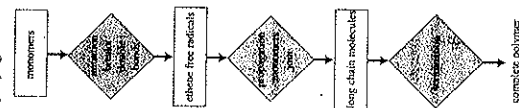


5 Production of Ethene (Ethylene)

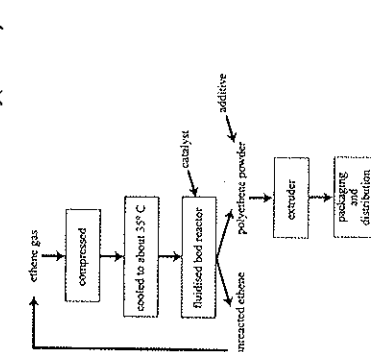
1. D
2. B
3. C
4. (a) ethylene
(b) $H_2C=C^*H$
(c) (i) natural gas (ii) petroleum
(d) Ethylene has a double bond which is more reactive than ethane's single bond.
(e) garbage bags, foam cups, carpets, rubber bands, snorkels, contact lenses, buttons, plastic flowers, hair spray, shoe soles, insulation, drycleaning fluids, computer discs, artificial flavours
5. (a) Large molecules are broken into smaller molecules using surface reactions with inorganic catalysts such as alumina-silica gel (zeolites).
(b) To prevent the combustion of reactants and products.
(c) Ethene is a raw material for production of most polymers which are used in large quantities.
(d) $2C_2H_6(g) \rightarrow 3C_2H_4(g) + 2H_2(g)$
(e) $C_4H_{10} \rightarrow 2C_2H_6 + C_2H_4$
(f) methane, ethane, propane, butane
(g) $C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$
(h) $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$
(i) incomplete combustion of carbon compounds
(j) $2NaOH(aq) + H_2S(g) \rightarrow Na_2S(aq) + 2H_2O(l)$
(k) $Na_2CO_3(aq) + H_2O(l) \rightarrow C_2H_4(g) + H_2(g)$
(l) Of the gas produced, at least 99.85% by weight is pure ethene. It contains a maximum of 0.15% (by weight) impurities.
(m) 998.5 kg
(n) ethyne
(o) Allows gases to be cooled quickly by water.
(p) Method of separating components of a mixture based on the components having different boiling points. Mixture is heated and the components with lowest boiling point evaporate first. These are extracted and the mixture is then heated to a higher temperature to separate out another fraction.
(q) natural gas
(r) thermal cracking

6. Poly(ethene)
1. A
2. B
3. D
4. Polymer made by lots of unsaturated monomer molecules adding on to each other after their C=C double bond is broken.
5. Physical tangling of chains, and lots of dispersion forces due to its large molecular mass.
6. (a) The development of transition metal catalysts which allow the reaction to occur at lower temperatures and pressures.
(b) Less expensive to build and maintain the low pressure plant and safer to operate.
(c) LDPE
(d) LDPE — branched chains would result in irregular packing, with chains not so close together, and thus would be less dense.
(e) (i) LDPE (ii) HDPE
(f) thermoplastic (flexible because chains are not bonded together — no cross links)
(g) thermoset (cross links maintain shape and prevent sliding of chains against one another)
(h) $F_2C=C^*F$
(i) 100.02
(j) 20.004
(k) addition reaction/polymerisation
(l) $-CH_2-CH=CH_2-CH_2-CH=CH_2-CH_2-CH=CH_2-$
(m) $CH_2-CH=CH_2-CH_2-CH=CH_2-CH_2-CH=CH_2-$
(n) $-CH_2-CH=CH_2-CH_2-CH=CH_2-CH_2-CH=CH_2-$
(o) (a) drink, milk and detergent containers
(b) food containers
(c) cling wrap
(d) boats, laundry baskets

11. Polythene is important because it:
• can be used for a large number of different products domestically and industrially, e.g. cling wrap, pipes, storage containers
• is manufactured relatively cheaply
• is safer and more convenient than glass.
12. $H_2C=CH_2$
13. $nCH_2=CH_2 \xrightarrow{\text{catalyst}} (-CH_2-CH_2-)_n$
14. initiation, propagation, termination



7 Industrial Production of Poly(ethene)



2. (a) A fluidised bed reactor contains a bed of polyethylene powder suspended over a perforated plate. The ethylene gas bubbles up through the powder, making it behave like a liquid (or fluid), rather like boiling water.
(b) transition metal/Ziegler-Natta
(c) Allows lower temperatures and pressures to be used for the reaction.
(d) This leaves the top of the reactor, is compressed, cooled and fed back into the reactor.
(e) To prevent the polymer decomposing as it forms.
3. Catalysts allow polymers to be produced at lower temperatures and pressures, thus it is cheaper to manufacture and more readily available for a greater variety of uses.
4. $n(C_2H_4) \rightarrow (C_2H_4)_n$
5. Properties — odourless; flexible; tough; forms a seal; stable and inert to acids and alkalis in food; insoluble in water.
Therefore extremely effective for use when storing and transporting a wide range of foods.
However, some oils may affect it, so care should be taken with oily foods and such foods should not be heated in contact with it.
6. • Changing pressure of manufacturing process to affect the density of the polymer produced.
• Adding dyes to make the product more attractive.
• Adding minerals such as silica to plastic being used to make bags so they can be opened more easily.
7. Product must be of consistent high quality to be able to be sold. Also, the process is exothermic,

8. (a) Mention uses and disadvantages. For example, polyethene can be used to make a large number of products which are practical and safe for both domestic and industrial use, e.g. plastic bags, cheap wrapping and food and rubbish containers. It replaced glass in many circumstances as it is cheaper, less dense and safer. It made possible the production of cheap disposable articles, e.g. medical tubing, which helped reduce the spread of infection. This, however, led to a huge increase in the waste to be disposed of. Make an assessment as to impact according to the weight of evidence you are able to present.
(b) Mention advantages, disadvantages and assess the impact, e.g. polyethene reduced the need for glass manufacture, so less sand needed.
Polyethene is not biodegradable so its production has created a disposal problem. Recently, the adverse effect of large amounts of plastic in landfill has been lessened by the development of the ability to recycle some plastics and the development of biodegradable polymers.
transition metal/Ziegler-Natta
fluidised bed reactor
firm, waterproof, inert
1933
manufacture of bullet-proof vests, ice rinks
9. (a) transition metal/Ziegler-Natta
(b) fluidised bed reactor
(c) firm, waterproof, inert
(d) 1933
(e) manufacture of bullet-proof vests, ice rinks