Mixtures in Industry

Many industries separate mixtures to produce pure products. In this section, you will learn about three industries that separate mixtures: the flour industry, the petroleum industry, and the nuclear power industry. As you read through this section, ask yourself these questions:

- What are the components of the mixture?
- Is the mixture a mechanical mixture or a solution?
- What method is used to separate the mixture into its pure components?
- How does the separation method work?

Making Wheat Flour

Bread, cake, cookies, and many other baked goods are made from wheat flour. How are the grains of wheat in Figure 1 made into flour?

Figure 1  Wheat grains are crushed and separated into their components.

Purifying the Wheat Grains

Wheat flour must be made from ground wheat grains and nothing else. Wheat grains arriving at a flour mill may be mixed with dust, sand, metal splinters, or parts of other plants. Figure 2 shows how the wheat is separated from the rest of this mixture.

Figure 2  Methods used to purify wheat grains

Wheat grains pass through metal sieves. Sticks and stones are caught by the sieve.

A vacuum extractor sucks up the impurities that are lighter than wheat grains, such as dust and leaves.

Magnets pick out any pieces of iron and steel in the mixture.
Grinding the Wheat
A wheat grain has three main parts: endosperm, bran, and wheat germ (Figure 3). In a process called "milling," metal rollers break open the wheat grains (Figure 4). The milled mixture is passed through a series of sieves to separate the endosperm, bran, and germ from each other. The endosperm is used to make white flour.

The bran and wheat germ are often sold separately from the endosperm. Bakers sometimes add bran and wheat germ to breads, muffins, and other baked goods. This adds fibre and nutrients. Whole-wheat flour is a mixture of all three parts of the wheat grain. Eating products made from whole-wheat flour, rather than white flour, is often a healthy choice because whole-wheat is less processed and contains more nutrients.

Refining Petroleum
Petroleum, or crude oil, is a homogeneous mixture of many pure substances found deep in the ground (Figure 5). Many products in your everyday life are made from petroleum, including plastics, asphalt, many medicines, synthetic fibres, and fertilizers. Most of the fuels that power cars, trucks, trains, and airplanes also come from petroleum.

To learn more about refining petroleum, Go to Nelson Science

Figure 3 Parts of a grain of wheat

Figure 4 Grinding and sieving the wheat grains

Figure 5 Petroleum is found in many places around the world, including Canada, Saudi Arabia, Russia, and the United States.
Petroleum comes out of the ground as a thick, liquid mixture of many different substances. Each component of the mixture boils at a different temperature. Engineers have developed a technology to separate the various components (Figure 6). First, a furnace heats petroleum until its components begin to evaporate. The hot gases rise through a tall column that cools the gases. This column is called a “fractional distillation column.” Different components of the gas mixture cool (becoming liquids) at different temperatures. The liquids produced settle at different levels in the column. The liquid collected at each level of the column is called a “fraction.” Each fraction can be further purified.

**Benefits of Refining Petroleum**

Natural petroleum is not very useful because it contains many chemicals that behave in different ways. When petroleum is refined, however, you can take advantage of the special characteristics of each fraction. If you need a material for surfacing a road, you would select the heaviest fraction: bitumen. Bitumen is thick and sticky, and good for making asphalt and roadways. If you need a liquid fuel for vehicles, you would choose a lighter fraction such as diesel. You could use the lightest fractions, such as gasoline and propane, as fuels for cars and barbecues, and to make paints, plastics, and medicines.

**Petroleum Refining and the Environment**

Refining petroleum has risks. Raw petroleum is piped or shipped to oil refineries, and the refined products are transported away again. Leaks and spills sometimes occur during transportation (Figure 7). These can seriously damage the environment, both land and water, and cause health problems for plants and animals. Leaks during the refining process may cause air pollution. The lighter fractions of petroleum catch fire easily, so explosions and fires are a risk. Refining petroleum also produces bad smells and noise. For these reasons, most petroleum industries are located away from areas where people live.

---

**Figure 6** Crude oil is purified in a fractional distillation column.

**Figure 7** Petroleum spills are difficult to clean up. This petroleum was spilled when a wind storm split an oil tanker in two.
Uranium and Nuclear Power

Ontario uses a lot of electricity for heating, cooling, and powering machines and electrical devices. Ontario’s electricity is produced using several energy sources. These include the energy of falling water, the energy in fossil fuels such as natural gas and coal, and the energy in the particles of special pure substances such as uranium. In each case, a machine called an electric generator converts the energy into electricity.

Uranium is a radioactive substance. This means that, unlike most pure substances, uranium’s particles break apart into smaller particles. As uranium particles split, they release a burst of energy called nuclear energy. This energy is used to generate electricity in a nuclear power plant.

Uranium occurs naturally in rocks called uranium ore. Uranium is separated from the ore by crushing the ore and adding a solution that dissolves the uranium. The waste rock is sieved out and the uranium-containing solution is collected. When the water evaporates from the solution, a solid remains. This solid is further processed into pure uranium and shaped into small pellets.

Inside a nuclear power plant, the uranium pellets are placed in the centre, or core, of a nuclear reactor (Figure 8). There, the uranium particles split apart and release energy in the form of intense heat and radiation. This energy heats water surrounding the core, and the water evaporates. As the hot water vapour expands, it turns the blades of large, fan-like turbines. The spinning turbines then turn generators that produce electricity.

When a certain fraction of uranium particles has split, the energy production slows down and the “used” uranium has to be replaced with new pellets. Over 90% of the used uranium is reprocessed and used again in a nuclear reactor. The remainder must be disposed of.
Nuclear power has two big advantages over energy from petroleum and petroleum products: it does not produce pollution that can lead to acid rain, and it does not release carbon dioxide that causes climate change. So, why do many people oppose nuclear power? There are two main reasons.

First, people are concerned that something could go wrong with the nuclear reactor and radioactive particles could be released into the environment. This happened in 1986 in Chernobyl, Ukraine, when a reactor core exploded and radioactive material contaminated much of eastern and northern Europe (Figure 9). High levels of radiation from radioactive substances can cause serious diseases, like cancer, and can even cause death.

Second, disposing of the used uranium is a problem. Used uranium is still radioactive and continues to release radiation and thermal energy for thousands of years. It cannot just be buried in a landfill, as the surrounding rock, soil, and water would be contaminated. One method of disposal involves mixing used uranium with a form of melted glass, cooling it, and burying the solid mixture in a deep disused mine. There is still the concern that earthquakes may disturb mines such as these, or that people may accidentally re-discover the buried waste in future centuries. The nuclear waste disposal problem has not yet been resolved and the debate goes on. Meanwhile, about half of Ontario’s electricity continues to come from nuclear power plants.

**Figure 9** Areas surrounding Chernobyl were deserted after the accident in 1986 due to high levels of radiation.

**CHECK YOUR LEARNING**

1. There were several diagrams in this section. (a) Which diagram did you find the hardest to understand? Explain why. (b) Where can you find help to understand the diagram?

2. Describe one way to separate each of the following mixtures: (a) wheat grains mixed with stones and large sticks (b) wheat grains mixed with pieces of metal (c) a mixture of different oil components that evaporate at different temperatures

3. List three methods of separating mixtures that are used in the flour industry.

4. (a) Why can uranium be used to produce electricity? (b) How is uranium used to produce electricity?

5. What is uranium ore, and how is uranium obtained from it?

6. (a) Why can waste uranium not be treated the same as regular garbage? (b) Describe one way in which uranium is disposed of.

7. List two risks and two benefits of nuclear power.