7.6 Controlling Fluid Flow

fluid mechanics: the study of fluids and how they behave when at rest and when moving

fluid dynamics: a part of the study of fluid mechanics concerned with how fluids move

aerodynamics: a part of fluid dynamics concerned with how gases move

hydrodynamics: a part of fluid dynamics concerned with how liquids move

Since fluids play an important role in our lives, we need to understand them and learn to control their flow. **Fluid mechanics** is the study of how fluids behave, both at rest and in motion. Part of the study of fluid mechanics is **fluid dynamics**—the study of fluids in motion. The field of fluid dynamics ranges from complex tasks, such as designing computer simulations of high-speed airflow around the space shuttle (Figure 1), to more everyday tasks such as developing a teapot spout that does not drip. Fluid dynamics is subdivided into two major areas. **Aerodynamics** is the study of moving gases, and **hydrodynamics** is the study of moving liquids.

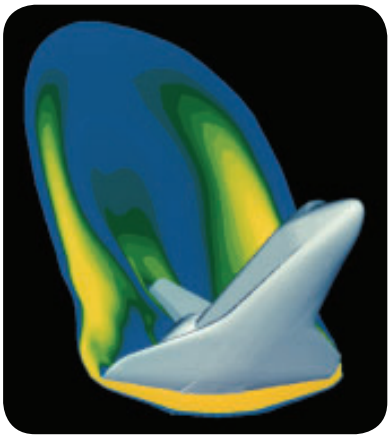

Figure 1 Aerodynamics engineers use programs designed to simulate high velocity airflow around vehicles like the space shuttle.

Aeronautics and Fluid Control

Many modern terms related to air travel come from sailing. Airplanes evolved from air ships, and we still use the term "spaceship" or "starship." Aeronautics is the study of the science of flight. Aeronautics literally means "to sail in the air." Aeronautical research deals with the science of air and space travel such as wing design to control airflow over and around wings. Figure 2 shows two other aspects of aeronautical research.

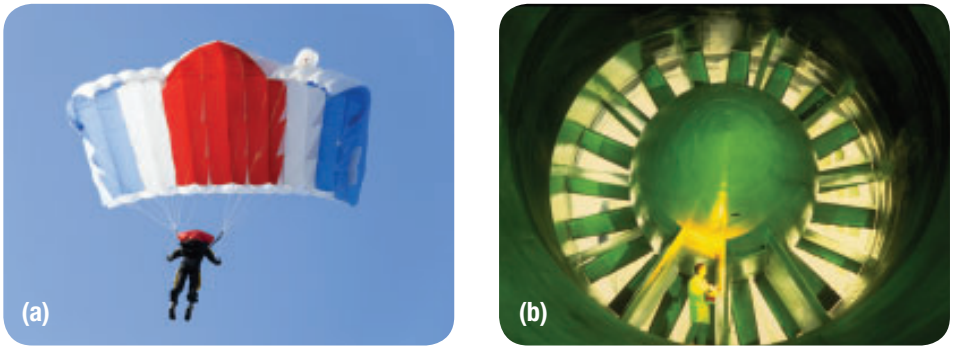

Figure 2 Aeronautical research includes (a) design of parachutes and paragliders and (b) wind tunnel design used to study and control airflow around objects.

Fluid Control in the Food Industry

One simple yet challenging task for the food industry is to get fluids to flow where and when we want them to, and to stop flowing when we are finished with them. Figure 3 shows a design developed to control fluid flow in the kitchen.

Controlling fluid flow is especially important during the processing of some foods. For example, margarine and shortening are made by bubbling hydrogen gas through liquid oils (usually vegetable oil). If the hydrogen gas mixes with the oil too quickly, a substance called "trans fat" may be produced. Trans fats have been related to heart disease, so controlling the flow of hydrogen is critical.

Figure 3 A dripless cooking oil bottle

Another example occurs with ethylene gas. This gas can be used to control the ripening of fruit. Fruit is often picked and transported before it is ripe because unripened fruit is firmer and less easily damaged. The fruit is then stored in a ripening room, where it is exposed to ethylene gas. Controlling airflow into and out of the ripening room is crucial. Too much ethylene gas too early in the ripening process will cause the food to spoil.

Controlling Water Flow

Dams are used throughout the world to control the flow of water. Water is stored behind the dam during times of heavy precipitation. Water is released during times of lower precipitation.

Many dams are also used to generate electricity (Figure 4). The weight of water behind the dam pushes water to the turbines through large pipes called penstocks. The water spins the blades of the turbines, which are connected to generators. The spinning turbine blades cause huge magnets in the generators to spin, producing electricity.

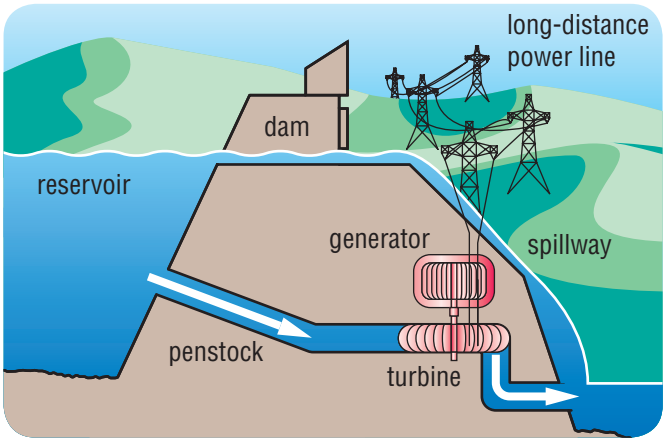

Figure 4 About 60 % of Canada's electrical power is produced by hydro-electric power plants.

LINKING TO LITERACY

Reading Diagrams

Diagrams usually provide information in two ways: an illustration and written words (labels and captions). Here are a few tips to help you "see" all of the information in a diagram:

- Look for things you recognize first. What do you already know about dams? Then, look to understand things that may not be as familiar.
- Scan the diagram. Make sure you notice all details.
- Follow connections, arrows, or lines between words and parts of the illustration. Can you locate the turbine?
- Read the caption.

The impact of dams on the environment continues to be debated. Dams do not emit the type of air pollution that coal- and gas-burning power plants do. Nor do they create the potentially dangerous radioactive wastes of nuclear power plants. However, there are negative impacts. The most obvious drawback is loss of land due to flooding. The construction of dams has flooded forests, wetlands, agricultural land, and lands used by First Nations peoples for fishing and hunting (Figure 5).

Figure 5 Major hydro-electric projects, such as the James Bay Project, have social and environmental impacts as well as economic ones.

Dams, and flooding related to dams, can also affect fish populations, contribute to bacteria growth, and cause the release of chemicals, such as mercury, into the water. Better dam design, construction of fish ladders, and careful management of water flows can reduce some of these impacts. However, some negative environmental impacts are unavoidable. Dam construction will always require careful consideration and responsible decision making. This becomes even more important when people construct dams in areas where natural disasters such as earthquakes are common.

Controlling Blood Flow

Blood flow is one of the most important fluid movements within your body, yet we rarely give it much thought. However, some people need medical assistance to maintain the flow of blood throughout the body:

- Blood thinners are medicines given to people whose blood forms clots (Figure 6) too easily. Clots inside arteries and veins can cause heart attacks and strokes.
- Some people have a condition called hemophilia. They may bleed excessively when injured, since their blood does not clot as it should. These people often take medicine to promote clotting.
- Artificial hearts have saved the lives of thousands of people whose own hearts were no longer strong enough to continuously pump blood throughout the body.

To learn more about how doctors can treat heart problems,
Go to Nelson Science

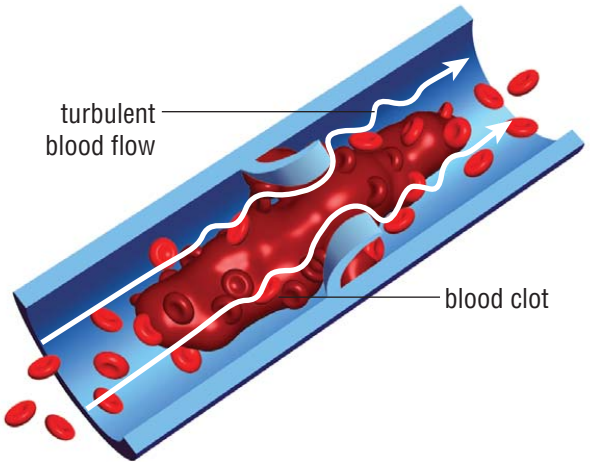

Figure 6 A blood clot in this vein slows the flow of blood back to the heart.

CHECK YOUR LEARNING

1. What is meant by fluid mechanics?
2. What is the relationship between fluid dynamics, hydrodynamics, and aerodynamics? Draw a concept map to show the relationship between the three terms.
3. Describe two applications each of hydrodynamics and aerodynamics.
4. Why is it important to control the presence of ethylene gas when ripening fruit?
5. Describe two aspects of dams that depend on the proper flow of fluids.
6. How has technology allowed us to control the flow of blood in humans?
7. Name two economic benefits of fluid flow and two environmental costs that are a result of human control of flowing fluids.