Caustic Soda

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A major building block in many industrial processes; to be handled with care.

Caustic soda – or sodium hydroxide – is the natural co-product of chlorine production; indeed, the laws of chemistry define that for every tonne of chlorine you produce around 1100 kg of caustic soda as well as 28 kg of hydrogen. Caustic soda is widely used in industrial processes. However, because of its chemical and physical properties, it needs to be handled with proper care.

What is Caustic Soda?

Caustic soda is the common name for the compound sodium hydroxide. This is the natural co-product when chlorine is produced by the electrolysis of sodium chloride. Its chemical formula is NaOH.

"Caustic" (as it is commonly called), is a white solid in its 'pure' form. It is mostly traded as an aqueous solution, typically concentrated to 50%, but many other concentrations are commercially available depending on the application of the compound. Caustic soda is also traded as concentrated solid pellets, flakes or bulk fused (about 98% concentration).

Any solutions are also called "soda lye" which are milky white to yellowish-brown coloured liquids.

Properties

The following properties of this substance are important:

- The product is highly alkaline and strongly hydrophilic. This capacity makes caustic soda extremely corrosive to skin tissue and hazardous to all animal and plant life.
  All direct, unprotected physical contact with the substance should be avoided.
- The substance is moderately toxic, however, the major hazard is its corrosive effects.
- Sodium hydroxide is not volatile or flammable.

Major applications

Sodium hydroxide is a very widely used chemical in numerous applications:

- It constitutes an essential reactant in the production of many useful organic chemicals (accounting for more than 30 % of caustic produced).
- Inorganic chemicals like paints, glass and ceramics and uses in fuel cell production and cosmetics are also very important.
- Paper, pulp and cellulose industries are major users of caustic soda.
- Other areas where caustic is essential are the food industry, water treatment (for the flocculation of heavy metals and acidity control), the soaps and detergents sector, the textile sector (as a bleaching agent), mineral oils (preparation of greases and fuel additives) and the synthesis of the synthetic fibre 'rayon'.
- About four per cent of caustic production is used in the process of refining aluminium from its ore bauxite.
- The remainder of caustic produced (more than 17%) has miscellaneous applications, like the synthesis of pharmaceutical compounds, rubber recycling and the neutralisation of acids.

Human exposure: acute effects

The extremely corrosive character of caustic constitutes its main hazard when humans or animals

are exposed to the concentrated substance. Contact with the eye may cause irreversible severe damage if there is no immediate treatment.

Inhalation is unlikely, because the substance is not volatile. However, if mists of the concentrate are inhaled, severe damage to mucous membranes and the lungs may be caused.

Ingestion of the concentrate can cause major damage to the mucous membranes and all other tissues that come into contact with the product.

As stated before, caustic soda is extremely corrosive to the skin and can cause deep scarring. In this characteristic hides an additional risk; it generally does not cause pain until after major damage has already been done. Contact with skin must lead to irrigation with plenty of water for several minutes whilst removing contaminated clothes.

Strong alkali, like caustic soda, combined with human tissue form soluble compounds results in deep and painful destruction of such tissue.

To be handled correctly

In view of the chemical and physical characteristics of caustic soda, it is obvious that the substance should be handled correctly, using proper techniques, selected materials and protective equipment for those people working with the product. Typical protective equipment for workers will consist of special coveralls, buttoned to the wrist and neck, a full face shield, PVC elbow-length gloves, an apron and rubber boots.

Special care must be given to eye protection; safety glasses are mandatory, especially if the face protection is not completely tight. Water supply should always be available near the point of use, including showers and water eye-bath.

Dilution of caustic should always been done by slowly adding the caustic to the water, with continuously stirring, and *not* water to the caustic.

Metals need to be properly degreased before any introduction of the caustic.

The material to use depends of the temperature and the concentration of the caustic. Carbon steel (below 50-55°C) and stainless steel are used safely for 50% caustic soda piping, valves, tanks and equipment; for temperature above 100°C, nickel alloys and even pure nickel are better. For cold, diluted caustic plastic pipes and tanks can be used.

Any storage tanks should always be installed in containment bunds to prevent emission to the environment; installations where spills are possible (e.g. loading stations) should have a collection system to convey the leaked fluid, after dilution by washing, to a neutralisation unit.

Caustic soda solutions are usually transported in stainless steel road or rail tankers.

In case of caustic soda leak during transportation, environmental protection measures include the containment of the leak with plastic sheets, sand bags, soil etc. After removal of the spilled liquid, contaminated areas can be washed with water or possibly neutralised with a mildly acidic solution.

Chemical reactivity data

The dilution reaction with water produces a lot of heat which can lead to a boiling solution with alkaline droplets projection and reaction with concentrated acids is very violent. Caustic also reacts with aluminium, tin, copper, zinc (galvanised recipients) and their alloys with production of hydrogen and can thus form explosive gas mixtures.

Sodium hydroxide also reacts violently with materials such as chlorinated compounds, oxidisers, organic molecules, and nitro compounds.

The reaction with ammonium and amine compounds can release toxic substances.

Know the hazard, manage the risk

As is the case for many chemicals, it is very important that caustic soda be handled correctly, understanding the hazard and controlling any risk.

This highly useful product can only play its full role as a key chemical in many industrial and mining areas, if it is handled with proper care and professionalism.

Much more about chlorine on www.eurochlor.org.
Chlorine chemistry applications: www.chlorinethings.eu

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