

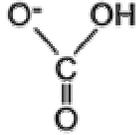
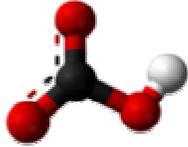
Sodium bicarbonate

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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 has a slightly salty, alkaline taste resembling that of washing soda (sodium carbonate). The natural mineral form is nahcolite. It is a component of the mineral natron and is found dissolved in many mineral springs. It is among the food additives encoded by European Union, identified by the initials E 500. Since it has long been known and is widely used, the salt has many related names such as **baking soda**, **bread soda**, **cooking soda**, and **bicarbonate of soda**. In colloquial usage, its name is sometimes shortened to **sodium bicarb**, **bicarb soda**, simply **bicarb**, or even **bica**. The word *saleratus*, from Latin *sal aeratus* 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. Sodium bicarbonate is usually called baking soda in general terms.

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Sodium bicarbonate	
Na^+ 	
	
	
IUPAC name	
Sodium hydrogen carbonate	
Other names	
Baking soda, bicarbonate of soda, nahcolite, sodium bicarbonate, sodium hydrogencarbonate	
Identifiers	
CAS number	144-55-8 ✓
PubChem	516892
ChemSpider	8609 ✓
UNII	8MDF5V39QO ✓
EC number	205-633-8
DrugBank	DB01390
KEGG	C12603 ✓
MeSH	Sodium+bicarbonate
ChEBI	CHEBI:32139 ✓
ChEMBL	CHEMBL1353 ✓
RTECS number	VZ0950000
ATC code	B05CB04 (http://www.whocc.no/atc_ddd_index/?code=B05CB04),B05XA02, QG04BQ01

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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.

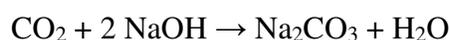
In 1791, a French chemist, Nicolas Leblanc, produced sodium carbonate, also known as soda ash. In 1846, two New York bakers, John Dwight and Austin Church, established the first factory to develop baking soda from sodium carbonate and carbon dioxide.^[6]

This compound, referred to as saleratus, is mentioned in the famous novel *Captains Courageous* by Rudyard Kipling as being used extensively in the 1800s in commercial fishing to prevent freshly-caught fish from spoiling.^[7]

Production

NaHCO₃ is mainly prepared by the Solvay process, which is the reaction of sodium chloride, ammonia, and carbon dioxide in water. Calcium carbonate is used as the source of CO₂ and the resultant calcium oxide is used to recover the ammonia from the ammonium chloride. The product shows a low purity (75%). Pure product is obtained from sodium carbonate, water and carbon dioxide as reported in one of the following reactions. It is produced on the scale of about 100,000 tonnes/year (as of 2001).^[8]

NaHCO₃ 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:

Beilstein Reference	4153970
Jmol-3D images	Image 1 (http://chemapps.stolaf.edu/jmol/jmol.php?model=%5BNa%2B%5D.OC%28%5B%5D%29%3DO)
SMILES	
InChI	
Properties	
Molecular formula	NaHCO ₃
Molar mass	84.007 g mol ⁻¹
Appearance	White crystals
Odor	odorless
Density	2.20 g cm ⁻³ ^[1]
Melting point	50 °C (122 °F; 323 K) (decomposes to sodium carbonate)
Solubility in water	9 g/100 mL 69 g/L (0 °C) ^[2] 96 g/L (20 °C) ^[3] 165 g/L (60 °C) ^[3] 236 g/L (100 °C) ^[2]
Solubility	0.02 %wt acetone, 2.13 %wt methanol @22°C. ^[4] insoluble in ethanol
log P	-0.82
Acidity (pK _a)	10.329 ^[5] 6.351 (carbonic acid) ^[5]
Refractive index (n _D)	1.3344
Structure	
Crystal structure	monoclinic
Pharmacology	
Routes of administration	Intravenous, oral
Hazards	
MSDS	External MSDS (http://siri.org/msds/f2/bdm/bdmjw.html)
Main hazards	Causes serious eye irritation



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:

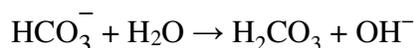


Mining

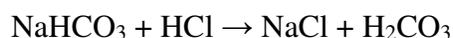
Naturally occurring deposits of nahcolite (NaHCO_3) are found in the Eocene-age (55.8–33.9 Ma) Green River Formation, Piceance Basin in Colorado. Nahcolite was deposited as beds during periods of high evaporation in the basin. It is commercially mined using in-situ leach techniques involving dissolution of the nahcolite by heated water that is pumped through the nahcolite beds and reconstituted through a natural cooling crystallization process.

Chemistry

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



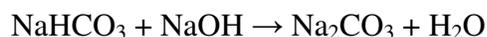
Sodium bicarbonate can be used as a wash to remove any acidic impurities from a "crude" liquid, producing a purer sample. Reaction of sodium bicarbonate and an acid produce a salt and carbonic acid, which readily decomposes to carbon dioxide and water:



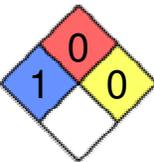
Sodium bicarbonate reacts with acetic acid (found in vinegar), producing sodium acetate, water, and carbon dioxide:



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.

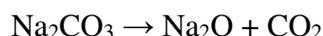
NFPA 704	
Flash point	incombustible
LD ₅₀	4.22 g kg ⁻¹
Related compounds	
Other anions	Sodium carbonate
Other cations	Ammonium bicarbonate Potassium bicarbonate
Related compounds	Sodium bisulfate Sodium hydrogen phosphate
Except where noted otherwise, data are given for materials in their standard state (at 25 °C (77 °F), 100 kPa)	
✓ (verify) (what is: ✓/✗?)	
Infobox references	

Thermal decomposition

Above 50 °C, sodium bicarbonate gradually decomposes into sodium carbonate, water and carbon dioxide. The conversion is fast at 200 °C:^[9]



Most bicarbonates undergo this dehydration reaction. Further heating converts the carbonate into the oxide (at over 850°C):^[9]



These conversions are relevant to the use of NaHCO₃ as a fire-suppression agent ("BC powder") in some dry powder fire extinguishers.

Applications

Sodium bicarbonate is used in a process for removing paint and corrosion called sodablasting; the process is particularly suitable for cleaning aluminium panels which can be distorted by other types of abrasive. It can be administered to pools, spas, and garden ponds to raise pH levels.^[10] It has weak disinfectant properties,^{[11][12]} and it may be an effective fungicide against some organisms.^[13] Because baking soda will absorb musty smells, it has become a reliable method for used-book sellers when making books less malodorous.^[14]

Fire extinguisher

Sodium bicarbonate can be used to extinguish small grease or electrical fires by being thrown over the fire.^[15] However, it should not be applied to fires in deep fryers, as it may cause the grease to splatter.^[15] 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.

Cooking

Sodium bicarbonate, referred to as "baking soda" is primarily used in cooking (baking), as a leavening agent. It reacts with acidic components in batters, releasing carbon dioxide, which causes expansion of the batter and forms the characteristic texture and grain in pancakes, cakes, quick breads, soda bread, and other baked and fried foods. 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.^[16] Many forms of baking powder contain sodium bicarbonate combined with calcium acid phosphate, sodium aluminum sulphate^[17] or cream of tartar.

Sodium bicarbonate was sometimes used in cooking vegetables, to make them softer, although this has gone out of fashion, as most people now prefer firmer vegetables. However, it is still used in Asian and Latin American cuisine to tenderise meats. Baking soda may react with acids in food, including Vitamin C (L-ascorbic acid). It is also used in breadings such as for fried foods to enhance crispness.

Heat causes sodium bicarbonate to act as a raising agent by releasing carbon dioxide when used in baking. The carbon dioxide production starts at temperatures above 80 °C. Since the reaction does not occur at room temperature, mixtures (cake batter, etc.) can be allowed to stand without rising until they are heated in the oven.

Neutralization of acids and bases

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. Also, sodium bicarbonate powder may be used to smother a small fire, as heating of sodium bicarbonate releases carbon dioxide.^[15]

A wide variety of applications follows from its neutralization properties, including reducing the spread of white phosphorus from incendiary bullets inside an afflicted soldier's wounds.^[18]

Medical uses

Sodium bicarbonate mixed with water can be used as an antacid to treat acid indigestion and heartburn.^[19] It is used as the medicinal ingredient in gripe water for infants.^[20]

Intravenous sodium bicarbonate is an aqueous solution that is sometimes used for cases of acidosis, or when there are insufficient sodium or bicarbonate ions in the blood.^[21] In cases of respiratory acidosis, the infused bicarbonate ion drives the carbonic acid/bicarbonate buffer of plasma to the left and, thus, raises the pH. It is for this reason that sodium bicarbonate is used in medically supervised cardiopulmonary resuscitation. Infusion of bicarbonate is indicated only when the blood pH is markedly (<7.1–7.0) low.^[22]

It is used for treatment of hyperkalemia. Since sodium bicarbonate can cause alkalosis, it is sometimes used to treat aspirin overdoses. Aspirin requires an acidic environment for proper absorption, and the basic environment diminishes aspirin absorption in the case of an overdose. Sodium bicarbonate has also been used in the treatment of tricyclic antidepressant overdose.^[23] It can also be applied topically as a paste, with three parts baking soda to one part water, to relieve some kinds of insect bites and stings (as well as accompanying swelling).^[24]

Adverse reactions to the administration of sodium bicarbonate can include metabolic alkalosis, edema due to sodium overload, congestive heart failure, hyperosmolar syndrome, hypervolemic hyponatremia, and hypertension due to increased sodium. In patients consuming a high-calcium or dairy-rich diet, calcium supplements, or calcium-containing antacids such as calcium carbonate (e.g., Tums), the use of sodium bicarbonate can cause milk-alkali syndrome, which can result in metastatic calcification, kidney stones, and kidney failure.

Sodium bicarbonate can be used to treat an allergic reaction to plants such as poison -ivy -oak or -sumac to relieve some of the associated itching.^[25]

Bicarbonate of soda can also be useful in removing splinters from the skin.^[26]

Some alternative practitioners, such as Tullio Simoncini, have promoted baking soda as a cancer cure, which the American Cancer Society has warned against due to both its unproven effectiveness and potential danger in use.

^[27]

Personal hygiene

Toothpaste containing sodium bicarbonate has in several studies shown to have a better whitening^{[28][28][29][30]} and plaque removal effect^{[31][32]} than toothpastes without it.

Sodium bicarbonate is also used as an ingredient in some mouthwashes. It has anti-caries and abrasive properties.^[33] It works as a mechanical cleanser on the teeth and gums, neutralizes the production of acid in the mouth and also acts as an antiseptic to help prevent infections.

Sodium bicarbonate in combination with other ingredients can be used to make a dry or wet deodorant.^{[34][35]} It may also be used as a shampoo.^[36]

Sodium bicarbonate may be used as a buffering agent, combined with table salt, when creating a solution for nasal irrigation.^[37]

In sports

Small amounts of sodium bicarbonate have been shown to be useful as a supplement for athletes in speed-based events, like middle distance running, lasting from about one to seven minutes.^{[38][39]} However, overdose is a serious risk because sodium bicarbonate is slightly toxic;^[40] gastrointestinal irritation is of particular concern.^[39] Additionally, this practice causes a significant increase in dietary sodium.

As a cleaning agent

A paste from baking soda can be very effective when used in cleaning and scrubbing.^[41] For cleaning aluminium objects, the use of sodium bicarbonate is discouraged as it attacks the thin unreactive protective oxide layer of this otherwise very reactive metal. A solution in warm water will remove the tarnish from silver when the silver is in contact with a piece of aluminium foil.^{[42][43]} A paste of sodium bicarbonate and water is useful in removing surface rust as the rust forms a water soluble compound when in a concentrated alkaline solution.^[44] Cold water should be used as hot water solutions can corrode steel.^[45]

Baking soda is commonly added to washing machines as a replacement for softener and to remove odors from clothes. Sodium bicarbonate is also effective in removing heavy tea and coffee stains from cups when diluted with warm water.

During the Manhattan Project to develop the atomic bomb in the early 1940s, many scientists investigated the toxic properties of uranium. They found that uranium oxides stick very well to cotton cloth, but did not wash out with soap or laundry detergent. The uranium would wash out with a 2% solution of sodium bicarbonate (baking soda). Clothing can become contaminated with depleted uranium (DU) dust and normal laundering will not remove it. Those at risk of DU dust exposure should have their clothing washed with baking soda (about 6 ounces (170g) of baking soda in 2 gallons (7.5l) of water).^[46]

As a biopesticide

Sodium bicarbonate can be an effective way of controlling fungus growth,^[47] and in the United States is registered by the Environmental Protection Agency as a biopesticide.^[48]

Cattle feed supplement

Sodium bicarbonate is sold as a cattle feed supplement, in particular as a buffering agent for the rumen.^[49]

In popular culture

Film

Sodium bicarbonate, as 'bicarbonate of soda', was a frequent source of punch lines for Groucho Marx in Marx brothers movies. In *Duck Soup*, Marx plays the leader of a nation at war. In one scene, he receives a message from the battlefield that his general is reporting a gas attack, and Groucho tells his aide, "Tell him to take a teaspoonful of bicarbonate of soda and a half a glass of water."^[50] In *A Night at the Opera*, Groucho's character addresses the opening night crowd at an opera by saying of the lead tenor, "Signor Lassparri comes from a very famous family. His mother was a well-known bass singer. His father was the first man to stuff spaghetti with bicarbonate of soda, thus causing and curing indigestion at the same time."^[51]

Difference between baking soda and baking powder

In comparison to baking powder, baking soda is more alkaline and requires an acid to avoid the metallic taste when the chemical change creates sodium carbonate. Baking powder, on the other hand, contains baking soda, a powdered acid and cornstarch. In scientific terms, baking soda is a pure substance; baking powder is a mixture.^[52]

If baking soda is used in baking, something acidic must be added to avoid the metallic taste of sodium carbonate; but with baking powder, non-acid ingredients such as whole milk or Dutch-processed cocoa must be added to avoid the over-flavouring of acidic taste.^[53]

See also

- Carbonic acid
- Irish soda bread
- List of ineffective cancer treatments
- List of minerals
- Nahcolite
- Natron
- Natrona (disambiguation)
- Trona
- Washing soda

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Further reading

- Bishop, D; Edge, J; Davis, C; Goodman, C (May 2004). "Induced metabolic alkalosis affects muscle metabolism and repeated-sprint ability". *Medicine and science in sports and exercise* **36** (5): 807–13. doi:10.1249/01.MSS.0000126392.20025.17 (<http://dx.doi.org/10.1249/01.MSS.0000126392.20025.17>). ISSN 0195-9131 (<https://www.worldcat.org/issn/0195-9131>). PMID 15126714 (<https://www.ncbi.nlm.nih.gov/pubmed/15126714>).
- David R. Lide, ed. (2003). *CRC Handbook of Chemistry and Physics* (<http://books.google.com/books?id=q2qJId5TKOkC>) (84th ed.). Boca Raton, FL: CRC Press. ISBN 0-8493-0484-9.

External links

- International Chemical Safety Card 1044 (<http://www.inchem.org/documents/icsc/icsc/eics1044.htm>)
- Differences between Baking Soda and Baking Powder (<http://chemistry.about.com/cs/foodchemistry/f/blbaking.htm/>)

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