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Master 2-3

Technologies Related to Air Pollution

Catalytic Converter

Millions of cars and trucks travel the roads every day in the United States. Each of these adds to the pollution in the air. The amount of pollution added to the air depends in part on the type of vehicle a person chooses to drive. Vans, SUVs, and pickup trucks use more gas than smaller cars. This means they can pollute much more than smaller cars. The gases in the exhaust from motor vehicles include nitrogen gas, carbon dioxide, water vapor, carbon monoxide, nitrogen oxides, and unburned fuel. Nitrogen gas and water vapor are not considered harmful, but carbon monoxide, nitrogen oxides, and unburned fuel are. Carbon monoxide, for example, can contribute to climate change.

Figure 2-3.1: Catalytic converters reduce the amount of harmful gases in car exhaust.

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Modern engines are designed to carefully control the amount of fuel they burn. Ideally, all of the fuel is burned using the oxygen in the air. Unfortunately, this does not usually happen. Catalytic converters are one type of technology related to air pollution. Catalytic converters are designed to reduce the air pollution caused by motor vehicles. They have been standard equipment on automobiles since the mid 1970s. What does a catalytic converter do? In general, a catalytic converter changes harmful pollutants into less harmful emissions. This happens before the emissions even leave the vehicle's exhaust system.

A catalytic converter has two sections, each of which contains a ceramic block that is covered with very expensive metals. There are thousands of small ducts or channels inside the block.

When the exhaust gases leave the motor, they are very hot, over 900°F. As the gases move through the converter, their temperature can increase up to 1300°F. The high temperatures are important for the catalytic converter's function. In the first section of the catalytic converter, the nitrogen oxide gas from the exhaust reacts with the metals coating the block. The harmful nitrogen oxide gas is changed into harmless nitrogen gas and oxygen. Nitrogen and oxygen are gases that are found naturally in the air.

The exhaust then moves into the second section of the catalytic converter. In this section carbon monoxide reacts with oxygen. This forms carbon dioxide, a much less harmful gas. In the second chamber also, unburned fuel from the exhaust reacts with oxygen to form carbon dioxide and water.

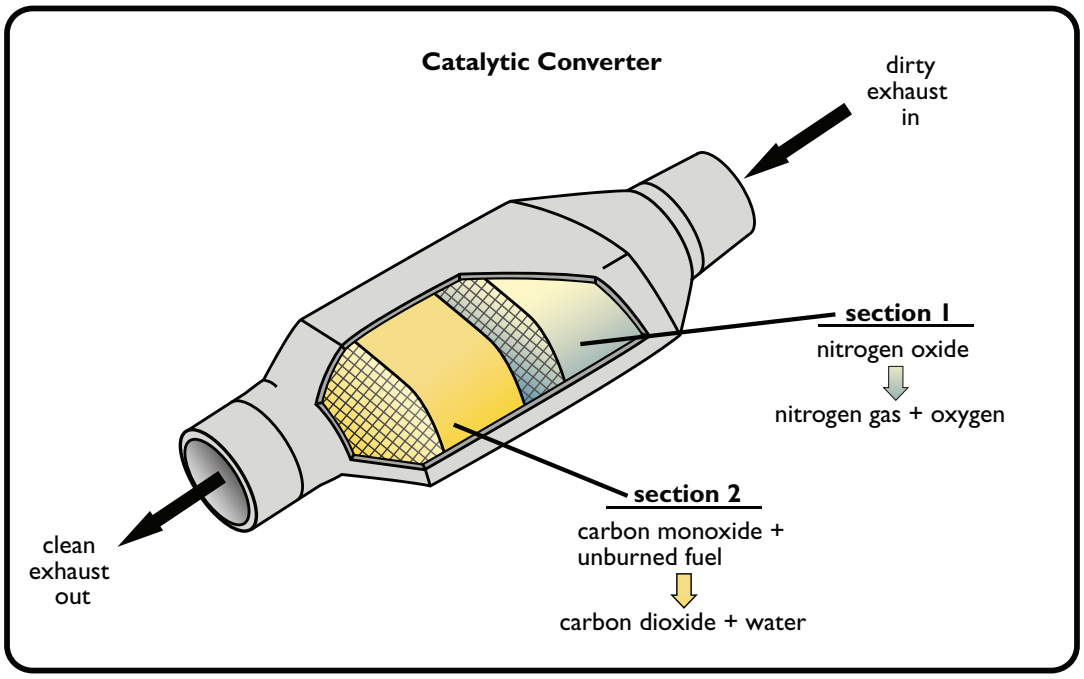

Figure 2-3.2: Catalytic converters cause reactions that change harmful gases into less harmful gases.

When a car is started it is cold. At these cold temperatures, the catalytic converter does very little to reduce pollution. In addition, not all devices with engines have catalytic converters. Lawnmowers and off-road equipment, for example, do not require catalytic converters. Finally, because catalytic converters contain very expensive metals, they are often stolen and the expensive metals are sold as scrap, usually for hundreds of dollars.

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Electrostatic Precipitator

Have you ever driven by a factory and noticed a lot of smoke coming out of the smokestacks? Have you wondered what is in that smoke and whether that smoke can cause problems for people? Some industries use electrostatic precipitators (ESP) to reduce pollution that goes into the air. Many factories use ESPs. These include factories that produce power or electricity, cement, chemicals, metals, or paper. When these factories are working, they produce dust and other solid particles. These are included in the smoke that leaves the factories' smokestacks.

This is where the ESP comes in. When the gas enters the ESP, the solid particles, including dust, are electrically charged. The ESP contains metal plates that are negatively charged. The positively charged solid particles stick to the plates. (Think about how opposite poles attract in a magnet.) The gas still contains the negatively charged particles. The gas then passes over a positively charged plate to attract these particles. When the plates have attracted an abundance of charged particles, they are cleaned. The dust is placed in containers and either thrown away or recycled. ESPs can often collect at least 99 percent of the particles from the exhaust gas.

The people who run the factories need to make several decisions when they choose an ESP. They need to know the type of particles in the gas and the amount of gas that will need to pass through the ESP. ESPs are available in different sizes and designs. Some factories or power plants may need more than one ESP. All of these choices affect the price of the ESP. The design and size of the ESP affects how much power it uses.

ESPs have also been made for use in homes as air purifiers. As you would expect, they are much smaller than those used in factories. An advantage of the air purifiers is that people do not need to replace parts such as filters. However, cleaning the metal plates can be messy. There is also concern about their use in homes. Some may produce toxic ozone and other harmful gases.

Comstock

Figure 2-3.3: The emissions from factories can contain many small particles.

Figure 2-3.4: Electrostatic precipitators remove particles before they are released into the air.

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Carbon Monoxide Detector

Carbon monoxide is one of the six most common types of air pollutants. It is a gas that is made up of one carbon atom and one oxygen atom. It is colorless, so you cannot see it in the air. You cannot smell it or taste it. It is very dangerous. Each year, thousands of people are taken to hospital emergency rooms because of carbon monoxide poisoning. Carbon monoxide is the leading cause of poisoning deaths in the United States.

Carbon monoxide can come from many sources, including motor vehicle exhaust. In homes and other buildings, carbon monoxide is produced when fuels such as natural gas, wood, coal, kerosene, and oil are burned. Equipment that burns fuel includes furnaces, water heaters, fireplaces, space heaters, and ranges. If the equipment is working properly, the carbon monoxide levels will be low and will not cause health problems. Problems can occur when the equipment does not work the way it should. Then, the fuel is not burned completely and the level of carbon monoxide in the home or building rises. Running a car in a closed garage can cause high levels of carbon monoxide in the house and in the garage.

Figure 2-3.5: The incomplete burning of fuels produces carbon monoxide. The equipment that burns fuel, such as this heater, must work properly if the fuel is to be burned efficiently.

Carbon monoxide detectors help protect people from carbon monoxide poisoning. This illness happens when people breathe in too much carbon monoxide. People with carbon monoxide poisoning may feel dizzy or nauseous. They may be very confused or sleepy. Carbon monoxide poisoning can lead to death. These detectors are not the same as smoke alarms.

Not all carbon monoxide detectors work the same way. People have decisions to make when buying carbon monoxide detectors. There are several different types of sensors that can be used in carbon monoxide detectors. Some sensors are more sensitive than others. Some sensors can also detect other harmful gases. Whereas others can detect many types of harmful gases. Some detectors use batteries, which must be replaced over time. Others use electrical power, which will not work if the power goes out. People also must decide how many detectors they need in their home and where to place each detector. There should be a carbon monoxide detector on each floor of the house. There should also be one near bedrooms. Some states require that homes have carbon monoxide detectors.

Figure 2-3.6: Carbon monoxide detectors warn people if the level of carbon monoxide reaches dangerous levels.

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Wind Power

Think about all of the things in your life that run on electric power. Most of us like having electric power whenever we want it. We may not, however, think about how the generation of electricity adds to air pollution. Most of our electricity is generated by power plants that burn fossil fuels such as coal and natural gas. The main pollutants from power plants include sulfur dioxide, nitrogen oxide, carbon dioxide, and particulate matter. Sulfur dioxide and nitrogen oxides are two of the gases that combine to form bad ozone. These emissions can lead to smog, acid rain, and haze.

One technology that is being used to produce electricity is wind power. Wind power can produce electricity without adding so much to air pollution. Wind power is not new. You might think of windmills in Holland that were used to grind grain. In the late 1800s and early 1900s, some farmers used windmills to pump water. In the 1980s, the interest in using wind to produce electricity began. Currently, only about 1 percent of the electricity used in the United States is produced using wind power. However, the interest in wind power appears to be growing. In 2007 and 2008, more than $27 billion dollars was invested in wind power development.

Wind power depends on the Sun. The Sun heats the air. The warm air rises and causes air movements (wind). The wind pushes against the blades of a wind turbine. This is somewhat like wind pushing on the sail of a sailboat to cause the boat to move. The moving blades of the wind turbine power a generator to produce electricity.

One of the main advantages of wind power is that it does not produce harmful emissions. However, there are some problems. Obviously, wind power requires wind. If the wind is not blowing strongly enough, the wind turbines will not turn and will not produce electricity. If the wind is blowing too strongly, the turbines must be shut down so they will not be damaged. There are concerns about how reliable wind power is. The wind does not blow at the same rate all of the time, and some areas of the country are windier than others. Some of the windiest areas are often located far away from where the electricity is needed most. Some people think wind turbines are unsightly, and they do not want them near their homes. Another concern is cost. Electricity produced by wind power may cost twice as much as electricity from fuel-burning power plants. As wind power becomes more common, and as the technology improves, it may become less expensive.

Figure 2-3.7: Wind power can generate electricity without the emissions caused by other power plants.