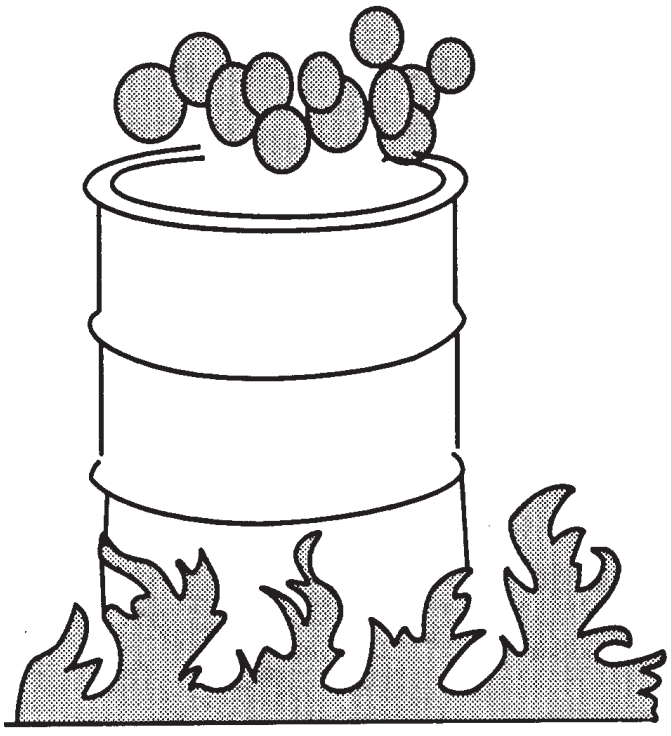
Section 4

Will it Burn, Blow Up or React? (Chemical Hazards)

Purpose

To understand chemical terms that you will find on a Material Safety Data Sheet (MSDS). These will tell you if a product will burn, blow up, or react violently.



Section 4

What you will find in this section...

Task 1

- **Explain what the property tells you about the chemical.**
- **Describe steps you should take to stay safe.**

Your group is the health and safety committee at Make S'More, a diversified parts supplier to the Big 3 auto companies. Your plant has large amounts of many chemicals stored on site.

As part of your chemical emergency planning, you have researched some of the properties of 10 chemicals found at your plant. Now you are trying to figure out what impact this information has for you and your co-workers.

As a group, please answer the questions below using the fact sheets in this section. Some groups will answer the even-numbered questions, and some the odd-numbered ones. Your instructor will tell you which to do. Please choose one person to report back to the class.

Example: A portable tank of lacquer thinner containing acetone springs a leak. The Material Safety Data Sheet (MSDS) says that acetone has a boiling point of 133 degrees F. What does "boiling point" mean? What does this boiling point tell you about the chemical? What should you do to prevent an emergency and stay safe in this situation?

Answer: Boiling point is the temperature of a liquid when it has enough energy (heat) to turn into a gas. Acetone will give off lots of vapors when it boils at 133 degrees. It's possible to reach this temperature inside the tank on a sunny summer day; so this tank could be a bomb waiting to go off. You should keep all heat and flames away from the spill, get out, and call a trained Haz Mat Team.

Task 1 continued

- **Explain what the property tells you about the chemical.**
- **Describe steps you should take to stay safe.**

1. A storage drum containing gasoline tips over. **The MSDS says the flash point is -50 F (50 below zero).** What does "flash point" mean? What does this flash point tell you the chemical will do? What steps should you take to stay safe in this case?

2. A can of lubricating oil breaks and spills next to a hot machine. **The MSDS says the oil is combustible (not flammable).** What does "combustible" mean? What does this fire hazard indicate? What steps should you take to stay safe?

3. A cylinder in your machine shop is venting acetylene through its relief valve. **The MSDS says the LEL is 2.5% and the UEL is 100%.** What's the definition of LEL and UEL? What do these flammable limits tell you about this chemical? What should you do to stay safe?

4. The parts washer containing 1,1,1 - trichloroethane in your shop has overflowed. **The MSDS says the vapor pressure at room temperature is 100 mm.** What does "vapor pressure" mean? What does this vapor pressure tell you the chemical will do? What should you do to stay safe?

Task 1 continued

- **Explain what the property tells you about the chemical.**
- **Describe steps you should take to stay safe.**

5. Barrels holding methyl alcohol are stored next to the vent for the drying ovens. The ovens are heated to a temperature of 1000 degrees. **The MSDS says the auto-ignition temperature of methyl alcohol is 867 degrees.** What does "auto-ignition temperature" mean? What does this auto-ignition temperature tell you the chemical will do? What should you do to stay safe in this situation?

6. A cylinder of chlorine is leaking in its storage area at your plant. **The MSDS says that chlorine is "incompatible with acetylene, turpentine, ammonia, and fuel gas."** What does this incompatibility tell you the chemical will do? What should you do to stay safe in this case?

7. A 5-gallon pail of etching solution containing nitric acid falls off a storage shelf and breaks open. **The MSDS says the pH is 1.0.** What does "pH" mean? What does this pH tell you the chemical will do? What should you do to stay safe?

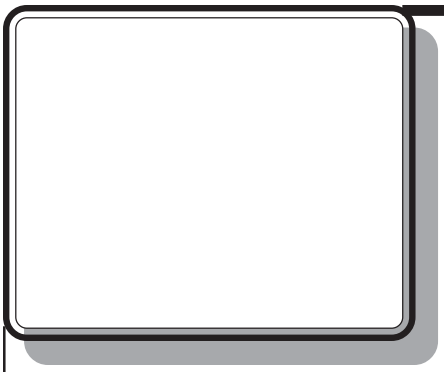
Task 1 continued

- **Explain what the property tells you about the chemical.**
- **Describe steps you should take to stay safe.**

8. A fork lift dumps a load of sodium hypochlorite (bleach) bottles in the aisle just outside the paint booth. **The MSDS says that sodium hypochlorite is an oxidizer.** What does this tell you about the chemical? What should you do to prevent an emergency in this case?

9. A pipe carrying toluene springs a leak overhead. **The MSDS says the vapor density is 3.1.** What does "vapor density" mean? What does this vapor density tell you the chemical will do? What should you do to stay safe?

10. A tank truck of diethylamine (used to make rubber and in petroleum refineries) goes off the road outside your plant and starts leaking into your storm drains. **The MSDS says the specific gravity is 0.71.** What does "specific gravity" mean? What does this specific gravity tell you the chemical will do? What should you do to stay safe?



Fact Sheet #1

What You Don't Know Can Hurt You

Worker Killed by Explosion from Welding on Tank

Two maintenance workers in Ohio were welding an access ladder onto the outside of a storage tank located about 30 feet from a warehouse. The tank contained asphalt. A 5-foot ladder leading down from the top of the tank was already in place. After welding the new ladder to the bottom of the tank, the workers were to bolt it to the ladder that was there.

The tank was 30 feet high and 10 feet in diameter. It was nearly 2/3 full with liquid asphalt. The liquid was about 30% Stoddard solvent and 70% asphalt according to the product's MSDS. The workers made two welds at the lower level, below the liquid level, with no problem. Then came the third weld, higher up on the tank. One of the two maintenance workers was at the warehouse when he saw his co-worker strike an arc on his welder for the third weld. He then heard a huge explosion and saw the tank fly through the air. Fire spread throughout the area. Two more explosions followed when other storage areas were hit by the fire.

The body of the maintenance man who had been working on the tank was found under the tank. He had been seriously burned and crushed by the tank. By sheer luck, no one else was hurt. The tank was hurled more than 50 feet, the warehouse was demolished, and other parts of the facility were badly damaged. Several cars parked nearby were gutted by fire.

Source: *Just the Facts, D. Terrible, OHIO Monitor, 3/91*

Fact Sheet #1, continued

What Happened?

If the maintenance workers had looked at MSDS's for asphalt and Stoddard Solvent, they would have seen this information:

Asphalt	Stoddard Solvent
Flash point: 400 degrees F Auto-ignition temp: 905 deg. F LEL: None reported UEL: None reported	Flash point: 102 - 110 deg. F Autoignition temp: Not known LEL and UEL: None reported

If you apply a welding torch at about 4000 degrees F to this mixture, you are going to heat it up well beyond the flash point and auto-ignition temperature.

Why didn't the tank explode until the third weld? At the lower levels the liquid asphalt was able to absorb and dissipate the heat from the welding torch. But the third weld was begun above the level of the liquid asphalt. This part of the tank was filled with the vapors from the heated liquid. The vapors were ignited from the heat alone and, then, caused the tank to explode.

Fact Sheet #2

Will it Burn or Explode?

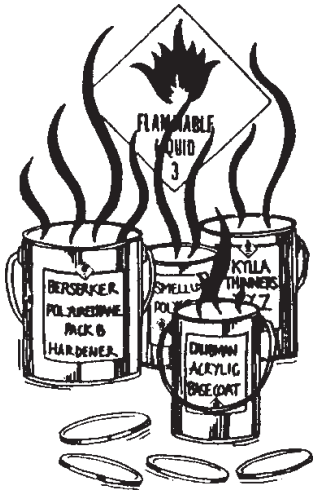
The first thing to know is that liquids do NOT burn; only the gases they give off will burn. So we are looking for information about how easy it is for a product to give off gas and how easy it is for those vapors to burn. **There are 4 different properties that help you figure out if a chemical or its vapors will burn or explode.**

1. Flash Point — the most important thing to know about liquids

Definition: The flash point of a liquid is the temperature at which the liquid gives off enough vapor to burn if a spark is in the area.

Examples:

Gasoline	-38 to -50 degrees F.
Propane	none — it's normally a gas
Acetone	0 degrees F
Toluene	40 degrees F
Kerosene	100 - 162 degrees F
Sulfuric Acid	none — it doesn't catch on fire



⇨ **The lower the flash point of a chemical, the more easily it will burn.**

Gases don't have a flash point, because they are already completely airborne in normal temperature ranges. But some gases can certainly burn!

High Fire Risk— Flash point less than 100 degrees F **(Flammable)**
Moderate Fire Risk — Flash point 100 to 200 degrees F **(Combustible)**
Low Fire Risk — Flash point greater than 200 degrees F

Fact Sheet #2, continued

2. Flammable (Explosive) Limits – Applies to liquids, gases

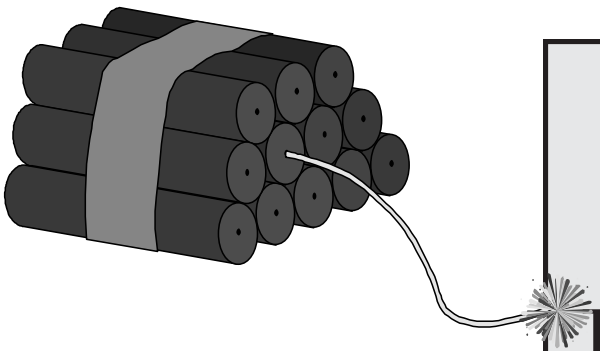
To start a fire (from a spark), the right mixture of fuel and air must be present. Flammable limits are a way of talking about this mixture. They are measured as percentages of a chemical mixing with air.

Definition: When there is just enough fuel in the air to burn if there is a spark, the **Lower Explosive Limit (LEL)** has been reached. When there is too much fuel in the air (not enough oxygen) to burn, the **Upper Explosive Limit (UEL)** has been passed. Before the days of fuel-injected cars, you could flood your carburetor by giving it too much gasoline. The amount of gas vapors was above the UEL for gasoline.

The upper and lower explosive limits are sometimes called upper and lower flammability limits (UFL and LFL). These terms mean the same thing.

Examples:

Chemical	Lower % (LEL)	Upper % (UEL)
Gasoline	1.4	7.6
Propane	2.4	9.5
Acetylene (used in welding)	2.5	100.0
Kerosene	0.7	5.0



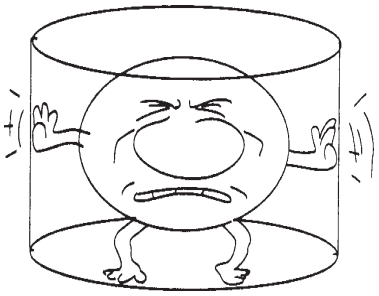
Look out for chemicals that have Low LEL's or a wide explosive range.

These are Dangerous!

Fact Sheet #2, continued

3. Vapor Pressure (VP)

Definition: Vapor pressure gives you an idea of how easy it is for liquid to evaporate. When a liquid evaporates, its vapors exert pressure on the surrounding air. This pressure is called vapor pressure. This chemical property is measured by seeing how hard the gas or the vapor from the liquid pushes against the sides of a closed container. It is usually measured in millimeters (mm) of mercury (Hg), like barometric pressures reported by weather forecasters. Vapor pressure rises when a chemical is heated.

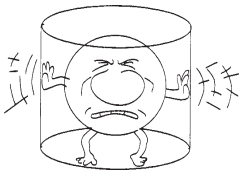


High vapor pressure – more than 10 mm at room temp.

Acetone	266 mm
Gasoline	38-300 mm

Medium vapor pressure – 1-10 mm, room temp.

Methyl cellosolve	6.2 mm
Kerosene (at 100 deg.)	5 mm



Low vapor pressure – less than 1 mm, room temp.

PCBs	.001 mm
Sulfuric Acid	.001 mm

What does Vapor Pressure Mean?

a. If a chemical has a high vapor pressure, more of it will get in the air than a product with a low vapor pressure. Once in the air, you can breathe it in, it could burn, or it could react with other products.

b. Vapor pressure can warn about the possibility of explosion. Chemicals with high vapor pressures that are in sealed containers could easily explode if there is a fire nearby or even on a very hot day.

c. Flammable liquids with a high vapor pressure are very dangerous, especially in a confined area.

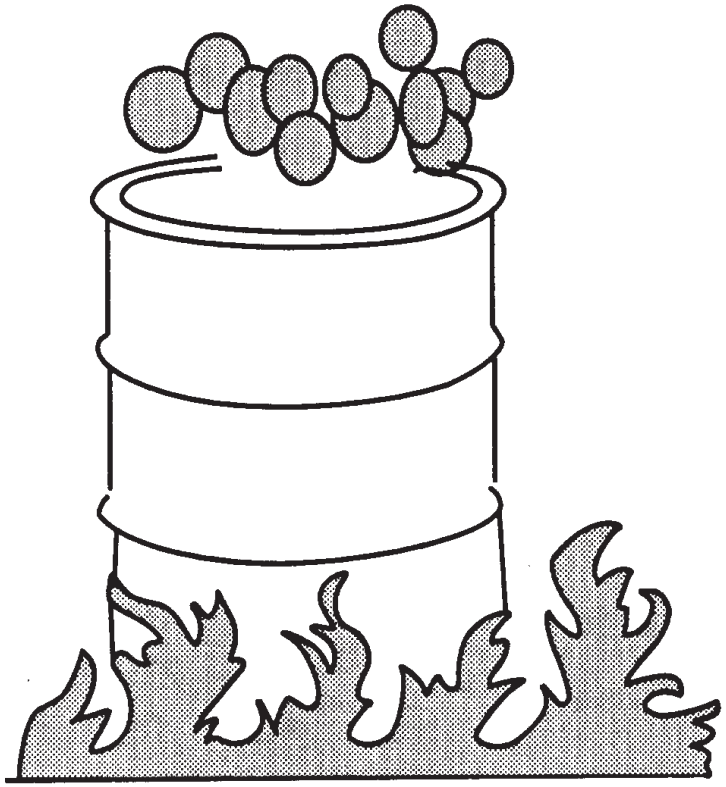
Fact Sheet #2, continued

4. Auto-Ignition Temperature

Definition: This is the lowest temperature needed to cause a chemical to ignite and keep on burning. A spark or flame is not needed because there's already enough energy (heat) to keep the chemical burning.

Chemicals with low ignition temperatures are very DANGEROUS.
Keep them stored in cool places.

Read the story of the worker killed while welding on a tank full of liquid asphalt to find out why the auto-ignition temperature is important (Fact Sheet #1).



Fact Sheet #3

Where is it?

An important part of emergency response is guessing where a chemical will go once it is loose from its container. Emergency responders try to keep chemicals in an area they can control.

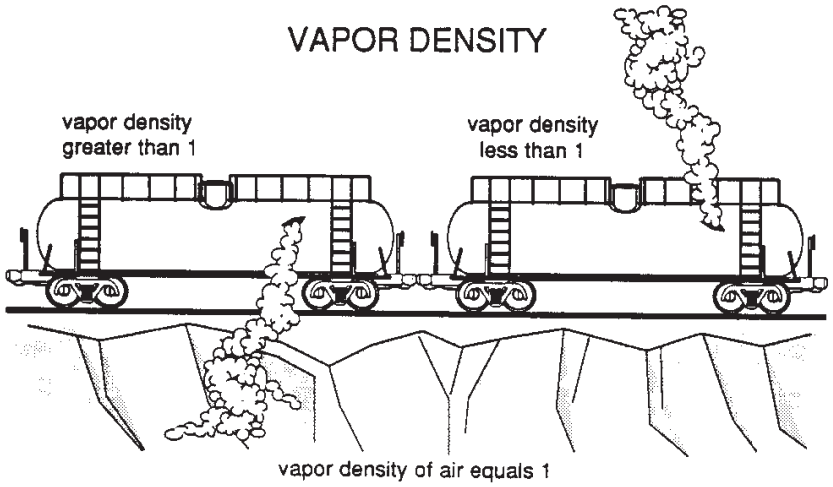
Two chemical properties will tell you where a chemical is likely to go.

1. Vapor Density — applies to gases and vapors

Definition: Vapor density is a measure of how heavy a gas is when compared to air. Air is given a vapor density of 1.

- Any vapor that has a density **greater than 1** is **heavier than air** and will sink. It will collect in low spots such as ditches or pits.
- Vapor density **less than 1** means the product is **lighter than air** and will rise.

Warning: Many flammable vapors are heavier than air. These heavy vapors can travel a long distance until they reach a flame or spark which will ignite the vapors.



Fact Sheet #3, continued

2. Specific gravity — applies to liquids

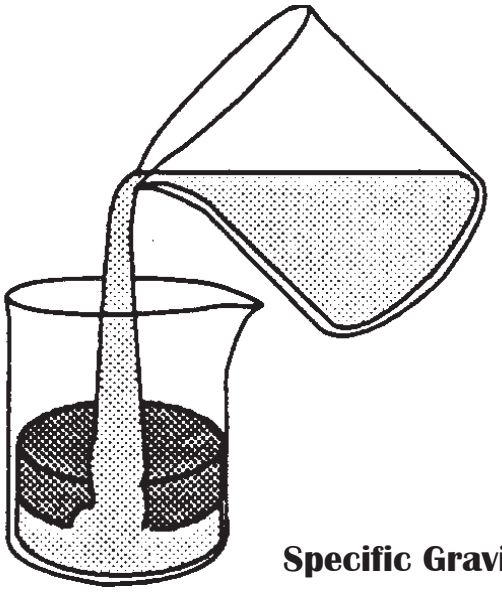
Definition: Specific Gravity tells you how heavy a liquid is when compared to water.

- A chemical with a specific gravity (weight) greater than 1 will sink in water.
- A chemical that has a specific gravity less than 1 will float on water.

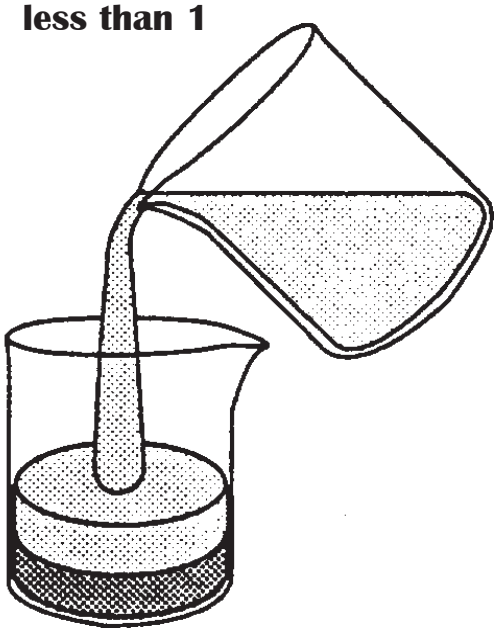
Knowing the specific gravity of a product tells you what to do if the product spills into a creek or river. To stop a product that has a specific gravity less than one, you would place booms across the top of the water. These surface booms would keep it from flowing down river. If the product were heavier than water, you would catch the product by building a berm along the bottom of the creek.

As an Operations-level responder, you would only place booms or build berms in a clean area, well ahead of a spill.

Specific Gravity greater than 1



Specific Gravity less than 1



Specific Gravity of water is 1

Fact Sheet #4

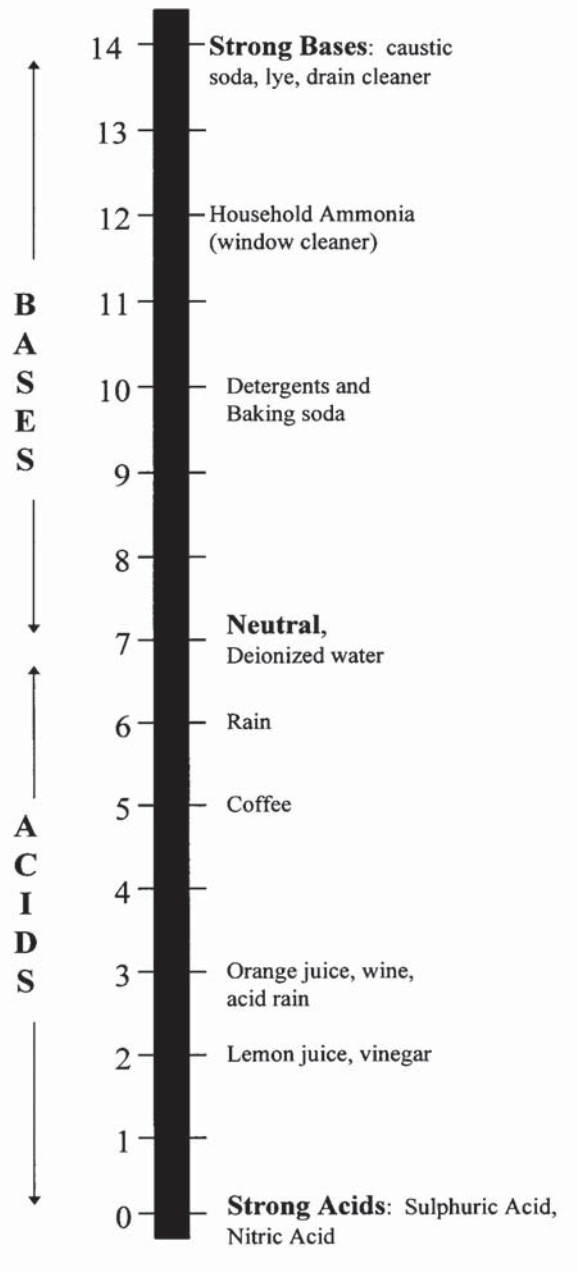
Is it an Acid or a Base?

Acids and Bases are CORROSIVE

Acids and bases can eat away human skin, eyes, and other living tissue. They can also corrode metals, even steel. Strong acids and bases also react violently with many other chemicals, even water.

The pH Scale

Definition: The pH of a chemical tells you whether it is an acid or a base. Bases are also called alkali or caustic. The pH scale goes from 0 to 14. The value of 7 is neutral, neither an acid nor a base.



How do you Read the pH scale?

pH less than 7 is an acid

pH more than 7 is a base

The farther you get from 7, the stronger the acid or base. The difference between each step is a factor of 10. So an acid with a pH of 4 is ten times stronger than an acid with a pH of 5. A base with a pH of 11 is ten times weaker than a base with a pH of 12.

Fact Sheet #4, continued

Many organic compounds, such as gasoline and benzene, have almost neutral pH's. But they can still be dangerous in other ways!

Why is pH Important?

1. Chemicals with pHs much lower or higher than 7 irritate and burn any part of the body they contact. The damage may be permanent, unless the material is washed off immediately.

2. Bases are much more dangerous to the eyes than acids. Bases penetrate eye tissue very quickly and cause lasting damage.

3. If you get splashed with an acid or a base, wash off with lots of clean water as fast as you can. Quickly remove clothes that have been splashed. They will hold the acid or base next to your skin.

4. Store acids in plastic containers, not metal. Acids not only corrode steel. In the reaction between acids and metal, hydrogen is released which is a highly flammable gas.

5. Store like with like. Chemicals with a low or high pH should only be near chemicals with like pH, never with their opposite or neutral chemicals.

Real-Life Story– What Acids can Do

A steel manufacturer spilled 5,000 gallons of chromic acid plating solution from a storage tank. Even though all valves to the tank and transfer pipe were in the right position (closed), the acid leaked out over a 3-day period. Later, they discovered that one of the valves was defective and the other was badly corroded by the acid. Both valves were replaced with lined plug valves that are better for acid.

Fact Sheet #5

Watch Out for Oxidizers

Definition: Oxidizers are oxygen-containing materials which add oxygen atom(s) to other compounds. Reactions in which oxidizers take part are called oxidation. These reactions tend to generate heat. Thus, oxidizers can cause other materials to combust more readily or make fires burn more fiercely. An example of oxidation is the process called corrosion, in which metal reacts with air to form the metal oxide "rust."

Some common oxidizers

- Chlorine
- Oxygen
- Hydrogen Peroxide
- Any chemical whose name ends in “ite”
  Examples: **Sodium hypochlorite = Bleach**
  Calcium nitrite
- Any chemical whose name ends in “ate”
  Examples: **Ammonium nitrate** (a common fertilizer) — Used in the bomb that destroyed the Federal Building in Oklahoma City
  Perchlorates
  Chlorates
- Nitric Acid

Store Oxidizers by themselves.
Never store oxidizers near products that will burn!!

Keep These Away From Each Other

Source: *Rapid Guide to Hazardous Chemicals in the Workplace, 3rd Edition, edited by Richard Lewis, 1990*

Fact Sheet #6

Like Go With Like

Never put old chemicals in the trash or pour them down the drain. You could start a fire or a bad chemical reaction. For example, lye and hydrochloric acid are both used to clean drains. But if these two mix they will give off gas and get very hot. If you store them together and a container leaks, they could mix by accident. **Do not store them in the same cabinet. Do not mix chemicals unless you know exactly what will happen.**

Do store similar chemicals together in labeled containers. **Look in the section called "Reactivity" or "Storage" on the MSDS.** This will tell you what not to mix or store the chemical with. This section often uses a lot of chemistry terms. For example, the MSDS might say: "Incompatible with strong oxidizers, and chemically reactive metals." Here are some examples to help you figure these terms out:

acids	hydrochloric acid, same as muriatic acid sulfuric acid, chromic acid, nitric acid
bases (also called alkalis or caustics)	sodium hydroxide, same as caustic soda ammonia, potassium hydroxide drain cleaners
oxidizers	bleach = sodium hypochlorite ammonium nitrate = fertilizer oxygen (in cylinders) peroxides
combustible materials	things that will catch fire such as acetone, saw dust, metal dust from grinders, hair, clothing
reactive metals	aluminum, magnesium, pure sodium

Source: *Drivers Guide to Hazardous Materials, American Trucking Association*

Fact Sheet #6, continued

The Fearsome Incompatibles

Keep These		Away From These	Or You May Get These
Acids	+	Bases	Heat Violent Reaction
Acids or Bases	+	Reactive Metals (Aluminum, Beryllium, Calcium, Lithium, Potassium, Magnesium, Sodium, Zinc Powder), Metal Hydrides	Fire Explosion Hydrogen Gas (which is highly flammable)
Water or Alcohols	+	Concentrated Acids or Bases, Calcium, Lithium, Potassium, Metal Hydrides, Other Water Reactive Waste	Heat Fire Explosion Flammable and Toxic Gases
Reactive Organic Compounds or Solvents (Alcohols, Aldehydes, Nitrated Hydrocarbons)	+	Concentrated Acids or Bases, Reactive Metals and Metal Hydrides	Fire Explosion
Cyanide or Sulfide Solution	+	Acids	Hydrogen Cyanide or Hydrogen Sulfide Gas- both are very toxic
Organic Acids, Strong Oxidizers (Chlorates, Chlorine, Chlorites, Chromic Acid, Hypochlorites. Nitrates, Perchlorates, Peroxides)	+	Concentrated Mineral Acids, Reactive Metals, Metal Hydrides, Reactive Organic, Compounds or Solvents, Flammable or, Combustible Waste	Fire Explosion

Summary

Will it Burn, Blow Up or React? (Chemical Hazards)

✯ Understanding some of the chemical terms on a Material Safety Data Sheet can help you prevent deadly explosions, fires, reactions, and accidents.

✯ Some chemicals form a deadly reaction when mixed together or with water. They can form a poisonous gas, explode, or catch fire. On a Material Safety Data Sheet or the NIOSH Pocket Guide, **check for the kinds of chemicals that are "incompatible" with a product. Store them separately.**

✯ Watch out for **oxidizers.** They can cause other chemicals to catch fire. **Store them alone.**

✯ Flash point and explosive range are properties that can help you find out how easily a chemical can catch on fire. Watch out for chemicals that have the following. They have a high-risk for fire:

- **Flash point less than 100 degrees F**
- **Low Lower Explosive Limit (LEL) or a wide explosive range (the difference between LEL and UEL is great)**

★ If a chemical has a **high vapor pressure, it gets into the air easily.** This means it is a health risk because you can breathe it in easily, too. Chemicals with high vapor pressures could be greater fire hazards, could react with other products, or could explode if kept in a sealed container.

✯ Acids and bases can burn your skin and eyes very badly. They can also corrode metals. Acids have a pH less than 7. Bases have a pH greater than 7.

Summary continued

Will it Burn, Blow Up or React? (Chemical Hazards)

✳ A chemical is heavier than air if its **vapor density** is greater than 1. It will sink into low lying areas, like ditches and pits. If it is flammable, it can flow along the ground until it finds a flame or spark. Then KABOOM!

✳ A liquid is lighter than water if its **specific gravity** is less than one. This means it will float on the surface of a river or lake. You would place skimmers or absorbent booms on top of the water to catch this kind of spill.

Once a chemical has reached its **auto-ignition temperature**, it has enough energy to burn all by itself, without even a spark or flame. Store chemicals with low ignition temperatures in a cool place.

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