

CHEMISTRY

**INVESTIGATORY
PROJECT**

**COMMERCIAL
ANTACIDS**

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CLASS : XII - C

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ANTACIDS

An **Antacid** is any substance, generally a base or basic salt, which neutralizes stomach acidity. They are used to relieve acid indigestion, upset stomach, sour stomach, and heartburn.

ACTION MECHANISM

Antacids perform a neutralization reaction, i.e. they buffer gastric acid, raising the pH to reduce acidity in the stomach. When gastric hydrochloric acid reaches the nerves in the gastrointestinal mucosa, they signal pain to the central nervous system. This happens when these nerves are exposed, as in peptic ulcers. The gastric acid may also reach ulcers in the esophagus or the duodenum.

Other mechanisms may contribute, such as the effect of aluminium ions inhibiting smooth muscle cell contraction and delaying gastric emptying.

INDICATIONS

Antacids are taken by mouth to relieve heartburn, the major symptom of gastro esophageal reflux disease, or acid indigestion. Treatment with antacids alone is symptomatic and only justified for minor symptoms. Peptic ulcers may require H₂-receptor antagonists or proton pump inhibitors.

The utility of many combinations of antacids is not clear, although the combination of magnesium and aluminium salts may prevent alteration of bowel habits.

SIDE EFFECTS

Excess calcium from supplements, fortified food and high-calcium diets, can cause the milk-alkali syndrome, which has serious toxicity and can be fatal. In 1915, Bertram Sippy introduced the "Sippy regimen" of hourly ingestion of milk and cream, the gradual addition of eggs and cooked cereal, for 10 days, combined with alkaline powders, which provided symptomatic relief for peptic ulcer disease. Over the next several decades, the Sippy regimen resulted in renal failure, alkalosis, and hypercalcemia, mostly in men with peptic ulcer disease. These adverse effects were reversed when the regimen stopped, but it was fatal in some patients with protracted vomiting. Milk alkali syndrome declined in men after effective treatments were developed for peptic ulcer disease. But during the past 15 years, it has been reported in women taking calcium supplements above the recommended range of 1200 to 1500 mg daily, for prevention and treatment of osteoporosis, and is exacerbated by dehydration. Calcium has been added to over-the-counter products, which contributes to inadvertent excessive intake.

The New England Journal of Medicine reported a typical case of a woman who arrived in the emergency department vomiting and altered mental

status, writhing in pain. She had consumed large quantities of chewable antacid tablets containing calcium carbonate (Tums). She gradually recovered.^[1]

Compounds containing calcium may also increase calcium output in the urine, which might be associated with kidney stones.^[2] Calcium salts may cause constipation.

Other adverse effects from antacids include:

1. **Carbonate**: Regular high doses may cause alkalosis, which in turn may result in altered excretion of other drugs, and kidney stones. A chemical reaction between the carbonate and hydrochloric acid may produce carbon dioxide gas. This causes gastric distension which may not be well tolerated. Carbon dioxide formation can also lead to headaches and decreased muscle flexibility.
2. **Aluminum hydroxide**: May lead to the formation of insoluble aluminium-phosphate-complexes, with a risk for hypophosphatemia and osteomalacia. Although aluminium has a low gastrointestinal absorption, accumulation may occur in the presence of renal insufficiency. Aluminium-containing drugs may cause constipation.
3. **Magnesium hydroxide**: Has laxative properties. Magnesium may accumulate in patients with renal failure leading to hypermagnesemia, with cardiovascular and neurological complications. See Milk of magnesia.
4. **Sodium**: Increased intake of sodium may be deleterious for arterial hypertension, heart failure and many renal diseases.

SOME MORE SIDE EFFECTS

Fortunately, because acid reflux is such a common problem, antacids are among the medicines available and free of side effects for most people. Side effects from antacids vary depending on individual and other medications they may be taking at the time. Those who experience side effects most commonly suffer from changes in bowel functions, such as diarrhea, constipation, or flatulence.

Although reactions to any drug may vary from person to person, generally those medications that contain aluminum or calcium are the likeliest to cause constipation, those that contain magnesium are the likeliest to cause diarrhea. Some products combine these ingredients, which essentially cancels them out, to forestall unpleasant side effects.

In general, people with kidney problems should probably not take antacids as this can sometimes cause a condition known as alkalosis. In other people, side effects may occur if substances such as salt, sugar, or aspirin, are added to a particular medication. As with all medications, always carefully read the product label on the package and check with your doctor or

pharmacist if you have any question about potential drug interactions or side effects.

Some side effects, such as constipation and diarrhea, are fairly obvious. Other more serious side effects, such as stomach or intestinal; bleeding, can be more difficult to recognize. In general, any sign of blood in the stool or the presence of vomiting is a danger sign and should be brought to the immediate attention of a physician.

If your symptoms persist for more than 10 days to two weeks while you are using the medication, you should stop taking it and consult your doctor. Persistent symptoms may indicate that you have more a serious problem than occasional acid reflux. Pregnant or nursing baby should always consult your doctor before taking this medication. Generally, you should not give these medications to children under the age of 12 unless under the advice and supervision of your doctor or the package label has indicated that the product is safe for young children. Constant use of antacids leads to a condition called acid rebound where the stomach begins to over secrete acid in order to make up for the quantity that is being neutralized.

HYPERACIDITY, CAUSE FOR INTAKE OF ANTACIDS

Hyperacidity or acid dyspepsia simply means increase of acidity in the stomach. The human stomach secretes hydrochloric acid which is necessary for the digestion of food. When the stomach contains an excessive amount of hydrochloric acid, then the condition is called as hyperacidity or acid dyspepsia.

Sometimes, hyperacidity is confused for a simple bellyache. This is because people with hyperacidity usually generally get pains in their stomachs with similar symptoms as bellyaches. This confusion is more rampant in children who cannot differentiate between different kinds of stomach ailments. However, hyperacidity can be found out with the sour belching and aftertaste of the already eaten food in the mouth.

The prime medical factors of hyperacidity or acid dyspepsia are as follows :

(i) **Stomach Ulcers:** Ulcers in the stomach are one of the prime causes of

hyperacidity. Once this is diagnosed, the treatment will be done by the surgical removal of the stomach ulcers.

(ii) **Acid Reflux Disease:** Some people have a gastric disorder called as the acid reflux disease. In this condition, the acids of the stomach, i.e. gastric acids or hydrochloric acid, get refluxed up to the food pipe, which is biologically called as the esophagus. When this happens, it builds up the level of acidity in the stomach.

(iii) Stomach Cancers: Stomach cancers can also cause hyperacidity as one of their symptoms. This is a very rare case, but the mortality rate is quite high. Hence, a hyperacidity that lasts more than two weeks must be immediately shown to the doctor and got checked for any cancer. A timely diagnosis can enable complete treatment of the disease.

SYMPTOMS OF HYPERACIDITY

Hyperacidity symptoms are observed a couple of hours after eating, when the food has been digested and still excess acids are left within the stomach. At this stage, the following symptoms are seen:-

1. A typical feeling of restlessness
2. Feeling of nausea (wanting to throw up) and actual vomiting
3. Sour belching with an aftertaste of the already-eaten food
4. Stiffness in the stomach, which is called as atonic dyspepsia
5. Lack of desire for any other type of food
6. Indigestion
7. Constipation

INTERACTIONS

Altered pH or complex formation may alter the bioavailability of other drugs, such as tetracycline. Urinary excretion of certain drugs may also be affected.

PROBLEMS WITH REDUCED STOMACH ACIDITY

Reduced stomach acidity may result in an impaired ability to digest and absorb certain nutrients, such as iron and the B vitamins. Since the low pH of the stomach normally kills ingested bacteria, antacids increase the vulnerability to infection. It could also result in reduced bioavailability of some drugs. For example, the bioavailability of ketoconazole (antifungal) is reduced at high intragastric pH (low acid content).

SOME FAMOUS ANTACID BRANDS

1. Alka-Seltzer – NaHCO_3 and/or KHCO_3
2. Equate – Al(OH)_3 and Mg(OH)_2
3. Gaviscon – Al(OH)_3
4. Maalox (liquid) – Al(OH)_3 and Mg(OH)_2
5. Maalox (tablet) – CaCO_3
6. Milk of Magnesia – Mg(OH)_2
7. Pepto-Bismol – $\text{HOC}_6\text{H}_4\text{COO}$
8. Pepto-Bismol Children's – CaCO_3
9. Rolaids – CaCO_3 and Mg(OH)_2
10. Tums – CaCO_3
11. Mylanta

DRUG NAMES

Some drugs used as antacids are :

1. Aluminium hydroxide
2. Magnesium hydroxide
3. Calcium carbonate
4. Sodium bicarbonate
5. Bismuth subsalicylate
6. Histamine
7. Cimetidine
8. Ranitidine
9. Omeprazole
10. Lansoprazole

SOME IMPORTANT COMMONLY USED ANTACIDS

1. ALUMINIUM HYDROXIDE



Aluminium hydroxide, $\text{Al}(\text{OH})_3$, Alum, is the most stable form of aluminium in normal conditions. It is found in nature as the mineral gibbsite (also known as hydrargillite) and its three, much more rare, polymorphs: bayerite, doyleite and nordstrandite. Closely related are aluminium oxide hydroxide, $\text{AlO}(\text{OH})$, and aluminium oxide, Al_2O_3 , differing only by loss of water. These compounds together are the major components of the aluminium ore bauxite. Freshly precipitated aluminium hydroxide forms gels, which is the basis for application of aluminium salts as flocculants in water purification. This gel crystallizes with time. Aluminium hydroxide gels can be dehydrated (e.g., with the utility of water-miscible non-aqueous solvents like ethanol) to form an amorphous aluminium hydroxide powder, which is readily soluble in acids. Heat-dried aluminium hydroxide powder is known as activated alumina and is used in gas purification, as a catalyst support and an abrasive.

PRODUCTION

Bauxites are heated in pressure vessels with sodium hydroxide solution at $150\text{--}200\text{ }^\circ\text{C}$ through which aluminium is dissolved as aluminate (Bayer process). After separation of ferruginous residue (red mud) by filtering, pure gibbsite is precipitated when the liquid is cooled and seeded with fine grained aluminium hydroxide. The aluminium hydroxide is further calcined to give alumina, which may be smelted in the Hall-Héroult process in order to produce aluminium.

CHEMISTRY

Gibbsite has a typical metal hydroxide structure with hydrogen bonds. It is built up of double layers of hydroxyl groups with aluminium ions occupying two-thirds of the octahedral holes between the two layers.

Aluminium hydroxide is amphoteric. It dissolves in acid, forming $\text{Al}(\text{H}_2\text{O})_6^{3+}$ (hexaaquaaluminum) or its hydrolysis products. It also dissolves in strong alkali, forming $\text{Al}(\text{OH})_4^-$ (tetrahydroxoaluminate).

PHARMACOLOGY

Pharmacologically, this compound is used as an antacid under names such as Alu-Cap, Aludrox or Pepsamar. The hydroxide reacts with excess acid in the stomach, reducing its acidity. This decrease of acidity of the contents of the stomach may in turn help to relieve the symptoms of ulcers, heartburn or dyspepsia. It can also cause constipation and is therefore often used with magnesium hydroxide or magnesium carbonate, which have counterbalancing laxative effects. This compound is also used to control phosphate (phosphorus) levels in the blood of people suffering from kidney failure.

Aluminium hydroxide, alum, is included as an adjuvant in some vaccines (e.g., Alhydrogel, Anthrax Vaccine), since it appears to contribute to induction of a good antibody (Th2) response. Its pharmacological action is not known. However, it has little capacity to stimulate cellular (Th1) immune responses, important for protection against many pathogens.

Because the brain lesions found in Alzheimer's disease sometimes contain traces of aluminium, there is concern that consumption of excess aluminium compounds may cause or contribute to the development of this and other neurodegenerative diseases. However, multiple epidemiological studies have found no connection between exposure to aluminium and neurological disorders.

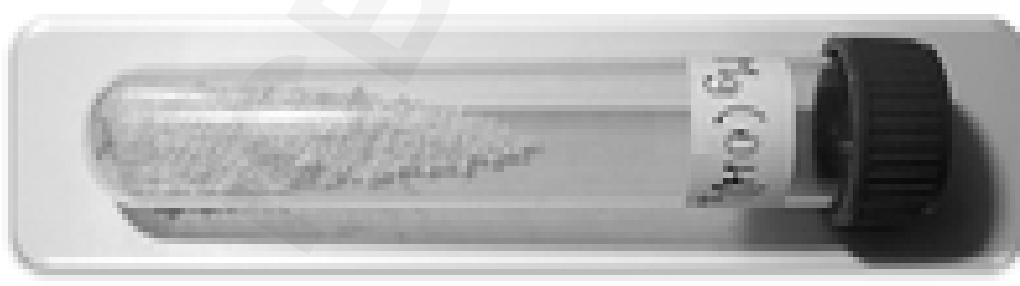
In addition, elevated aluminium levels in blood, resulting from kidney dialysis with well water containing high aluminium, may result in dementia that is similar to but probably different from that of Alzheimer's disease. However, this hypothesis is controversial.

In 2007, tests with mice of the anthrax vaccine using aluminium hydroxide adjuvant were reported as resulting in adverse neuropathy symptoms.

USE AS A FIRE RETARDANT

Aluminium hydroxide also finds use as a fire retardant filler for polymer applications in a similar way to magnesium hydroxide and hydromagnesite. It decomposes at about 180 °C giving off water vapour.

2. MAGNESIUM HYDROXIDE



Magnesium hydroxide is an inorganic compound with the chemical formula $\text{Mg}(\text{OH})_2$. As a suspension in water, it is often called **milk of magnesia** because of its milk-like appearance. The solid mineral form of magnesium hydroxide is known as brucite.

Magnesium hydroxide is common component of antacids and laxatives; it interferes with the absorption of folic acid and iron. Magnesium hydroxide has low solubility in water, with a K_{sp} of 1.5×10^{-11} ; all of magnesium hydroxide that does dissolve does dissociate. Since the dissociation of this small amount of dissolved magnesium hydroxide is complete, magnesium hydroxide is considered a strong base.

HISTORY

In 1829, Sir James Murray used a fluid magnesia preparation of his own design to treat the Lord Lieutenant of Ireland, the Marquis of Anglesey. This was so successful (advertised in Australia and approved by the Royal College of Surgeons in 1838) that he was appointed resident physician to Anglesey and two subsequent Lords Lieutenants, and knighted. His fluid magnesia product was patented two years after his death in 1873.

The term milk of magnesia was first used for a white-colored, aqueous, mildly alkaline suspension of magnesium hydroxide formulated at about 8%w/v by Charles Henry Phillips in 1880 and sold under the brand name Phillips' Milk of Magnesia for medicinal usage.

Although the name may at some point have been owned by GlaxoSmithKline, USPTO registrations show "Milk of Magnesia" to be registered to Bayer, and "Phillips' Milk of Magnesia" to Sterling Drug. In the UK, the non-brand (generic) name of "Milk of Magnesia" and "Phillips' Milk of Magnesia" is "Cream of Magnesia" (Magnesium Hydroxide Mixture, BP).

PREPARATION

Magnesium hydroxide can be precipitated by the metathesis reaction between magnesium salts and sodium, potassium, or ammonium hydroxide:



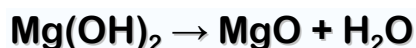
USES

Suspensions of magnesium hydroxide in water (milk of magnesia) are used as an antacid to neutralize stomach acid, and a laxative. The diarrhea caused by magnesium hydroxide carries away much of the body's supply of potassium, and failure to take extra potassium may lead to muscle cramps. Magnesium hydroxide is also used as an antiperspirant armpit deodorant. Milk of magnesia is useful against canker sores (aphthous ulcer) when used topically.

Milk of magnesia is sold for medical use as chewable tablets, capsules, and as liquids having various added flavors. It is used as an antacid, though more modern formulations combine the antimotility effects of equal concentrations of aluminum hydroxide to avoid unwanted laxative effects.

Magnesium hydroxide powder is used industrially as a non-hazardous alkali to neutralise acidic wastewaters. It also takes part in the Biorock method of building artificial reefs.

Solid magnesium hydroxide has also smoke suppressing and fire retarding properties. This is due to the endothermic decomposition it undergoes at 332 °C (630 °F) :



BIOLOGICAL METABOLISM

When the patient drinks the milk of magnesia, the suspension enters the stomach. Depending on how much was taken, one of two possible outcomes will occur.

As an antacid, milk of magnesia is dosed at approximately 0.5–1.5g in adults and works by simple neutralization, where the hydroxide ions from the Mg(OH)_2 combine with acidic H^+ ions produced in the form of hydrochloric acid by parietal cells in the stomach to produce water.

Only a small amount of the magnesium from milk of magnesia is usually absorbed from a person's intestine (unless the person is deficient in magnesium). However, magnesium is mainly excreted by the kidneys so longterm, daily consumption of milk of magnesia by someone suffering from renal failure could lead in theory to hypermagnesemia.

3. CALCIUM CARBONATE



Calcium carbonate is a chemical compound with the chemical formula CaCO_3 . It is a common substance found in rock in all parts of the world, and is the main component of shells of marine organisms, snails, pearls, and eggshells. Calcium carbonate is the active ingredient in agricultural lime, and is usually the principal cause of hard water. It is commonly used medicinally as a calcium supplement or as an antacid, but excessive consumption can be hazardous.

CHEMICAL PROPERTIES

Calcium carbonate shares the typical properties of other carbonates. Notably:

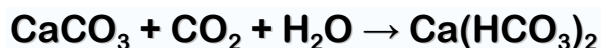
- it reacts with strong acids, releasing carbon dioxide:



- it releases carbon dioxide on heating (to above 840 °C in the case of CaCO_3), to form calcium oxide, commonly called quicklime, with reaction enthalpy 178 kJ / mole:



Calcium carbonate will react with water that is saturated with carbon dioxide to form the soluble calcium bicarbonate.

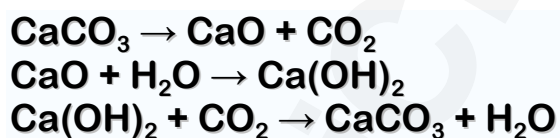


This reaction is important in the erosion of carbonate rocks, forming caverns, and leads to hard water in many regions.

PREPARATION

The vast majority of calcium carbonate used in industry is extracted by mining or quarrying. Pure calcium carbonate (e.g. for food or pharmaceutical use), can be produced from a pure quarried source (usually marble).

Alternatively, calcium oxide is prepared by calcining crude calcium carbonate. Water is added to give calcium hydroxide, and carbon dioxide is passed through this solution to precipitate the desired calcium carbonate, referred to in the industry as precipitated calcium carbonate (PCC):



GEOLOGY

Carbonate is found frequently in geologic settings. It is found as a polymorph. A polymorph is a mineral with the same chemical formula but different chemical structure. Aragonite, calcite, limestone, chalk, marble, travertine, tufa, and others all have CaCO_3 as their formula but each has a slightly different chemical structure. Calcite, as calcium carbonate is commonly referred to in geology is commonly talked about in marine settings. Calcite is typically found around the warm tropic environments. This is due to its chemistry and properties. Calcite is able to precipitate in warmer shallow environments than it does under colder environments because warmer environments do not favour the dissolution of CO_2 . This is analogous to CO_2 being dissolved in soda. When you take the cap off of a

soda bottle, the CO_2 rushes out. As the soda warms up, carbon dioxide is released. This same principle can be applied to calcite in the ocean. Cold water carbonates do exist at higher latitudes but have a very slow growth rate.

In tropic settings, the waters are warm and clear. Consequently, you will see many more coral in this environment than you would towards the poles where the waters are cold. Calcium carbonate contributors such as corals, algae, and microorganisms are typically found in shallow water environments because as filter feeders they require sunlight to produce calcium carbonate.

USES

Industrial applications

The main use of calcium carbonate is in the construction industry, either as a building material in its own right (e.g. marble) or limestone aggregate for roadbuilding or as an ingredient of cement or as the starting material for the preparation of builder's lime by burning in a kiln.

Calcium carbonate is also used in the purification of iron from iron ore in a blast furnace. Calcium carbonate is calcined in situ to give calcium oxide, which forms a slag with various impurities present, and separates from the purified iron.

Calcium carbonate is widely used as an extender in paints, in particular matte emulsion paint where typically 30% by weight of the paint is either chalk or marble.

Calcium carbonate is also widely used as a filler in plastics. Some typical examples include around 15 to 20% loading of chalk in unplasticized polyvinyl chloride (uPVC) drain pipe, 5 to 15% loading of stearate coated chalk or marble in uPVC window profile. PVC cables can use calcium carbonate at loadings of up to 70 phr (parts per hundred parts of resin) to improve mechanical properties (tensile strength and elongation) and electrical properties (volume resistivity). Polypropylene compounds are often filled with calcium carbonate to increase rigidity, a requirement that becomes important at high use temperatures. It is also routinely used as a filler in thermosetting resins (Sheet and Bulk moulding compounds) and has also been mixed with ABS, and other ingredients, to form some types of compression molded "clay" Poker chips.

Fine ground calcium carbonate is an essential ingredient in the microporous film used in babies' diapers and some building films as the pores are nucleated around the calcium carbonate particles during the manufacture of the film by biaxial stretching.

Calcium carbonate is known as whiting in ceramics/glazing applications, where it is used as a common ingredient for many glazes in its white powdered form. When a glaze containing this material is fired in a kiln, the whiting acts as a flux material in the glaze.

It is used in swimming pools as a pH corrector for maintaining alkalinity "buffer" to offset the acidic properties of the disinfectant agent.

It is commonly called chalk as it has traditionally been a major component of blackboard chalk. Modern manufactured chalk is now mostly gypsum, hydrated calcium sulfate $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

HEALTH AND DIETARY APPLICATIONS

Calcium carbonate is widely used medicinally as an inexpensive dietary calcium supplement or antacid. It may be used as a phosphate binder for the treatment of hyperphosphatemia (primarily in patients with chronic renal failure). It is also used in the pharmaceutical industry as an inert filler for tablets and other pharmaceuticals.

Calcium carbonate is used in the production of toothpaste and is also used in homeopathy as one of the constitutional remedies. Also, it has seen a resurgence as a food preservative and color retainer, when used in or with products such as organic apples or food.

Excess calcium from supplements, fortified food and high-calcium diets, can cause the "milk alkali syndrome," which has serious toxicity and can be fatal. In 1915, Bertram Sippy introduced the "Sippy regimen" of hourly ingestion of milk and cream, and the gradual addition of eggs and cooked cereal, for 10 days, combined with alkaline powders, which provided symptomatic relief for peptic ulcer disease. Over the next several decades, the Sippy regimen resulted in renal failure, alkalosis, and hypercalcemia, mostly in men with peptic ulcer disease. These adverse effects were reversed when the regimen stopped, but it was fatal in some patients with protracted vomiting. Milk alkali syndrome declined in men after effective treatments for peptic ulcer disease.

A form of food additive is designated as E170. It is used in some soy milk products as a source of dietary calcium; one study suggests that calcium carbonate might be as bioavailable as the calcium in cow's milk.

4. SODIUM BICARBONATE



Sodium bicarbonate or **sodium hydrogen carbonate** is the chemical compound with the formula NaHCO_3 . Sodium bicarbonate is a white solid that is crystalline but often appears as a fine powder. It can be used to experiment and is not very dangerous. It has a slight alkaline taste resembling that of washing soda (sodium carbonate). It is a component of the mineral natron and is found dissolved in many mineral springs. The natural mineral form is known as **nahcolite**. It is found in its dissolved form in bile, where it serves to neutralize the acidity of the hydrochloric acid produced by the stomach, and is excreted into the duodenum of the small intestine via the bile duct. It is also produced artificially.

Since it has long been known and is widely used, the salt has many related names such as **baking soda**, **bread soda**, **cooking soda**, **bicarbonate of soda**. Colloquially, its name is shortened to **sodium bicarb**, **bicarb soda**, or simply **bicarb**. The word *saleratus*, from Latin *sal aërat* meaning "aerated salt", was widely used in the 19th century for both sodium bicarbonate and potassium bicarbonate. The term has now fallen out of common usage.

HISTORY

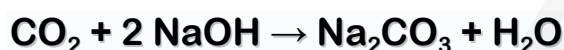
The ancient Egyptians used natural deposits of natron, a mixture consisting mostly of sodium carbonate decahydrate and sodium bicarbonate. The natron was used as a cleansing agent like soap.

In 1791, a French chemist, Nicolas Leblanc, produced sodium bicarbonate as we know it today. In 1846 two New York bakers, John Dwight and Austin Church, established the first factory to develop baking soda from sodium carbonate and carbon dioxide.

PRODUCTION

NaHCO_3 is mainly prepared by the Solvay process, which is the reaction of calcium carbonate, sodium chloride, ammonia, and carbon dioxide in water. It is produced on the scale of about 100,000 ton/year (as of 2001).^[2]

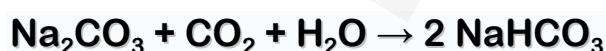
NaHCO_3 may be obtained by the reaction of carbon dioxide with an aqueous solution of sodium hydroxide. The initial reaction produces sodium carbonate:



Further addition of carbon dioxide produces sodium bicarbonate, which at sufficiently high concentration will precipitate out of solution:

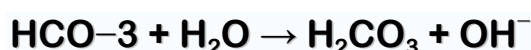


Commercial quantities of baking soda are also produced by a similar method: soda ash, mined in the form of the ore trona, is dissolved in water and treated with carbon dioxide. Sodium bicarbonate precipitates as a solid from this method:

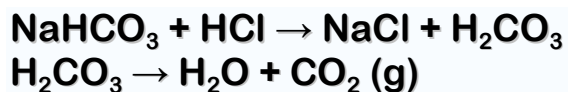


CHEMISTRY

Sodium bicarbonate is an amphoteric compound. Aqueous solutions are mildly alkaline due to the formation of carbonic acid and hydroxide ion:



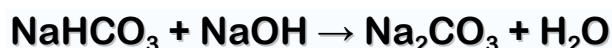
Sodium bicarbonate can be used as a wash to remove any acidic impurities from a "crude" liquid, producing a purer sample. Reaction of sodium bicarbonate and an acid to give a salt and carbonic acid, which readily decomposes to carbon dioxide and water:



Sodium bicarbonate reacts with acetic acid (CH_3COOH) to form sodium acetate:



Sodium bicarbonate reacts with bases such as sodium hydroxide to form carbonates:



Sodium bicarbonate reacts with carboxyl groups in proteins to give a brisk effervescence from the formation of CO_2 . This reaction is used to test for the presence of carboxylic groups in protein.

APPLICATIONS

Sodium bicarbonate is primarily used in cooking (baking) where it reacts with other components to release carbon dioxide, that helps dough "rise". The acidic compounds that induce this reaction include phosphates, cream of tartar, lemon juice, yogurt, buttermilk, cocoa, vinegar, etc. Sodium bicarbonate can be substituted for baking powder provided sufficient acid reagent is also added to the recipe.^[3] Many forms of baking powder contain sodium bicarbonate combined with one or more acidic phosphates (especially good) or cream of tartar. It can also be used for softening peas ($\frac{1}{8}$ tsp. per pint of water and bring to boil for one hour)

Many laboratories keep a bottle of sodium bicarbonate powder within easy reach, because sodium bicarbonate is amphoteric, reacting with acids and bases. Furthermore, as it is relatively innocuous in most situations, there is no harm in using excess sodium bicarbonate. Lastly, sodium bicarbonate powder may be used to smother a small fire.

Sodium bicarbonate is used in an aqueous solution as an antacid taken orally to treat acid indigestion and heartburn. It may also be used in an oral form to treat chronic forms of metabolic acidosis such as chronic renal failure and renal tubular acidosis. Sodium bicarbonate may also be useful in urinary alkalization for the treatment of aspirin overdose and uric acid renal stones.

Sodium bicarbonate can be used to extinguish small grease or electrical fires by being poured or dumped over the fire. However, it should not be poured or dumped onto fires in deep fryers as it may cause the grease to splatter. Sodium bicarbonate is used in BC dry chemical fire extinguishers as an alternative to the more corrosive ammonium phosphate in ABC extinguishers. The alkali nature of sodium bicarbonate makes it the only dry

chemical agent, besides Purple-K, that was used in large scale fire suppression systems installed in commercial kitchens. Because it can act as an alkali, the agent has a mild saponification effect on hot grease, which forms a smothering soapy foam. Dry chemicals have since fallen out of favor for kitchen fires as they have no cooling effect compared to the extremely effective wet chemical agents specifically designed for such hazards.

5. BISMUTH SUBSALICYLATE



Bismuth subsalicylate, with a chemical formula $C_7H_5BiO_4$, is a drug used to treat nausea, heartburn, indigestion, upset stomach, diarrhea, and other temporary discomforts of the stomach and gastrointestinal tract. Commonly known as **pink bismuth**, it is the active ingredient in popular medications such as Pepto-Bismol and modern (since 2003) Kaopectate.

PHARMACOLOGY

As a derivative of salicylic acid, bismuth salicylate displays anti-inflammatory action and also acts as an antacid.

ADVERSE EFFECTS AND CONTRAINDICATIONS

There are some adverse effects. It can cause a black tongue and black stools in some users of the drug, when it combines with trace amounts of sulfur in saliva and the gastrointestinal tract. This discoloration is temporary and harmless.

Some of the risks of salicylism can apply to the use of bismuth subsalicylate.

Children should not take medication with bismuth subsalicylate while recovering from influenza or chicken pox, as epidemiologic evidence points to an association between the use of salicylate-containing medications during certain viral infections and the onset of Reye's syndrome. For the same reason, it is typically recommended that nursing mothers not use

medication containing bismuth subsalicylate (such as Pepto-Bismol) because small amounts of the medication are excreted in breast milk and pose a theoretical risk of Reye's syndrome to nursing children.

RADIOACTIVITY

While bismuth is technically radioactive, its half life is so long, on the order of hundreds of billions of years, that its radioactivity presents absolutely no threat under all medical and other ordinary purposes.

DECOMPOSITION

Bismuth subsalicylate is the only active ingredient in an over the counter medication that will actually leave a shiny metal slag behind.

INVESTIGATORY EXPERIMENT

OBJECTIVE :

To analyse the given samples of commercial antacids by determining the amount of hydrochloric acid they can neutralize.

REQUIREMENTS :

Burettes, pipettes, titration flasks, measuring flasks, beakers, weight box, fractional weights, sodium hydroxide, sodium carbonate, hydrochloric acid, phenolphthalein.

PROCEDURE :

1. Prepare 1 litre of approximately $\frac{N}{10}$ HCl solution by diluting 10 ml of the concentrated acid for one litre.
2. Similarly, make 1 litre of approximately $\frac{N}{10}$ NaOH solution by dissolving 4.0g of NaOH to prepare one litre of solution.
3. Prepare $\frac{N}{10}$ Na₂CO₃ solution by weighing exactly 1.325 g of anhydrous sodium carbonate and then dissolving it in water to prepare exactly 0.25 litres (250 ml) of solution.
4. Standardize the HCl solution by titrating it against the standard Na₂CO₃ solution using methyl orange as indicator.
5. Similarly, standardize NaOH solution by titrating it against standardized HCl solution using phenolphthalein as indicator.
6. Powder the various samples of antacid tablets and weigh 1.0 g of each.
7. Add a specific volume of standardised HCl to each of the weighed sample is taken in conical flasks. The acid should be in slight excess, so that it can neutralize all the alkaline component of the tablet.
8. Add 2 drops of phenolphthalein and warm the flask till most of powder dissolves. Filter off the insoluble material.
9. Titrate this solution against the standardised NaOH solution, till a permanent pinkish tinge is obtained. Repeat this experiment with different antacids.

OBSERVATIONS AND CALCULATIONS :

Standardisation of HCl solution :

Volume of $\frac{N}{10}$ Na₂CO₃ solution taken = 20.0 ml

S No. of obs.	Burette readings		Volume of acid used
	Initial	Final	
1.	0 ml	15.0 ml	15.0 ml
2.	0 ml	15.1 ml	15.1 ml
3.	0 ml	15.0 ml	15.0 ml
4.	0 ml	15.0 ml	15.0 ml
5.	0 ml	15.0ml	15.0 ml

Concordant volume = 15.0 ml

Applying normality equation,

$$N_1 V_1 = N_2 V_2$$

$$N_1 * 15.0 = \frac{1}{10} * 20$$

Normality of HCl, $N_1 = \frac{2}{150.0} = 0.133 \text{ N}$

Standardisation of NaOH solution :

Volume of the given NaOH solution taken = 20.0 ml

S No. of obs.	Burette readings		Volume of acid used
	Initial	Final	
1.	0 ml	26.5 ml	26.5 ml
2.	0 ml	26.8 ml	26.8 ml
3.	0 ml	26.6 ml	26.6 ml
4.	0 ml	26.6 ml	26.6 ml
5.	0 ml	26.6ml	26.6 ml

Concordant volume = 26.6 ml

Applying normality equation,

$$N'_1 V'_1 = N'_2 V'_2$$

$$0.133 * 26.6 = N'_2 * 20$$

Normality of NaOH, $N'_2 = \frac{3.537}{20} = 0.176 \text{ N}$

Analysis of antacid tablet :

Weight of antacid tablet powder = 1.0 g

Volume of HCl solution added = 20.0 ml

Antacid	Vol. Of NaOH soln. Used to neutralise unused HCl	Vol. Of HCl soln. Used to neutralise 1.0 g of antacid matter
1. Gelusil	12.1 ml	12.0 ml
2. Digene	16.0 ml	16.2 ml
3. Aludrox	19.3 ml	18.9 ml
4. Logas	24.3 ml	24.4 ml
5. Ranitidine	21.4 ml	21.7 ml
6. Ocid 20	22.7 ml	21.9 ml

CONCLUSION :

The antacid which has maximum volume of HCl is used for neutralizing i.e. OCID 20 is more effective.

BIBLIOGRAPHY

THIS PROJECT IS MADE WITH THE HELP OF FOLLOWING LINKS :

1. WEBSITES :

- www.wikipedia.org
- www.google.com
- www.yahoo.com
- www.pharmaceutical-drugmanufacturers.com
- www.icbse.com

2. BOOKS :

- Comprehensive Practical Manual for class XII
- Pradeep's New Course Chemistry
- NCERT Class XII Part II