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> Coursebook answers

Chapter 8

Science in context

This activity introduces learners to the ways that industrial chemical processes develop over time to make them more efficient and less polluting. The production of ammonia is a case in point. One of the most important factors in 'improving' a process is to make it more energy efficient. This reduces the volume of pollutant gases present in the atmosphere (link with Science in context in Chapter 6). Other more energy efficient / less polluting industrial processes include the use of bacteria (see Science in context Chapter 3) and finding alternative processes such as producing zinc by electrolysis rather than using a blast furnace. Copper can be produced by growing bacteria on low grade copper ore. The solid copper is obtained from the copper ions produced by displacement from the solution with zinc or by electrolysis.

Ideas for greener manufacturing processes could include:

- Find a method which is more energy efficient, preferably methods which can take place at room temperature and pressure (use of enzymes / bacteria). The higher the temperature and the higher the pressure, the more energy is used.
- Atom economy: design methods to maximise the use of the reactants so that no unwanted waste products are formed in the reaction, e.g. try and find a method that produces a single product with no side reactions
- Try to find a method that produces waste that is less hazardous.
- Use chemicals which are less hazardous: If pollution does occur, the risks to the environment are minimised, e.g. try to use methods that do not involve use of cyanide (see Science in context Chapter 3 for the use of cyanide).

- Use safer solvents. Solvents are used as a medium in which to carry out the reaction and are also used as separating agents (link with partition coefficients in Chapter 21).
- Use of catalysts to lower the energy requirement for the reaction. The development of better and more efficient catalysts is important (link to Science in context Chapter 1 using molecular clusters).
- Design products so they break down easily in the environment to materials which don't produce harmful gases, e.g. polymers based on plant or animal material. (Mention of some 'biodegradable plastics' forming microscopic particles which are harmful to wildlife.)
- Reduce use of 'fillers' in products which bulk out or have other properties, e.g. make plastics more or less flexible. Reduce potentially harmful dyes and inks.
- Redesign processes so that chemicals used for temporary modification of chemicals in a process (to stop unwanted reactions) are not used. These add to additional waste.
- Monitor the whole manufacturing process constantly to be able to shut down the process if any poisonous substances are released.
- Safety procedures to prevent accidents, either from hazardous chemicals themselves or to minimise the dangers from fires, high pressure explosions etc.
- Devise processes which reuse or recycle waste material and make these into useful products which can themselves be recycled.

The second question touches upon the bad press that chemists have sometime had for polluting the environment. From time to time, there have been incidents in which chemicals have leaked from factories or there have been explosions polluting the air with toxic materials. However, nowadays, the (responsible) chemical industries do

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DP Hallahan



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