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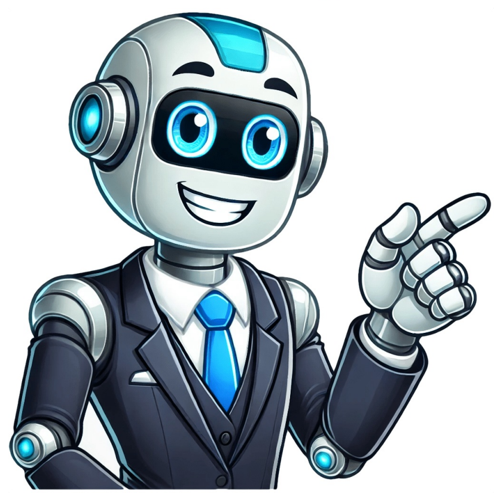

BACKGROUND OF THE INVENTION The present invention relates to the preparation of sodium silicate from quartz by reaction with caustic soda in aqueous medium, under pressure. The existing processes for the industrial production of sodium silicate generally comprise: (i) a calcination of the mixture of sand and sodium carbonate at over 1100° C.; (ii) a solubilization of the sodium silicate having thus been obtained, in the autoclave at moderate pressure, i.e., 2 to 5 bars; and (iii) a filtration. Such processes are costly, since the calcination consumes fuel such as fuel oil or coal. Furthermore, the calcination installation requires a great deal of maintenance because of the possibility of attack on the refractory materials by the sodium carbonate. Consequently, various efforts have been made in order to eliminate the calcination of the mixture of sand and sodium carbonate and to carry out directly the solubilization of silica by heating in an autoclave with sodium hydroxide; as described more particularly in Chemical Engineering 1962, Feb. 2, p. 76-78 and U.S. Pat. No. 2,881,049. In order to control and avoid the corrosion of the equipment, especially of the autoclaves, the solubilization is carried out at moderate pressures; i.e., 3 to 6 bars. However, the low temperatures which result from these pressures make it necessary to select the nature of the sand, to crush it or to have this sand undergo a pretreatment generally consisting of a calcination followed by water hardening. Such processes thus proved to be just as burdensome as the calcination of the mixture of quartz and sodium carbonate, the latter being the only industrial process which is being used. SUMMARY OF THE INVENTION A process has now been invented for the manufacture of sodium silicate from quartz or quartz sand by heating in the autoclave with caustic soda, and which does not present the drawbacks of the previous processes. Briefly, the present invention comprises a process for the manufacture of a sodium silicate solution in a continuous manner from a silicon dioxide-containing material, comprising continuously adding to a reaction zone a stream of said silicon dioxide-containing material and a stream of a sodium hydroxide-sodium carbonate solution, reacting said silicon dioxide-containing material and said sodium hydroxide-sodium carbonate at a temperature and pressure and for a time sufficient to form a sodium silicate solution, and recovering said sodium silicate solution from the reaction zone. BRIEF DESCRIPTION OF THE DRAWING The single FIGURE is a schematic diagram of the process of the invention. DETAILED DESCRIPTION The silicon dioxide-containing material used can be quartz or sand; the latter because of the prevalence of quartz is commonly referred to as "quartz sand". It is preferred to use quartz sand. The instant process does not require any pretreatment of the sand or sand of any particular nature or physical structure, except that the size of the grains must be below 1 mm, and in some instances this may require a crushing operation. The problems of corrosion by the caustic soda (sodium hydroxide) have been solved by using a caustic soda solution containing sodium carbonate, by carrying out a preheating of the sodium hydroxide solution in appropriate exchangers made of nickel which thus do not run the risk of being abraded by the quartz, and by carrying out a continuous solubilization of the quartz by heating in an autoclave. The autoclave or autoclaves thus are not necessarily lined with nickel on the interior in order to solve the problems of corrosion by the caustic soda. They are made of regular steel, and lead to a noticeably reduced plant investment and maintenance expenses. This process makes it possible to obtain a solution of sodium silicate at a cost which is clearly lower than present-day processes. Moreover, this solution contains less than 30 to 40 mg. of Fe per liter. It can therefore be used, in particular, in order to manufacture very white zeolites. The different steps of the process are illustrated in the accompanying drawing and are: 1. The raw materials consist of quartz sand passing through a 1 mm sieve and an industrial caustic soda lye diluted to a concentration of 180 to 230 g of NaOH per liter. To this caustic soda solution are added 15 to 20 g of Na2 CO3 per liter in order to obtain the "attack liquor" (L1). 2. At (A), the quartz is placed in suspension by mixing with a fraction of the sodium hydroxide solution (L1), in such a way that the dry matter content of the obtained suspension (L3) allows it being pumped under pressure into autoclave (C). The quartz charge is such that the weight ratio of SiO2 /total NaOH brought into play falls into the 1.7-2.6 range. 3. At (B), the remainder of the sodium hydroxide solution (L1) is heated to a temperature of 250° to 280° C. in tubular or nickel-plated exchangers. This indirect heating is continuous thanks to the vapor (V1) recovered in the pressure-reducing valves (D) described below, plus a complementary input of vapor (V2). Since the heated solution does not contain quartz, there is no abrasion of the metal of the exchangers. This "attack liquor" heated to 250°-280° C. or L2, is injected continuously into autoclave (C). 4. It is in this autoclave (C) that the solubilization of the quartz takes place in continuous manner. The "attack liquor" (L2) and the quartz suspension (L3) are introduced continuously. These injections of solution and of suspension are carried out under pressure. The temperature in the autoclave or autoclaves amounts to 225° to 245° C., with the pressure going from 27 to 32 bars, and the reaction time from 20 to 35 minutes. Under these conditions, the solubilization of the quartz, whatever its origin may be, is rapid. This rapid continuous solubilization makes it possible to obtain a steady solution in the autoclave, which contains over 160 g of solubilized SiO2 per liter and is not corrosive toward the regular steel being employed in the autoclave, since the sodium hydroxide is neutralized by the solubilized silica. The temperature of the autoclaves is maintained by injection of vapor (V3). At the outlet of autoclaves C, over 95% of the quartz charge has been solubilized. 5. The suspension (L4) coming out of the autoclaves and composed of sodium silicate, containing the quartz not having reacted, is cooled and its pressure is brought back to atmospheric pressure in a series of pressure-reducing flashes (D). The emitted vapor (V1) is reused at (B) for the preheating of the sodium hydroxide solution. The silicate solution (L5) can be diluted in order to avoid the crystallization of the silicate, Na2 O.SiO2, decanted and filtered. The separated solid is partially recycled at (A). The obtained sodium silicate solution is characterized by a silica concentration of 320 to 370 g of SiO2 per liter, a concentration of 160 to 200 g of NaOH per liter, and an iron content below 40 mg of Fe per liter. This solution is prefectly suitable for the manufacture of sodium silico-aluminate and, in particular, zeolite. The invention will be further described in connection with the following example which is set forth for purposes of illustration only. EXAMPLE 1 A solution of caustic soda (sodium hydroxide) and of sodium carbonate is prepared from 428 kg of soda lye containing 193 kg of NaOH, to which 8 kg of Na2 CO3 and 570 kg of water are added. The solution (L1) which is obtained has a volume of 0.83 m3 and contains: ______________________ NaOH 193 kg Na.sub.2 CO.sub.3 8 kg H.sub.2 O 805 kg ______________________ A fraction of this solution; i.e., a volume of 0.21 m3 is utilized at (A) in order to place a charge of 343 kg of sand containing 341 kg of SiO2 into suspension. The suspension (L3) which is obtained has a volume of 0.34 m3. It is injected into autoclave (C). Simultaneously, the remainder of solution (L1) is heated at (B) to 275° C., then injected into autoclave (C). In the autoclave, the suspension has a temperature regulated to 240° C., with the heating up taking place very rapidly, and the pressure amounts to 27 bars. The reaction time at that temperature and under that pressure amounts to 25 minutes. At the end of this reaction under pressure, the suspension is cooled by flash, then diluted with 0.22 m3 of water, and subsequently decanted and filtered. The separated solid has a total weight of 15 kg. It contains 13 kg of SiO2. The filtered solution has a volume of 1.03 m3. It contains: ______________________ NaOH 191 kg Na.sub.2 CO.sub.3 7.5 kg SiO.sub.2 328 kg Fe 32 g ______________________ While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention has defined by the appended claims. read : 816 time : 2024-06-17 12:01:00 from : 化易天下 Manufacturing Method of Sodium SilicateI. OverviewSodium silicate, also known as water glass, is an inorganic compound widely used in chemical, light industry, textile, ceramics, construction and other industries. Its main components are silica and sodium oxide, and it has excellent bonding, acid resistance, heat resistance and electrical insulation. In order to meet the growing market demand, it is crucial to research and develop efficient and environmentally friendly manufacturing methods for sodium silicate. II. Manufacturing Methods1. Wet ProcessWet process is the commonly used method of sodium silicate production. First, quartz sand and soda ash are mixed in a certain proportion and then added to the blast furnace for high temperature melting. The molten material is cooled to form solid sodium silicate, which is then crushed and ground, and finally formulated into sodium silicate solutions of different concentrations. The advantage of this method is the high purity of the product, but the energy consumption is large. 2. Dry process Dry process is a new type of sodium silicate production method. This method adopts high-purity silica and sodium carbonate as raw materials, and produces sodium silicate through high-temperature calcination, crushing, sieving and other steps. Compared with the wet method, the dry process has the advantages of low energy consumption, high production efficiency and stable product quality. 3. Production process 1. Raw material preparation: prepare appropriate amount of quartz sand, soda ash and other raw materials according to the production needs. 2. Dosing: According to the specified proportion, mix the raw materials into the mixer and stir well. 3. Melting: Add the mixture after dosing into the blast furnace for high temperature melting. 4. Cooling: The melt is cooled to form solid sodium silicate. 5. Crushing and Grinding: The solid sodium silicate is crushed and ground to make powder. 6. Preparation: The powdered sodium silicate is prepared into sodium silicate solutions of different concentrations, to be further processed or used. 4. Precautions 1. During the production process, the quality and proportion of raw materials should be strictly controlled to ensure product quality. 2. During the melting process of blast furnace, proper temperature and pressure should be maintained to avoid producing undesirable by-products. 3. During the cooling, crushing and grinding process, safe production practices should be followed to ensure the safety of workers and equipment. 4. When preparing sodium silicate solution, the concentration should be adjusted according to the actual demand, and attention should be paid to the storage and use conditions of the solution. V. Environmental protection and sustainable developmentWith the improvement of environmental protection consciousness and the deep implementation of sustainable development strategy, the environmental protection and sustainability of sodium silicate production process are getting more and more attention. In the production process, effective measures should be taken to reduce energy consumption and waste emissions and improve resource utilization. For example, waste can be utilized for recycling to reduce production costs; at the same time, the treatment of wastewater, waste gas and other pollutants should be strengthened to ensure that the emission standards are met. In addition, the research and development of new low-energy, high-efficiency production processes and equipment is also the key to realizing the sustainable development of the sodium silicate manufacturing industry. VI. Market Prospects and Prospects With the continuous progress of science and technology and the expansion of application fields, the market prospect of sodium silicate is broad. In the future, with the rapid development of new energy, new materials and other industries, the application fields of sodium silicate will be further expanded. At the same time, with the strengthening of environmental protection policies and the requirements of sustainable development, the sodium silicate manufacturing industry will face new challenges and opportunities. Therefore, increasing investment in research and development, improving product quality and technical content, and reducing costs will be the key to the future development of the sodium silicate manufacturing industry. An Indian consultancy company offers to supply sodium silicate plant on turnkey basis. The conventional process of manufacturing sodium silicate is by the reaction of silica sand with soda ash at about 1,100oC forming water glass, which is crushed & dissolved in water and digested under pressure with steam. The process offered by the company involves reaction of silica present in rice husk ash and caustic soda in an autoclave under pressure with steam. Rice husk contains appreciable quantity of silica and on burning the husk contains appreciable quantity of silica and on burning the husk for raising steam in the boiler, the ash obtained is mostly silica in highly reactive form. The solution of sodium silicate so formed on pressure digestion is filtered from the unreacted, unburnt carbon particles originally present in the ash and finally concentrated in an evaporator. Equipment Required The list of main equipment required for production silicated are as follows: vibrating screen (1 number), digestor (2 number), filter press- plate and frame type (1 number), evaporator (2 number), condensers (2 number), boiler (1 number), transfer pump with softener (1 number), cooling tower with ID fan (1 number), NaOH solution preparation tank (1 number), NaOH solution measuring tank (1 number), filter feed tank (1 number), bleacher feed tank (1 number), soft water storage tank (1 number), chimney for boiler (1 number), interconnecting pipelines for steam and process fluids (1 number), technological structure (1 set) Areas of Application In Chemical industry. It is used in soaps, detergents, adhesives silica gel, etc Inputs Required Raw materials - Caustic soda flakes: 215 kgs/ton of sodium silicate - Rice husk: 1,675 kgs/ton of sodium silicate - Rice husk ash: 135 kgs/ton of sodium silicate - Chlorine gas: 3.5 kgs/ton of sodium silicate Water: 2.5 cubic meters per ton of sodium silicate Electricity: 25 HP connected load Manpower: 8 nos per shift Production capacity 1,500 MT per annum based on 2 shift/day operation. Economic Data Cost of project (excluding land, shed & building): Rs 7 million (US $ 0.145 million approximately). Forms of Transfer Turnkey plant For further information please contact Asian & Pacific Centre for Transfer of Technology P O Box: 4575, Qutab Institute Area New Delhi 110016 Tel: (011) 26856276 Fax: 26856274 Email: rvijh@apctt.org « Back to Previous | Back to Top ↑ Hygroscopic chemical compound of variable Na2O/SiO2 ratio precursor of waterglass "E550" redirects here. For the Italian locomotive, see FS Class E550. This article's lead section may be too short to adequately summarize the key points. Please consider expanding the lead to provide an accessible overview of all important aspects of the article. (June 2023) Sodium silicate is a generic name for chemical compounds with the formula Na2xSiyO2y+x or (Na2O)x·(SiO2)y, such as sodium metasilicate (Na2SiO3), sodium orthosilicate (Na4SiO4), and sodium pyrosilicate (Na6Si2O7). The anions are often polymeric. These compounds are generally colorless transparent solids or white powders, and soluble in water in various amounts. Sodium silicate is also the technical and common name for a mixture of such compounds, chiefly the metasilicate, also called waterglass, water glass, or liquid glass. The product has a wide variety of uses, including the formulation of cements, coatings, passive fire protection, textile and lumber processing, manufacture of refractory ceramics, as adhesives, and in the production of silica gel. The commercial product, available in water solution or in solid form, is often greenish or blue owing to the presence of iron-containing impurities. In industry, the various grades of sodium silicate are characterized by their SiO2:Na2O weight ratio (which can be converted to molar ratio by multiplication with 1.032). The ratio can vary between 1:2 and 3.75:1.[1] Grades with ratio below 2.85:1 are termed alkaline. Those with a higher SiO2:Na2O ratio are described as neutral. Soluble silicates of alkali metals (sodium or potassium) were observed by European alchemists in the 16th century. Giambattista della Porta observed in 1567 that tartari salis (cream of tartar, potassium bitartrate) caused powdered crystallum (quartz) to melt at a lower temperature.[2] Other possible early references to alkali silicates were made by Basil Valentine in 1520,[3] and by Agricola in 1550. Around 1640, Jan Baptist van Helmont reported the formation of alkali silicates as a soluble substance made by melting sand with excess alkali, and observed that the silica could be precipitated quantitatively by adding acid to the solution.[4] In 1646, Glauber made potassium silicate, which he called liquor silicum, by melting potassium carbonate (obtained by calcinating cream of tartar) and sand in a crucible, and keeping it molten until it ceased to bubble (due to the release of carbon dioxide). The mixture was allowed to cool and then was ground to a fine powder.[5] When the powder was exposed to moist air, it gradually formed a viscous liquid, which Glauber called "Oleum oder Liquor Silicum, Arenæ, vel Crystallorum" (i.e., oil or solution of silica, sand or quartz crystal).[6] However, it was later claimed that the substances prepared by those alchemists were not waterglass as it is understood today.[7] That would have been prepared in 1818 by Johann Nepomuk von Fuchs, by treating silicic acid with an alkali; the result being soluble in water, "but not affected by atmospheric changes".[8] The terms "water glass" and "soluble glass" were used by Leopold Wolff in 1846,[9] by Émile Kopp in 1857,[10] and by Hermann Krätzer in 1887.[11] In 1892, Rudolf Von Wagner distinguished soda, potash, double (soda and potash), and fixing (i.e., stabilizing) as types of water glass. The fixing type was "a mixture of silica well saturated with potash water glass and a sodium silicate" used to stabilize inorganic water color pigments on cement work for outdoor signs and murals.[12][13][14][15] Sodium silicates are colorless glassy or crystalline solids, or white powders. Except for the most silicon-rich ones, they are readily soluble in water, producing alkaline solutions.[citation needed] When dried up it still can be rehydrated in water.[16] Sodium silicates are stable in neutral and alkaline solutions. In acidic solutions, the silicate ions react with hydrogen ions to form silicic acids, which tend to decompose into hydrated silicon dioxide gel.[citation needed] Heated to drive off the water, the result is a hard translucent substance called silica gel, widely used as a desiccant. It can withstand temperatures up to 1100 °C.[citation needed] Solutions of sodium silicates can be produced by treating a mixture of silica (usually as quartz sand), caustic soda, and water, with hot steam in a reactor. The overall reaction is 2x NaOH + SiO2 → (Na2O)x·SiO2 + x H2O Sodium silicates can also be obtained by dissolving silica SiO2 (whose melting point is 1713 °C) in molten sodium carbonate (that melts with decomposition at 851 °C):[17] x Na2CO3 + SiO2 → (Na2O)x·SiO2 + x CO2 The material can be obtained also from sodium sulfate (melting point 884 °C) with carbon as a reducing agent: 2x Na2SO4 + C + 2 SiO2 → 2 (Na2O)x·SiO2 + 2 SO2 + CO2 In 1990, 4 million tons of alkali metal silicates were produced.[1] Further information: Ferrosilicon § Hydrogen production Sodium silicate may be produced as a part of hydrogen production by dissolving ferrosilicon in an aqueous sodium hydroxide (NaOH·H2O) solution:[18] 2NaOH + Si + H2O → Na2SiO3 + 2H2 Though unprofitable, Na2SiO3 is a byproduct of Bayer process which is often converted to calcium silicate (Ca2SiO4). This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. (December 2022) (Learn how and when to remove this message) The main applications of sodium silicates are in detergents, paper industry (as a deinking agent), water treatment, and construction materials.[1] The adhesive properties of sodium silicate were noted as early as the 1850s[19] and have been widely used at least since the First World War.[20] The largest application of sodium silicate solutions is a cement for producing cardboard.[1] When used as a paper cement, the sodium silicate joint tends to crack within a few years, at which point it no longer holds the paper surfaces cemented together. Sodium silicate solutions can also be used as a spin-on adhesive layer to bond glass to glass[21] or a silicon dioxide–covered silicon wafer to one another.[22] Sodium silicate glass-to-glass bonding has the advantage that it is a low-temperature bonding technique, as opposed to fusion bonding.[21] It also requires less processing than glass-to-glass anodic bonding,[23] which requires an intermediate layer such as silicon nitride (SiN) to act as a diffusion barrier for sodium ions.[23] The deposition of such a layer requires a low-pressure chemical vapor deposition step.[23] A disadvantage of sodium silicate bonding, however, is that it is very difficult to eliminate air bubbles.[22] This is in part because the technique does not require a vacuum and also does not use field assistance[clarification needed] as in anodic bonding.[24] This lack of field assistance can sometimes be beneficial, because field assistance can provide such high attraction between wafers as to bend a thinner wafer and collapse[24] onto nanofluidic cavity or MEMS elements. Sodium silicate may be used for various paints and coatings, such as those used on welding rods. Such coatings can be cured in two ways. One method is to heat a thin layer of sodium silicate into a gel and then into a hard film. To make the coating water-resistant, high temperatures of 100 °C (212 °F; 373 K) are needed.[16] The temperature is slowly raised to 150 °C (302 °F; 423 K) to dehydrate the film and avoid steaming and blistering. The process must be relatively slow, but infrared lamps may be used at first.[16] In the other method, when high temperatures are not practical, the water resistance may be achieved by chemicals (or esters), such as boric acid, phosphoric acid, sodium fluorosilicate, and aluminium phosphate.[16] Before application, an aqueous solution of sodium silicate is mixed with a curing agent.[16] It is used in detergent auxiliaries such as complex sodium disilicate and modified sodium disilicate. The detergent granules gain their ruggedness from a coating of silicates.[1] Sodium silicate is used as an alum coagulant and an iron flocculant in wastewater treatment plants. Sodium silicate binds to colloidal molecules, creating larger aggregates that sink to the bottom of the water column. The microscopic negatively charged particles suspended in water interact with sodium silicate. Their electrical double layer collapses due to the increase of ionic strength caused by the addition of sodium silicate (doubly negatively charged anion accompanied by two sodium cations) and they subsequently aggregate. This process is called coagulation.[1] Main article: Sand casting § Sodium silicate See also: Calcium silicate It is used as a binder of the sand when doing sand casting of all common metals. It allows for the rapid production of a strong mold or core by three main methods.[citation needed] Method 1 requires passing carbon dioxide gas through the mixture of sand and sodium silicate in the sand molding box or core box. The carbon dioxide reacts with the sodium silicate to form solid silica gel and sodium carbonate.[citation needed] This provides adequate strength to remove the now hardened sand shape from the forming tool. Additional strength occurs as any unreacted sodium silicate in the sand shape dehydrates. Method 2 requires adding an ester (reaction product of an acid and an alcohol) to the mixture of sand and sodium silicate before it is placed into the molding box or core box. As the ester hydrolyzes from the water in the liquid sodium silicate, an acid is released which causes the liquid sodium silicate to gel. Once the gel has formed, it will dehydrate to a glassy phase as a result of syneresis. Commonly used esters include acetate esters of glycerol and ethylene glycol as well as carbonate esters of propylene and ethylene glycol. The higher the water solubility of the ester, the faster the hardening of the sand.[citation needed] Method 3 requires microwave energy to heat and dehydrate the mixture of sand and sodium silicate in the sand molding box or core box. The forming tools must pass through microwaves for this to work well. Because sodium silicate has a high dielectric constant, it absorbs microwave energy very rapidly. Fully dehydrated sand shapes can be produced within a minute of microwave exposure. This method produces the highest strength of sand shapes bonded with sodium silicate.[citation needed] Since the sodium silicate does not burn during casting (it can actually melt at pouring temperatures above 1800 °F), it is common to add organic materials to provide for enhanced sand breakdown after casting. The additives include sugar, starch, carbons, wood flour and phenolic resins. Water glass is a useful binder for solids, such as vermiculite and perlite. When blended with the latter lightweight fraction, water glass can be used to make hard, high-temperature insulation boards used for refractories, passive fire protection, and high-temperature insulations, such as in moulded pipe insulation applications. When mixed with finely divided mineral powders, such as vermiculite dust (which is common scrap from the exfoliation process), one can produce high temperature adhesives. The intumescence[clarification needed] disappears in the presence of finely divided mineral dust, whereby the waterglass becomes a mere matrix. Waterglass is inexpensive and abundantly available, which makes its use popular in many refractory applications. Sodium silicate is used as a deflocculant in casting slips helping reduce viscosity and the need for large amounts of water to liquidize the clay body. It is also used to create a crackle effect in pottery, usually wheel-thrown. A vase or bottle is thrown on the wheel, fairly narrow and with thick walls. Sodium silicate is brushed on a section of the piece. After five minutes, the wall of the piece is stretched outward with a rib or hand. The result is a wrinkled or cracked look. It is also the main agent in "magic water", which is used when joining clay pieces, especially if the moisture level of the two differs.[25] Sodium silicate solution is used as a fixative for hand dyeing with reactive dyes that require a high pH to react with the textile fiber. After the dye is applied to a cellulose-based fabric, such as cotton or rayon, or onto silk, it is allowed to dry, after which the sodium silicate is painted on to the dyed fabric, covered with plastic to retain moisture, and left to react for an hour at room temperature.[26] Sodium silicate is used, along with magnesium silicate, in muffler repair and fitting paste. Magnesium silicate can be mixed with a solution of sodium silicate to form a thick paste that is easy to apply. When the exhaust system of an internal combustion engine heats up to its operating temperature, the heat drives out all of the excess water from the paste. The silicate compounds that are left over have glass-like properties, making a temporary, brittle repair that can be reinforced with glass fibre.[citation needed] Sodium silicate can be used to fill gaps in the head gasket of an engine. This is especially useful for aluminium alloy cylinder heads, which are sensitive to thermally induced surface deflection. Sodium silicate is added to the cooling system through the radiator and allowed to circulate. When the sodium silicate reaches its "conversion" temperature of 100–105 °C (212–221 °F), it loses water molecules and forms a glass seal with a re-melting temperature above 810 °C (1,490 °F). This repair can last two years or longer, and symptoms disappear instantly. However, this repair works only when the sodium silicate reaches its "conversion" temperature. Also, sodium silicate (glass particulate) contamination of lubricants is detrimental to their function, and contamination of engine oil is a serious possibility in situations in which a coolant-to-oil leak is present. Sodium silicate solution is used to inexpensively, quickly, and permanently disable automobile engines. Running an engine with half a U.S. gallon (or about two liters) of a sodium silicate solution instead of motor oil causes the solution to precipitate, catastrophically damaging the engine's bearings and pistons within a few minutes.[27] In the United States, this procedure was used to comply with requirements of the Car Allowance Rebate System (CARS) program.[27][28] A mixture of sodium silicate and sawdust has been used in between the double skin of certain safes. This not only makes them more fire resistant, but also makes cutting them open with an oxyacetylene torch extremely difficult due to the smoke emitted. Sodium silicate is frequently used in drilling fluids to stabilize and avoid the collapse of borehole walls. It is particularly useful when drill holes pass through argillaceous formations containing swelling clay minerals such as smectite or montmorillonite. Concrete treated with a sodium silicate solution helps to reduce porosity in most masonry products such as concrete, stucco, and plasters. This effect aids in reducing water penetration, but has no known effect on reducing water vapor transmission and emission.[29] A chemical reaction occurs with the excess Ca(OH)2 (portlandite) present in the concrete that permanently binds the silicates with the surface, making them far more durable and water repellent. This treatment generally is applied only after the initial cure has taken place (approximately seven days depending on conditions). These coatings are known as silicate mineral paint. An example of the reaction of sodium silicate with the calcium hydroxide found in concrete to form calcium silicate hydrate (CSH) gel, the main product in hydrated Portland cement, follows.[30] Na2SiO3 + y H2O + x Ca(OH)2 → x CaO.SiO2.y H2O + 2NaOH When crystals of a number of metallic salts are dropped into a solution of water glass, simple or branching stalagmites of colored metal silicates are formed. This phenomenon has been used by manufacturers of toys and chemistry sets to provide instructive enjoyment to many generations of children from the early 20th century until the present. An early mention of crystals of metallic salts forming a "chemical garden" in sodium silicate is found in the 1946 Modern Mechanix magazine.[31] Metal salts used included the sulfates and/or chlorides of copper, cobalt, iron, nickel, and manganese. Sodium silicate with additives was injected into the ground to harden it and thereby to prevent further leakage of highly radioactive water from the Fukushima Daiichi nuclear power plant in Japan in April, 2011.[32] The residual heat carried by the water used for cooling the damaged reactors accelerated the setting of the injected mixture. On June 3, 1958, the USS Nautilus, the world's first nuclear submarine, visited Everett and Seattle. In Seattle, crewmen dressed in civilian clothing were sent in to secretly buy 140 quarts (160 liters) of an automotive product containing sodium silicate (originally identified as Stop Leak) to repair a leaking condenser system. The Nautilus was en route to the North Pole on a top secret mission to cross the North Pole submerged.[33] A historical use of the adhesive properties of sodium silicates is the production of paper cartridges for black powder revolvers produced by Colt's Manufacturing Company between 1851 and 1873, especially during the American Civil War. Sodium silicate was used to seal combustible nitrated paper together to form a conical paper cartridge to hold the black powder, as well as to cement the lead ball or conical bullet into the open end of the paper cartridge. Such sodium silicate cemented paper cartridges were inserted into the cylinders of revolvers, thereby speeding the reloading of cap-and-ball black powder revolvers. This use largely ended with the introduction of Colt revolvers employing brass-cased cartridges starting in 1873.[34][35] Similarly, sodium silicate was also used to cement the top wad into brass shotgun shells, thereby eliminating any need for a crimp at the top of the brass shotgun shell to hold a shotgun shell together. Reloading brass shotgun shells was widely practiced by self-reliant American farmers during the 1870s, using the same waterglass material that was also used to preserve eggs. The cementing of the top wad on a shotgun shell consisted of applying from three to five drops of waterglass on the top wad to secure it to the brass hull. Brass hulls for shotgun shells were superseded by paper hulls starting around 1877. The newer paper-hulled shotgun shells used a roll crimp in place of a waterglass-cemented joint to hold the top wad in the shell. However, whereas brass shotshells with top wads cemented with waterglass could be reloaded nearly indefinitely (given powder, wad, and shot, of course), the paper hulls that replaced the brass hulls could be reloaded only a few times. World War I poster suggesting the use of waterglass to preserve eggs Sodium silicate and other silicates are the primary components in "instant" wrinkle remover creams, which temporarily tighten the skin to minimize the appearance of wrinkles and under-eye bags. These creams, when applied as a thin film and allowed to dry for a few minutes, can present dramatic results. This effect is not permanent, lasting from a few minutes up to a couple of hours. It works like water cement, once the muscle starts to move, it cracks and leaves white residues on the skin. Waterglass has been used as an egg preservative with large success, primarily when refrigeration is not available. Fresh-laid eggs are immersed in a solution of sodium silicate (waterglass). After being immersed in the solution, they are removed and allowed to dry. A permanent air tight coating remains on the eggs. If they are then stored in appropriate environment, the majority of bacteria which would otherwise cause them to spoil are kept out and their moisture is kept in. According to the cited source, treated eggs can be kept fresh using this method for up to five months. When boiling eggs preserved that way, the shell is no longer permeable to air, and the egg will tend to crack unless a hole in the shell is made (e.g., with a pin) in order to allow steam to escape.[36] Sodium silicate's flocculant properties are also used to clarify wine and beer by precipitating colloidal particles. As a clearing agent, though, sodium silicate is sometimes confused with isinglass which is prepared from collagen extracted from the dried swim bladders of sturgeon and other fishes. Eggs can be preserved in a bucket of waterglass gel, and their shells are sometimes also used (baked and crushed) to clear wine.[37] Sodium silicate gel is also used as a substrate for algal growth in aquaculture hatcheries.[38] Precipitated silica Sodium carbonate Sodium stannate Sodium germanate ^ a b c d e f Gerard Lagaly, Werner Tufar, A. Minihan, A. Lovell "Silicates" in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, 2005. doi:10.1002/14356007.a23_661 ^ della Porta, Giambattista (1569). Magia naturalis sive de miraculis rerum naturalium, libri iiii [Natural magic or on the miracles of nature, in four books] (in Latin). Lyon (Lugdunum), France: Guillaume Rouillé (Gulielmum Rovillium). pp. 290–291. See pp. 290–291, "Crystallus, ut fusilis fiat" (Quartz, so made molten)] ^ Kohn, C. (1862). "Die Erfindung des Wasserglas im Jahre 1520" [The invention of waterglass in the year 1520]. Zeitschrift des Österreichischen Ingenieur-Vereines [Journal of the Austrian Engineer Association] (in German). 14: 229–230. ^ van Helmont, Johannes (1644). Opuscula medica inaudita (in Latin). Cologne, Germany: Jost Kalckhoven (Jodocum Kalcoven). p. 53. In Part I: De Lithiasi, page 53, van Helmont mentions that alkalis dissolve silicates: "Porro lapides, gemmae, arenae, marmora, silices, &c. adjuncto alcali, vitrificantur: sin autem plure alcali coquantur, resolvuntur in humido quidem: ac resoluta, facili negotio acidorum spirituum, separantur ab alcali, pondere pristini pulveris lapidum." (Furthermore, stone, gems, sand, marble, silica, etc., become glassy by the addition of alkali: but if roasted with more alkali, they are dissolved in moisture: and the former weight of the stone powder is separated from the alkali and released by simply adding acid.) ^ Glauber, Johann Rudolf (1647). Furni Novi Philosophici [New Philosophical Furnace] (in German). Vol. 2. Amsterdam, Netherlands: Johann Fabel. pp. 136–137. See: "Wie durch Hülff eines reinen Sandes oder Kißlings auß Sale Tartari ein kräfftiger Spiritus kan erlanget werden." (How with the help of a pure sand or silica a powerful solution can be gotten from cream of tartar). ^ (Glauber, 1647), p. 138 ^ Anon. (1863). "Die Erfindung des Wasserglases im Jahre 1520" [The invention of waterglass in the year 1520]. Kunst- und Gewerbe-Blatt (in German). 49: 228–230. Reprinted in: Anon. (1863). "Die Erfindung des Wasserglases im Jahre 1520" [The invention of waterglass in the year 1520]. Polytechnisches Journal (in German). 168: 394–395. Reprinted in: Anon. (1863). "Die angebliche Erfindung des Wasserglases im Jahre 1520" [The alleged invention of waterglass in the year 1520]. Neues Repertorium für Pharmacie (in German). 12: 271–273. ^ Nepomuk von Fuchs, Johann (1825). "Ueber ein neues Produkt aus Kieselerde und Kali" [On a new product from silica and potash]. Archiv für die gesammte Naturlehre (in German). 5 (4): 385–412. From page 386: "Ich erhielt es zuerst, vor ungefähr 7 Jahren" (I first obtained it about 7 years ago). Reprinted in: Nepomuk Fuchs, Joh. (1825). "Ueber ein neues Produkt aus Kieselerde und Kali; und dessen nüzliche Anwendung als Schuzmittel gegen schnelle Verbreitung des Feuers in Theatern, als Bindemittel, firnißartigen Anstrichen u.s.w." [On a new product from silica and potash; and its useful application as a protection against the rapid spread of fire in theaters, as a glue, varnish, etc.]. Polytechnisches Journal (in German). 17: 465–481. ^ Wolff, Leopold (1846). Das Wasserglas: Seine Darstellung, Eigenschaften und seine mannichfache Anwendung in den technischen Gewerben [Water-glass: its preparation, properties, and its manifold uses in technical commerce] (in German). Quedlinburg and Leipzig, Germany: Gottfried Basse. ^ Emile Kopp (1857): "Sur la préparation et les propriétés du verre soluble ou des silicates de potasse et de soude; analyse de tous les travaux publiés jusqu'a ce jour sur ce sujet" (On the preparation and properties of soluble glass or the silicates of potash and soda; analysis of all works published until today on this subject). Le Moniteur scientifique, volume 1, 337–349, pages 366–391. ^ Krätzer, Hermann (1887). Wasserglas und Infusorienerde, deren Natur und Bedeutung für Industrie, Technik und die Gewerbe [Water-glass and soluble earths, their nature and significance for industry, technology, and commerce] (in German). Vienna, Austria: Hartleben. ^ Von Wagner, Rudolf (1892; translation of 13th edition by Willian Crookes) Manual of Chemical Technology [1] ^ Von Wagner, Manual of Chemical Technology (1892 translation) ^ Hermann Mayer (1925): Das Wasserglas; Sein Eigenschaften, Fabrikation und Verwendung auf Grund von Erfahrungen und Mitteilungen der Firma Henkel & Cie. (The Water-glass: Its properties, production, and application on the basis of experiences and communications of the firm of Henkel & Co.) Published by Vieweg, Braunschweig, Germany. ^ Morris Schrero (1922): Water-glass: A Bibliography. Published by Carnegie Library, Pittsburgh, Pennsylvania. ^ a b c d e The OxyChem Sodium Silicate Handbook (PDF), 2019 ^ Greenwood, Norman N.; Earnshaw, Alan (1997). Chemistry of the Elements (2nd ed.). Butterworth-Heinemann. ISBN 978-0-08-037941-8. ^ Brack, Paul; Dann, Sandie E.; Wijayantha, K. G. Upul; Adcock, Paul; Foster, Simon (November 2015). "An old solution to a new problem? Hydrogen generation by the reaction of ferrosilicon with aqueous sodium hydroxide solutions". Energy Science & Engineering. 3 (6): 535–540. Bibcode:2015EneSE...3..535B. doi:10.1002/ese3.94. S2CID 54929253. ^ Commerce, Royal Society for the Encouragement of Arts, Manufactures and (1859). Journal. RSA.{{cite book}}: CS1 maint: multiple names: authors list (link) ^ Furness, Rex (1922-09-30). "Sodium silicate as an adhesive". Journal of the Society of Chemical Industry. 41 (18): 381R – 384R. doi:10.1002/jctb.5000411801. ^ a b Wang, H.Y; Foote, R.S; Jacobson, S.C; Schneibel, J.H; Ramsey, J.M (1997-12-15). "Low temperature bonding for microfabrication of chemical analysis devices". Sensors and Actuators B: Chemical. 45 (3): 199–207. Bibcode:1997SeAcB..45..199W. doi:10.1016/S0925-4005(97)00294-3. ISSN 0925-4005. ^ a b Puers, R; Cozma, A (1997-09-01). "Bonding wafers with sodium silicate solution". Journal of Micromechanics and Microengineering. 7 (3): 114–117. Bibcode:1997JMiMi...7..114P. doi:10.1088/0960-1317/7/3/008. ISSN 0960-1317. S2CID 250822654. ^ a b c Berthold, A.; Nicola, L.; Sarro, P.M.; Vellekoop, M.J (2000-05-15). "Glass-to-glass anodic bonding with standard IC technology thin films as intermediate layers". Sensors and Actuators A: Physical. 82 (1–3): 224–228. Bibcode:2000SeAcA..82..224B. doi:10.1016/S0924-4247(99)00376-3. ISSN 0924-4247. ^ a b Li, Dongqing, ed. (2008). Encyclopedia of Microfluidics and Nanofluidics. Boston, MA: Springer US. doi:10.1007/978-0-387-48998-8. ISBN 978-0-387-32468-5. ^ "Ceramic, Pottery, Sculpture and Kintsugi Repair | China repair and restoration". ^ Burch, Paula (March 22, 2010). "Sodium silicate as a fixative for dyeing". Retrieved March 22, 2010. ^ a b Helliker, Kevin. "The Killer App for Clunkers Breathes Fresh Life Into 'Liquid Glass'" The Wall Street Journal, 4 August 2009. ^ Engine Disablement Procedures for the CARS program Archived 2010-10-19 at the Wayback Machine, cars.gov ^ "Home" (PDF). Archived from the original (PDF) on 2018-08-10. Retrieved 2018-08-09. ^ JLR Thompson et al Characterization of Silicate Sealers on Concrete Cement and Concrete Research Vol. 27 No. 10 1997 ^ "Magic garden". Mechanix Illustrated: 88. April 1946. Archived from the original on 2012-02-10. Retrieved 2007-04-30. ^ Press Release (TEPCO:2011.4.6) ^ Commander William R. Anderson with Clay Blair Jr., Nautilus 90 North (Cleveland and New York: The World Publishing Co., 1959), pp. 133–137; Commander William R. Anderson with Clay Blair Jr., Nautilus 90 North (New York: The New American Library, 1959), 89–90 ^ Tom Kelley (August 1995). "Making and using combustible paper pistol cartridges". Archived from the original on 2008-03-27. Retrieved 2010-12-17. ^ Kirst, W.J. (1983). Self consuming paper cartridges for the percussion revolver. Minneapolis, Minnesota: Northwest Development Co. ^ How To Store Fresh Eggs. motherearthnews.com ^ SM Tritton (1956) Amateur wine making. ^ Bechtold, M. F. (1955). "Polymerization and Properties of Dilute Aqueous Silicic Acid from Cation Exchange". The Journal of Physical Chemistry. 59 (6): 532–541. doi:10.1021/j150528a013. Ashford's Dictionary of Industrial Chemicals, third edition, 2011, page 8369. Wikimedia Commons has media related to Sodium silicates. Centre Européen d'Etudes des Silicates International Chemical Safety Card 1137 ChemSub Online : Silicic acid, sodium salt ChemSub Online : Sodium metasilicate Retrieved from " Sodium silicates are crystalline solids that have a glassy appearance. The common terms for an aqueous solution of sodium silicate are water glass and liquid glass. They produce alkaline solutions, since they are soluble in water. This chemical compound is soluble is stable in alkaline as well as neutral solutions. However, acidic medium, the ions of silicate react with the ions of hydrogen to produce silicic acid, which has the tendency to decompose into hydrated silicon dioxide gel. The final product obtained, after driving off the water is silica gel, which is a hard-translucent substance. Production Sodium Silicate Plant consists of sections such as raw materials dosing, reaction and filtration. The production process of sodium silicate is based on batch-wise operations. Sodium silicate can be produced by dissolving silica in molten sodium carbonate. It can also be produced in a reactor, by treating a mixture of caustic soda, water and silica in the form of quartz sand with hot steam. The chemical compound can be also be produced from sodium sulfate with carbon as a reducing agent. Uses Sodium silicate is an important glass industry chemical compound, due to the presence of silica and sodium oxide. The liquid form of sodium silicate finds many applications such as iron deflocculant in wastewater treatment plants, glass manufacturing, fire protection, detergent auxiliaries, cement formulation, drilling fluids, textile processing, desiccant, production of silica gel and manufacture of refractory ceramics. Sodium silicate solution is used as a paper cement in the production of cardboard. Liquid glass is used as a drilling fluid for the stabilization of borehole walls. In the automotive industry, this chemical compound is used as a crack sealer and exhaust system joint for repairing resonators, tailpipes, mufflers and other components. Water glass is used for the preservation of eggs, when refrigeration is not available. Sodium silicate flocculant is used to clarify beer and wine, through precipitation of colloidal particles. Gels of sodium silicate are used as substrates for the growth of algae in aquaculture hatcheries. Health Hazards Sodium Silicate is found in pesticides and household cleaning products. This chemical compound must be handled with caution, due to its toxic nature and subsequent hazardous effects on the body. Inhalation of water glass can cause irritation of the upper respiratory tract and mucous membrane. Prolonged exposure can lead to the permanent damage of the lungs. In the event of ingestion, liquid glass could burn all the areas of the digestive tract. This would induce vomiting, nausea and diarrhea. On coming in contact with skin, it can result in itching, redness and pain. Burning sensation in the eyes can occur, when it would come in contact. Scope There is an increasing demand for water glass in the electrode coating, waste treatment, soil stabilization, cosmetics, rubber and paper industry. Asia Pacific will continue to be a major hub for chemical industry players due to the rapid growth of end-user industries like paper, textiles, automotive, oil and gas in the region. Sodium silicate manufacturers from the developed countries will continue to expand their network of sales in the developing regions like Asia Pacific, Africa and Middle East. Europe accounts to 20% of the global sodium silicate production.