Topic 3 - How Do You Spell Relief

Acids and Bases

Properties and Examples

Acids *taste sour, are soluble in water and undergo similar chemical reactions, have a pH of less than 7*

phosphoric acid (fertilizers, detergents, pharmaceuticals, flavoring agent - tangy)

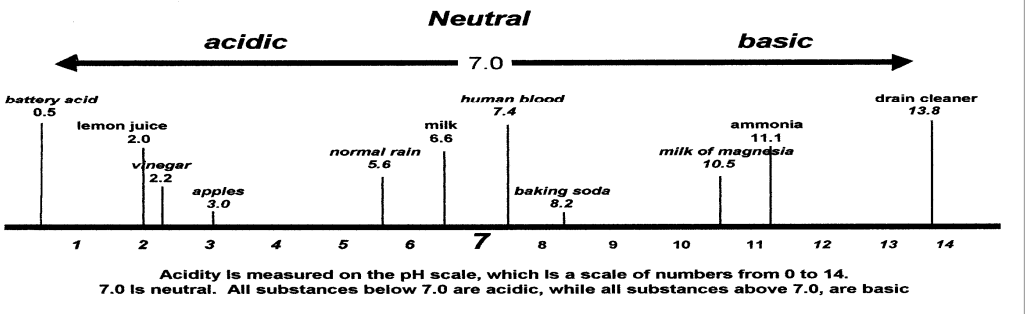
sulfuric acid (car battery, paints, dyes, oil and gas refining, synthetic textiles)

Substances that are neither acidic nor basic, such as water, are said to be ***neutral***.

Bases *taste bitter, are soluble in water, feel slippery, and react with acids, have a pH of more than 7*

sodium hydroxide (household cleaners, bleaching agent, fixative in textiles, solvent in making electronic circuit boards, reagent in film processing)

aluminum hydroxide (antacid tablets)



pH is a measure of the concentration of hydrogen ions in a solution.
It means the *"power of hydrogen"* and
refers to the formation of hydrogen atoms that have lost an electron (ions).

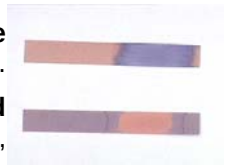
pH: Powerful Scale

The strength or concentration of an acid or base determines the extent to which it reacts with water. The reaction changes the electrical conductivity of the water, which can be measured with a sensitive conductivity test meter. The pH scale is a way of comparing the relative acidity or alkalinity of a substance. To identify a substance as an acid, a base, or neutral, an **indicator** is used. It changes color according to the type of substance it is put into. Indicators can be solids, such as litmus paper, or universal indicator (which change color over a wide pH range can identify many different substances and is more precise), or they can be liquids, such as phenol red. *Common indicators* include: litmus paper / universal indicator paper / phenolphthalein / BTB (Bromothymol Blue) grape Juice / red cabbage Juice / tea

A **universal indicator** is used to measure **pH** over a wide range.

Red litmus paper will turn **blue** in the presence of a **base**.

Blue litmus paper will **turn red** in the presence of an **acid**,



Neutralization

Acids and bases react together when they are mixed. This type of reaction is called neutralization. Both the acid and the base are used up in this type of reaction. A salt and water are produced.

Hydrochloric Acid + Sodium Hydroxide ------ » Sodium Chloride + Water
HCL + NaOH ------ » NaCl + H_2O

Acid in your stomach has a normal pH of 2. This acid helps in the digestion of food and kills off bacteria. If you eat too quickly, or are under stress, your stomach produces an excess amount of gastric acid (giving you heartburn). To neutralize the excess acid, an antacid tablet is swallowed. This antacid is a mild base. (eg. Tums, Rolaids, Milk of Magnesia, Pepto Bismal)

Acid Precipitation – A Global Concern

Sulfur, nitrogen and carbon oxides emitted from industries (such as smelters) combine with water vapor in the air to produce sulfuric, nitric and carbonic acid.

$SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$ [sulfurous acid]

$SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$ [sulfuric acid]

$2NO_{2(g)} + H_2O_{(l)} \rightarrow HNO_{2(aq)} + HNO_{3(aq)}$ [nitrous and nitric acid]

$CO_{2(g)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)}$ [carbonic acid]

These pollutants then fall to the ground as **acid precipitation** (with a pH lower than normal rain - which is about 5.6)

... chemical change reduces soil fertility
... kills organisms in lakes & streams
... leaches toxic chemicals from the soil
…damages or destroys aquatic ecosystems
... retards tree growth
... corrodes exposed metal surfaces
... breaks down stone and limestone

Acidity is measured on the pH scale with anything below 7 being acidic. A decrease of one unit indicates the acidity has been multiplied by a factor of 10. Periods of extreme acidity (like in the spring when the acid snow melts and the acidic water enters the waterways) are called **acid shock**. Concentrations of chemical indicators are usually measured in …

parts per million (ppm) $\text{ppm} = \frac{\text{grams of solute}}{\text{grams of solution}} \times 10^6$

or **milligrams per Litre** (mg/L) $\text{ppm} = \frac{\text{mg of solute}}{\text{L solution}}$

One part per million means that one unit of an element or chemical can be found in one million units of solution. Investigating Parts per million

International Agreements

In 1996 an agreement between Canada and the US targeted a 10% reduction in industrial exhaust emissions by the year 2000. Vehicle emissions for cars built before 1998 was also targeted to be reduced by 60%. As a result total emissions are on the decline.

Acid precipitation dissolves minerals in the soil and allows them to be washed or leached away, leaving fewer nutrients for plants to grow healthy. Heavy metals have also be released into streams and water supply systems where they are consumed as toxic substances by plants and animals.

Using Chemistry to Control Acid Effects

To neutralize acid rain precipitation, lime (calcium hydroxide - which is a base) is added to lakes.

Calcium Hydroxide + Sulfuric Acid ------ » Calcium Sulfate + Water

$Ca(OH)_2 + H_2SO_4$ ------ » $CaSO_4 + H_2O$

This is not necessary in Alberta because the mountains contain rich deposits of limestone, making the water naturally basic. When the acid rain falls, it is neutralized almost immediately.

Alkaline minerals – such as calcium carbonate or calcite - left after glaciers melted, following the Ice Age provide a basic aquatic environment, so that the acid precipitation gets neutralized almost immediately after it enters lakes and water systems.

Using Chemistry to Control Harmful Emissions

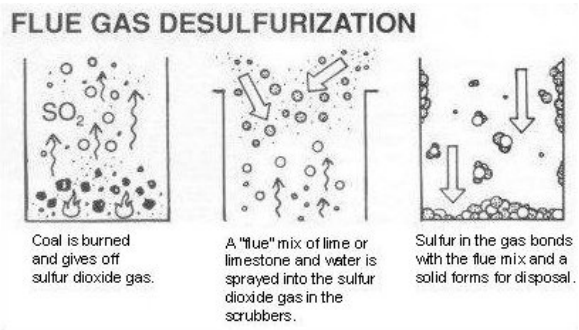
The concentration of chemicals in the environment can be changed using different techniques. Dispersion is the scattering of a substance away from its source. Dilution reduces the concentration of a pollutant by mixing it with large quantities of air or water. A fast flowing river or air mass can disperse and dilute a chemical very quickly. Regulations set by governments require that acceptable levels of pollutants be achieved. To do this biodegradation may also be an effective alternative.

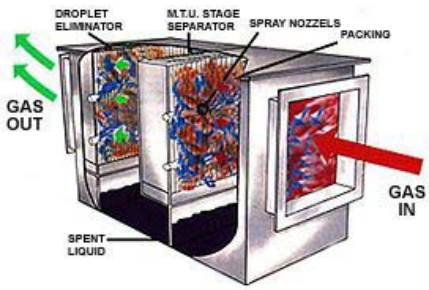
Reducing emissions at the source is more economical and more effect. Catalytic converters contain a ceramic or wire honeycomb-like structure that is coated with a thin layer of metallic catalysts, which speed up chemical reactions, without being used up. A converter helps the formation of CO_2 and H_2O, reducing CO and NO_2. The purpose of the converter is to encourage complete oxidation.

Scrub Those Cares Away

The oxide emissions from industries and thermal-electric power plants that burn coal can be a major source of oxides, depending on the concentration of sulfur in the coal. The addition of 'scrubbers' is a technological solution to reduce oxide emissions.

A scrubber is a device that uses a sorbent that absorbs or captures the sulfur oxides.





The key to scrubbing exhaust gases is the addition of calcium oxide (**CaO**), which reacts with the sulfur dioxide gas ($\mathbf{SO_{2(g)}}$) to form calcium sulfite ($\mathbf{CaSO_3}$) – the sorbent, which is soluble in water.

Newer scrubber technologies utilize metal oxide sorbents. The **COBRA** system uses a sorbent of small aluminum oxide (impregnated with copper) beads. As a result of this process, sulfur, sulfuric acid and ammonium sulfate fertilizer can be recovered as by-products, which then provide added revenue to the industry.

An added bonus in the COBRA scrubber, the addition of ammonia to the heated gases triggers a catalytic reaction that breaks down nitrogen oxides into nitrogen, oxygen gas and water vapour.