Published on *ASSIST* (https://assist.asta.edu.au)

Chemical Storage Timeframes

Posted by Anonymous on Thu, 2014-10-09 13:50

Chemical Storage Timeframes: I was wondering if there are any guidelines that relate to how long chemicals can be stored in a secondary school prep lab before they go 'bad' - essentially a use by date? None of my chemicals have use by dates, but some are very old (from the 90's), and I'd like some information to forward to my HOD to back up my request for disposal. I've asked this question on a discussion list and someone replied with 5yrs, but didn't provide any evidence to support this.

Also is there a list of chemicals and their shelf life available to download?

Voting:
☆☆☆☆☆
No votes yet

Year Level:
7
8
9
10
Senior Secondary
Laboratory Technicians:
Laboratory Technicians

Showing 1-2 of 2 Responses

Answer by ginny.r.ward on question Chemical Storage Timeframes

Submitted by on 14 November 2014

Answer reviewed 27 February 2023

The shelf life of a chemical depends on the nature of the chemical, the conditions under which it is stored and how frequently the bottle is opened. Chemicals may deteriorate due to reactivity to air and water, sensitivity to light, air-oxidation to form peroxides, photochemical reactions and volatility. Solutions may also lose water through transpiration (loss of vapour) via the cap and thread, leading to an increase in the concentration of the solution.

Generally, chemicals should be stored in a cool, dry place with no exposure to light, especially direct sunlight. Bottles should be capped tightly after use. The SDS for a particular chemical should be consulted for specific storage and handling requirements (Part 7) and stability and reactivity (Part 10) of the chemical. The month and year of purchase/opening should be recorded on the bottle.

Schools should endeavour to store chemicals in minimum quantities and chemical stock should be assessed periodically. Chemicals should be inspected for absorption of water, any cloudiness or crystals which have developed in a liquid and any change to the colour or form of a substance. Part 9 of the SDS, Physical and Chemical Properties, can be consulted for information on the form and appearance of a chemical if there is any uncertainty about what it should look like. Consideration should be given to whether the chemical is safe to use and whether it is fit for purpose.

A visual inspection of the chemical stock should include an inspection of labels, containers and bottle caps for signs of deterioration. Labels which have become illegible should either be replaced, or the chemical decanted and relabelled, or disposed of. Particular care should be taken with old bottles of corrosive substances which can eat through bottle caps. Spare bottle caps can be purchased through science equipment suppliers.

We are not aware of any list of chemicals and their shelf life available to download.

Please see below for further details on some specific issues to consider in the maintenance of school science chemicals.

Absorption of water

Many substances are hygroscopic, which means that they will absorb water from the air. Examples of hygroscopic substances include sodium chloride, potassium bromide, ferric chloride, sulfuric acid and glycerol. Some substances are deliquescent which means that they will absorb water from the air to the extent the substance goes into solution. Examples of deliquescent substances include sodium hydroxide, potassium hydroxide, calcium chloride, potassium carbonate and zinc chloride. Absorption of water does not necessarily make the chemical unfit for purpose in a school, as it may still be used for solutions which are used for qualitative observations. However, if a chemical has absorbed so much water that it is very difficult to handle or has formed a solution, then disposal and replacement of the chemical is recommended.

Hygroscopic solids can be protected from moisture in the air by storage in a desiccator along with a desiccant. There is quite a range of substances which can be used as desiccants, however, taking into consideration safety, availability and ease of handling, we recommend silica gel for use in desiccators. Silica gel is available as self-indicating, which means that it will change colour with the absorption of water. Silica gel can be regenerated by drying in an oven at 105–120°C for 2–3 hours.

Storing chemicals in a desiccator

- An evaporating dish or similar open vessel containing a desiccant should be placed in the base of the desiccator. The ceramic plate is placed over the evaporating dish and the bottles of chemicals to be stored are placed on the ceramic plate.

- A small amount of vacuum grease should be applied to the rims of both the lid and base of the desiccator. This creates a barrier to protect against the ingress of water.
- A desiccator should be opened by **sliding**, not lifting, the lid from the base. The vacuum grease may seize up over time, which makes it very difficult to remove the desiccator lid. In such cases, the grease can be warmed by heating the rim of the desiccator with a heat gun or hairdryer. The old vacuum grease should then be removed with paper towel and fresh grease applied.
- The desiccant used will need to be either regenerated or replaced periodically, depending on the ambient conditions.
- The storage incompatibilities of chemicals should be observed when storing different chemicals together in a desiccator (i.e. incompatible classes of chemicals should not be stored together in the same desiccator).

Absorption of carbon dioxide

Substances such as alkali and alkaline earth metal hydroxides and oxides absorb carbon dioxide from the air, to give the corresponding carbonates as is described by the following example equations:

$2\ NaOH + CO_2$ à $Na_2CO_3 + H_2O$

$CaO + CO_2$ à $CaCO_3$

$Ca(OH)_2 + CO_2$ à $CaCO_3 + H_2O$

Sodium hydroxide pellets are deliquescent and will absorb water and carbon dioxide so that the pellets become fused together and slushy over time. Degradation of sodium hydroxide makes it difficult to handle and the contamination with water and the carbonate means that it cannot be weighed accurately.

Apart from the difficulties in handling degraded sodium hydroxide, the presence of a significant amount of the carbonate may affect the result of an acid–base titration. For such applications it is preferable to use a fresh batch of sodium hydroxide or to purchase a volumetric standard sodium hydroxide solution from a chemical supplier.

Solutions of hydroxides also absorb carbon dioxide from the air. This is most obvious in solutions of calcium hydroxide (limewater) and barium hydroxide, which form insoluble carbonates that precipitate from the solution. Dilute solutions of hydroxides more readily absorb carbon dioxide than concentrated solutions.

Calcium is oxidised on exposure to air to form calcium oxide which can further react with carbon dioxide to form calcium carbonate. While calcium metal has a grey appearance, formation of the degradation products transforms the grey metal to a white, powdery substance. Calcium which has substantially degraded should be disposed of via a hazardous waste disposal company.

Photochemical reactions

Many organic compounds undergo photochemical reactions on exposure to visible or ultraviolet light. For this reason, such chemicals are supplied in amber bottles and should be stored away from direct sunlight.

Concentrated nitric acid can form nitrogen oxides on exposure to light, imparting a brown colour to the acid. A slight colour change is generally not a problem for school purposes, however, disposal of the acid should be considered if the colour change is significant.

Efflorescent substances

Some hydrated salts are **efflorescent**, which means that they can lose their water of crystallisation to the air. The conditions under which this occurs are specific for the individual chemical. For example, sodium thiosulfate pentahydrate will start to lose its water of crystallisation at 33°C in dry air. Copper sulfate pentahydrate will effloresce at 30°C in dry air, with loss of two molecules of water of crystallisation. The deep blue copper sulfate pentahydrate will thus develop a paler blue, powdery appearance on the surface of the crystals. Again, slight degradation of these chemicals is not usually an issue in schools.

Peroxide forming chemicals

Organic substances such as ethers (e.g. diethyl ether), secondary alcohols (e.g. 2-butanol, 2-octanol), and alkenes (e.g. cyclohexene) have the potential to form peroxides on exposure to air and light. If a sufficient concentration of peroxides is generated, there is the potential for an explosion to occur. Peroxides can form at the junction of the lid and the rim of the bottle so that the friction generated when the lid is opened can initiate an explosion. Many chemicals which are susceptible to the formation of peroxides are supplied with added peroxidation inhibitors to prevent peroxide formation. However, it is possible for all of the inhibitor to be consumed if the substance is very old or sufficiently exposed to air/light. The inhibitor can also be removed through purification of the substance, e.g., by distillation, to give a distillate which is free of inhibitor.

Bottles of peroxide forming chemicals should be inspected prior to use. If white crystals are observed around the lid of the bottle, or if a precipitate or a viscous oily layer is present in the liquid within the bottle, then this indicates that dangerously high levels of peroxide are present and the bottle should not be opened . A bottle showing these signs of peroxide formation should be disposed of via a hazardous waste disposal company.

Chemicals which have the potential to form peroxides should be tested for peroxide concentration periodically and before use. The test can be performed using peroxide test strips for a roughly qualitative result, or the iodide test, which we recommend as the more reliable method. Science ASSIST will soon be publishing an information sheet on the safe storage and handling of peroxide-forming chemicals.

Potassium metal is commercially available as pieces stored under light paraffin oil. Over time, the potassium becomes oxidised through its reaction with oxygen in the air, forming a surface layer of white or grey potassium oxide, K_2O. Over years, the potassium can be oxidised further to the yellow potassium peroxide, K_2O_2, and with further oxidation, the canary yellow potassium superoxide, KO_2, may form. Both the yellow potassium peroxide and the canary yellow superoxide pose an explosion risk in contact with organic materials or when handled or cut. Bottles of potassium metal should be checked periodically for signs of peroxidation. If any yellow peroxidised products are observed, then the bottle should not be opened and should be disposed of via a hazardous waste disposal company.

Note that Potassium is not on our List of recommended chemicals for science in Australian schools 2021 . For further information see a Q&A dedicated to Potassium metal

tert-Butanol or 2-methyl-2-propanol

This alcohol has a melting point of about 25°C so that it in cool weather a bottle of *tert*-butanol can freeze. Observing this for the first time can be alarming as the solid alcohol can be misinterpreted for peroxide formation. The frozen *tert*-butanol can be melted by placing the bottle in a plastic bag in a warm water bath.

Hydrogen peroxide, H_2O_2

Hydrogen peroxide is usually supplied with a stabiliser which reduces its rate of decomposition. Nevertheless, its slow decomposition over time is inevitable. Hydrogen peroxide decomposes to oxygen and water according to the equation:

$2\ H_2O_2$ à $O_2 + 2\ H_2O$

At room temperature, it is estimated that stabilised hydrogen peroxide decomposes at about 0.5% per year. Hydrogen peroxide is supplied in bottles with vented caps to avoid the build up of oxygen in the container.

Hydrogen peroxide should be stored upright in the original container in a cool, dry place away from oxidising agents, combustible materials and alkalis. Light catalyses the decomposition of hydrogen peroxide and therefore it should be stored away from light, especially direct sunlight. Hydrogen peroxide should not be stored in a domestic refrigerator which is not spark-proofed, as the build up of oxygen could pose an explosion hazard.

The decomposition of hydrogen peroxide is accelerated with increased temperature; for every 10°C rise in temperature, the rate of decomposition increases 2 to 3 times. Hydrogen peroxide is also very sensitive to contamination. Contamination by metal salts, even at very low concentrations, will result in fast decomposition of hydrogen peroxide to oxygen and water. To some extent, contamination with any insoluble solid will also lead to decomposition. Hydrogen peroxide is very sensitive to pH, its optimum pH range being pH 3.5 to 4.5. At alkaline pH levels (pH greater than 7), decomposition to oxygen and water is rapid.

The concentration of a hydrogen peroxide solution can be analysed by titration with potassium permanganate (see, for example, https://www.flinnsci.com/hydrogen-peroxide-analysis/vel1253/.

References

Bretherick, L., *Bretherick's Handbook of Reactive Chemical Hazards*, 4th edition, Butterworths, **1990**.

ChemSupply Australia website, (2023), *Safety Data Sheet: Copper sulfate pentahydrate.* Please search the product information page on the website for the current SDS for Copper sulfate pentahydrate https://shop.chemsupply.com.au/

ChemSupply Australia website, (2023), *Safety Data Sheet: Hydrogen peroxide 20-50%*. Please search the product information page on the website for the current SDS for Hydrogen peroxide 20-50% https://shop.chemsupply.com.au/

ChemSupply Australia website, (2023), *Safety Data Sheet: Sodium thiosulfate pentahydrate* Please search the product information page on the website for the current SDS for Sodium thiosulfate pentahydrate https://shop.chemsupply.com.au/

DeLaHunt, John S.; Lindemann, Theodore G. *J. Chem. Health Safety* **2007,** *14* (2), 21.

Flinn Scientific Inc. Video, *Hydrogen Peroxide Analysis*, **2016**, https://www.flinnsci.com/hydrogen-peroxide-analysis/vel1253/

Grubelnik, Andreas; Meyer, Veronika R.; Bützer, Peter and Schönenberger, Urban W., *J. Chem. Educ.*, **2008**, 85 (5), 634.

Queensland Government Department of Education. (2018). *Dangers of prolonged storage of ‘time sensitive’ chemicals*, Retrieved from the Queensland Government Department of Education website: https://education.qld.gov.au/initiatives-and-strategies/health-and-wellbeing/workplaces/safety/resources

Reusch, William, *Virtual Textbook of Organic Chemistry*, **1999**, Photochemistry, https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/photchem.htm

Science ASSIST. (2021). *List of recommended chemicals for science in Australian schools 2021*, Retrieved from the Science ASSIST website, https://assist.asta.edu.au/resource/4669/list-recommended-chemicals-science-australian-schools-2021

Science ASSIST. (2023). *Potassium metal, Science ASSIST Q&A*, Retrieved from the Science ASSIST website: https://assist.asta.edu.au/question/4699/potassium-metal

Silica Gel Australia, 2023, *Silica gel information*, Silica Gel Australia website, https://www.silicagel.com.au/silica-gel-info/

Solvay S.A., Solvay Interox *Hydrogen peroxide Handling and Storage*, **2019**, https://www.solvay.com/sites/g/files/srpend221/files/2019-10/H2O2%20North%20American%20Hydrogen%20Peroxide%20Producers%20Safety%20Standard%20Storage%20a

Answer by Judy Hasse on question Chemical Storage Timeframes

Submitted by on 13 October 2014

If the chemical is a stable inorganic chemical it could be many years. I use the following as guidelines for keeping chemicals. If the container is in good condition and the chemical looks to have its original condition (colour, crystal structure), still reacts as required for pracs and is still needed, then it is kept. If there is any doubt, throw it out. The 5 years probably comes from the requirement to review (M)SDS every 5 years. It doesn't mean the chemical "has gone off", just that there may be new data or information available about the chemical.

Source URL:https://assist.asta.edu.au/question/2497/chemical-storage-timeframes