mechanical motion is then linked to a pointer to give a pressure reading.

31. An 'isochoric' process is a thermodynamic process that occurs at constant:

- A) Pressure
- B) Volume
- C) Temperature
- D) Entropy

Answer: B) Volume

Explanation: In an isochoric (or isometric) process, no work is done on or by the system because the volume does not change. The heating of a gas in a rigid, sealed container is an example.

32. A 'promoter' in catalysis is a substance that:

- A) Is the active catalyst itself.
- B) Is added in small amounts to a catalyst to increase its activity, selectivity, or stability.
- C) Deactivates the catalyst.
- D) Acts as a support for the catalyst.

Answer: B) Is added in small amounts to a catalyst to increase its activity, selectivity, or stability.

Explanation: A promoter may not be catalytically active on its own but enhances the performance of the primary catalyst.

33. The 'auto-ignition temperature' of a fuel is the:

- A) Lowest temperature at which it gives off enough vapor to be ignited by an external source.
- B) Temperature at which it boils.

C) Temperature at which it will ignite spontaneously without any external ignition source.

D) Temperature at which it freezes.

Answer: C) Temperature at which it will ignite spontaneously without any external ignition source.

Explanation: This property is critical for safety and is also the basis for the operation of diesel engines, which use the heat of compression to ignite the fuel.

34. A 'gasket' is a mechanical seal used to:

- A) Provide structural support for a pipe.
- B) Join two lengths of pipe together.
- C) Create a static seal between two stationary flange faces.
- D) Allow for thermal expansion in a pipe.

Answer: C) Create a static seal between two stationary flange faces.

Explanation: Gaskets are made of a deformable material that is compressed between two flanges to fill any imperfections and prevent leaks.

35. A 'relief valve' is a safety device designed to:

- A) Open gradually to control the pressure in a vessel at a setpoint.
- B) Open quickly to relieve excess pressure and then re-close when the pressure drops back to a safe level.
- C) Stay open permanently after it has been activated.
- D) Prevent vacuum formation in a tank.

Answer: B) Open quickly to relieve excess pressure and then re-close when the pressure drops back to a safe level.

Explanation: Relief valves are self-actuating and are essential for protecting equipment from overpressure due to process upsets or external fires.

36. 'Variable costs' in an economic analysis are costs that:

- A) Do not change with the level of production.
- B) Have already been paid and cannot be recovered.
- C) Change in direct proportion to the level of production, such as raw material and utility costs.
- D) Are incurred only at the start of a project.

Answer: C) Change in direct proportion to the level of production, such as raw material and utility costs.

Explanation: The more product you make, the higher your variable costs will be.

37. The 'fertile' isotopes in nuclear engineering, such as Uranium-238 and Thorium-232, are isotopes that:

- A) Can sustain a chain reaction on their own.
- B) Are not radioactive.
- C) Can capture a neutron and be converted into a fissile isotope.
- D) Are the main products of fission.

Answer: C) Can capture a neutron and be converted into a fissile isotope.

Explanation: Fertile materials are the raw materials for creating new nuclear fuel. For example, U-238 can be converted into the fissile Pu-239.

38. 'Slag' is a non-metallic, glass-like by-product of:

- A) Smelting and other high-temperature metallurgical processes.
- B) Polymerization reactions.
- C) Petroleum refining.
- D) Pharmaceutical manufacturing.

Answer: A) Smelting and other high-temperature metallurgical processes.

Explanation: Slag consists of impurities from the ore and fluxing agents (like limestone). It is less dense than the molten metal, so it floats on top and can be separated.

39. The 'hot face' of a refractory lining in a furnace is the side that is:

- A) Exposed to the high-temperature process.
- B) In contact with the furnace shell.
- C) Facing the ambient air.
- D) The coolest part of the lining.

Answer: A) Exposed to the high-temperature process.

Explanation: The refractory material must be chosen to withstand the maximum temperature and corrosive conditions at the hot face.

40. 'Thermal pollution' is the degradation of water quality caused by:

- A) The discharge of hot water from industrial processes into a body of water.
- B) The presence of heavy metals.
- C) High levels of organic matter.
- D) Acid rain.

Answer: A) The discharge of hot water from industrial processes into a body of water.

Explanation: Raising the temperature of a river or lake can decrease the amount of dissolved oxygen and harm aquatic ecosystems.

41. 'Cross-linking' in polymers is the process of:

- A) Aligning the polymer chains in a single direction.
- B) Forming chemical bonds between adjacent polymer chains.
- C) Breaking down the polymer chains into monomers.
- D) Adding plasticizers to make the polymer more flexible.

Answer: B) Forming chemical bonds between adjacent polymer chains.

Explanation: Cross-linking creates a three-dimensional network structure, which is characteristic of thermosetting polymers and vulcanized rubber, leading to increased strength, stiffness, and thermal stability.

42. 'Boundary layer' in fluid mechanics is the:

- A) Thin layer of fluid in the immediate vicinity of a bounding surface where viscous effects are significant.
- B) Interface between two immiscible fluids.
- C) Centerline of a pipe where the velocity is maximum.
- D) Shock wave that forms in supersonic flow.

Answer: A) Thin layer of fluid in the immediate vicinity of a bounding surface where viscous effects are significant.

Explanation: The concept of the boundary layer, introduced by Ludwig Prandtl, is fundamental to understanding fluid drag and convection.

43. In a shell and tube heat exchanger, 'baffles' are used to:

- A) Support the tubes and induce cross-flow in the shell-side fluid.
- B) Clean the inside of the tubes.
- C) Reduce the pressure drop.
- D) Prevent fouling.

Answer: A) Support the tubes and induce cross-flow in the shell-side fluid.

Explanation: By forcing the shell-side fluid to flow across the tube bundle rather than parallel to it, baffles significantly increase the turbulence and the heat transfer coefficient.

44. 'Bond's Law' of crushing states that the energy required for size reduction is proportional to the:

- A) New surface area created.

- B) Logarithm of the reduction ratio.
- C) Square root of the surface-to-volume ratio of the product.
- D) Initial size of the particles.

Answer: C) The square root of the surface-to-volume ratio of the product.

Explanation: Bond's law is often considered the most realistic of the classical crushing laws for estimating the power requirements of crushers and grinding mills over a wide range of feed and product sizes.

45. The 'operating line' on a McCabe-Thiele diagram for a distillation column represents the:

- A) Vapor-liquid equilibrium relationship.
- B) Material balance across a section of the column.
- C) Enthalpy of the feed.
- D) Pressure drop in the column.

Answer: B) The material balance across a section of the column.

Explanation: The McCabe-Thiele method uses the equilibrium curve (representing thermodynamics) and the operating lines (representing material balances) to graphically determine the number of theoretical stages required for a separation.

46. The 'pour point' of a petroleum product is the:

- A) Temperature at which it boils.
- B) Temperature at which it ignites.
- C) Lowest temperature at which it will flow or can be poured.
- D) Temperature at which it solidifies.

Answer: C) The lowest temperature at which it will flow or can be poured.

Explanation: The pour point is a critical property for fuels and lubricants that must be used in cold weather conditions, as it indicates the temperature below which the oil will no longer flow by gravity.

47. In the fertiliser industry, the 'steam reforming' of natural gas is used to produce:

- A) Ammonia.
- B) Hydrogen.
- C) Nitric acid.
- D) Urea.

Answer: B) Hydrogen.

Explanation: Steam reforming is the primary industrial process for producing hydrogen. Methane (from natural gas) is reacted with steam at high temperature over a nickel catalyst to produce a mixture of hydrogen and carbon monoxide (syngas). This hydrogen is then used to synthesize ammonia.

48. A 'Piping and Instrumentation Diagram' (P&ID) is a detailed schematic that shows:

- A) Only the major pieces of equipment and flow paths.
- B) The complete layout of all process piping, equipment, and instrumentation, including control loops.
- C) Only the electrical systems of a plant.
- D) The civil and structural details of a plant.

Answer: B) The complete layout of all process piping, equipment, and instrumentation, including control loops.

Explanation: A P&ID is a much more detailed document than a PFD and is used for the detailed design, construction, and operation of a plant.

49. 'Bypass' is a process stream that:

- A) Is recycled back to an earlier stage.
- B) Skips one or more stages of a process and goes directly to a later stage.
- C) Is removed from the process to prevent the buildup of inerts.
- D) Is the main product stream.

Answer: B) Skips one or more stages of a process and goes directly to a later stage.

Explanation: Bypassing is often used to control the composition or properties of a final mixed stream.

50. A 'differential pressure' (DP) cell is a common instrument used to infer the flow rate of a fluid by measuring the pressure drop across a:

- A) Thermocouple.
- B) Control valve.
- C) Primary flow element like an orifice plate or venturi meter.
- D) Section of straight pipe.

Answer: C) A primary flow element like an orifice plate or venturi meter.

Explanation: The DP cell measures the pressure difference created by the flow element, and since this pressure drop is related to the square of the flow rate, the flow can be calculated.

51. An 'exothermic' reaction is a chemical reaction that:

- A) Absorbs heat from the surroundings.
- B) Releases heat to the surroundings.
- C) Occurs at constant temperature.
- D) Requires a catalyst.

Answer: B) Releases heat to the surroundings.

Explanation: In an exothermic reaction, the change in enthalpy is negative. Combustion is a common example of a highly exothermic process.

52. The 'Thiele modulus' is a dimensionless parameter used to estimate the importance of:

- A) Heat transfer limitations within a catalyst pellet.
- B) Pore diffusion limitations within a catalyst pellet.
- C) External mass transfer limitations.
- D) The reaction rate compared to the residence time.

Answer: B) Pore diffusion limitations within a catalyst pellet.

Explanation: A large Thiele modulus indicates that the reaction is fast compared to the rate of diffusion within the catalyst pores, meaning the reaction is limited by diffusion and the catalyst is not being used effectively.

53. 'Pyrolysis' is the thermal decomposition of a material at elevated temperatures in:

- A) The presence of excess oxygen.
- B) The absence of oxygen.
- C) The presence of a catalyst.
- D) A high-pressure environment.

Answer: B) The absence of oxygen.

Explanation: Pyrolysis is a key process in converting biomass or plastics into useful liquid fuels (bio-oil) and charcoal (biochar) without simply burning the material.

54. The material 'Hastelloy' is a:

- A) Type of stainless steel.
- B) High-performance nickel-based alloy known for its excellent corrosion resistance.
- C) Type of refractory ceramic.
- D) Polymer composite.

Answer: B) High-performance nickel-based alloy known for its excellent corrosion resistance.

Explanation: Hastelloy and other nickel alloys are used in extremely corrosive environments where even stainless steels are inadequate, such as in handling hot acids or chlorine compounds.

55. A 'diaphragm pump' is a type of:

- A) Centrifugal pump.
- B) Axial-flow pump.
- C) Positive displacement pump.
- D) Jet pump.

Answer: C) Positive displacement pump.

Explanation: A diaphragm pump uses a flexible diaphragm that is reciprocated by a mechanical linkage or pressurized fluid. It is a sealless design, making it excellent for pumping corrosive, abrasive, or toxic fluids.

56. The 'discounted cash flow rate of return' (DCFROR) is another name for the:

- A) Payback period.
- B) Net present value (NPV).
- C) Internal rate of return (IRR).
- D) Fixed capital investment.

Answer: C) The internal rate of return (IRR).

Explanation: DCFROR is the more formal name for IRR, emphasizing that the calculation is based on cash flows that have been discounted to account for the time value of money.

57. The 'cladding' on a nuclear fuel element is the outer layer of metal that:

- A) Provides structural strength.
- B) Contains the radioactive fuel and fission products, preventing them from contaminating the coolant.
- C) Slows down neutrons.
- D) Absorbs neutrons to control the reaction.

Answer: B) Contains the radioactive fuel and fission products, preventing them from contaminating the coolant.

Explanation: The cladding (typically made of a zirconium alloy like Zircaloy) is the first barrier in the defense-in-depth safety philosophy of nuclear reactors.

58. A 'recuperator' is a type of heat exchanger where:

- A) Heat is exchanged between two process streams that are flowing at the same time.

- B) Heat is stored in a solid matrix and then transferred to another stream later.
- C) The hot and cold streams are mixed directly.
- D) Heat is transferred from the hot flue gas to the incoming cold combustion air.

Answer: D) Heat is transferred from the hot flue gas to the incoming cold combustion air.

Explanation: A recuperator is a specific application of a heat exchanger used in furnaces and gas turbines to recover waste heat and improve thermal efficiency.

59. The 'softening point' of a refractory is the temperature at which it:

- A) Begins to melt and become a liquid.
- B) Fails structurally under a specified load.
- C) Becomes electrically conductive.
- D) Changes color.

Answer: B) Fails structurally under a specified load.

Explanation: The refractoriness-under-load (RUL) or softening point is often a more practical measure of a refractory's high-temperature performance than its melting point, as it indicates the temperature at which it will begin to deform in service.

60. 'Composting' is an environmental engineering process that:

- A) Burns organic waste to produce energy.
- B) Uses anaerobic digestion to produce biogas.
- C) Uses aerobic microorganisms to decompose organic waste into a stable, humus-like material.
- D) Converts plastic waste into liquid fuel.

Answer: C) Uses aerobic microorganisms to decompose organic waste into a stable, humus-like material.

Explanation: Composting is a natural process of recycling organic matter, such as food scraps and yard waste, into a valuable soil conditioner.