SODIUM SULFITE

INTRODUCTION

Sodium sulfite (Na$_2$SO$_3$) is odourless, colourless or off white compound. It is soluble in water and glycerol. It is insoluble in acetone, other alcohol and most of other organic solvents. Sodium sulfite is a soluble sodium salt of sulfurous acid. It is a part of the flue-gas desulfurization process where sulfur dioxide scrubbing takes place.

Anhydrous sodium sulfite will remain stable in dry air at ambient temperature (100°C) while in moist air it will oxidize to sodium sulfate. If sodium sulfite is heat on above 900°C it decomposed in to sulfur dioxide and sodium oxide. Sulfur is added to sodium sulfite to form sodium thiosulfate. The chemistry of sodium sulfite at acidic pH is same as in case of the sulfur dioxide, bisulfite and metabisulfite.

The sulfite anion structure can be described with three equivalent resonance structures. In each resonance structure, the sulfur atom is double-bonded to one oxygen atom with a formal charge of neutral and singly bonded to the other two oxygen atoms, which each carry a formal charge of -1, together accounting for the -2 charge on the anion. Its structure predicted as trigonal pyramidal, as observed in case of ammonia.

Sodium sulfite has been approved as a food additive in USA since 1664. Generally sulfites were added to fresh foods in restaurants and grocery stores to prevent browning but further the Food and Drug Administration (FDA) banned the use of sulfites in fresh foods in 1986.

MANUFACTURE

Raw material

Basis: 1000kg of sodium sulfite
Sodium carbonate 410kg
Sulfur dioxide
Sodium hydroxide

Reaction

$$2\text{NaOH} + 2\text{SO}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{SO}_3 + \text{CO}_3 + \text{H}_2\text{O}$$

Manufacture process

Block diagram of manufacturing process

Diagram with process equipment

Animation

Sodium carbonate solution was allowed to percolate downward through a series of absorption towers, where sulfur dioxide was passed counter currently. Sulfur dioxide gas enters the absorbing section and meets with the downward flowing liquid. After the series of absorption, the solution leaving the towers was chiefly sodium bisulfite of 27wt% combined sulfur dioxide content while the waste gases were removed from the tower. The solution was then run into a stirred tank where aqueous sodium carbonate or caustic soda was added to the point where the bisulfite was completely converted to sulfite.

The sodium may be filtered if necessary to attain the required product grade. A pure grade of anhydrous sodium sulfate was then charged to the crystallizer where it crystallized above 40°C, since the solubility decrease with increasing temperature.
Various processes have been disclosed where in moist sodium pyrosulfite was stirred in a steam-heated vessel with sodium carbonate. The exothermic reaction is helpful for producing dry product and there so, drying of product is not required.

**Consumption pattern**

It is consumed 60% in sulfite pulping, 15% in water treatment, 12% in photography and 13% in miscellaneous uses.

The different commercial grades of sodium sulfite are shown below:

- **Photographic grade**
  
  It is a white crystalline material which contains 97wt% minimum Na$_2$SO$_3$, 0.5wt% maximum insoluble matter, 0.15wt% maximum alkalinity as Na$_2$CO$_3$, 20ppm maximum iron, 20ppm maximum heavy metals (as Pb), 0.01wt% maximum thiosulfate (as S$_2$O$_3^2-$).

- **Anhydrous technical grade**
  
  It is a white granular material which contains minimum 95.0 - 97.5wt% Na$_2$SO$_3$.

- **Codex grade**
  
  It contains minimum 95wt% Na$_2$SO$_3$, 3ppm mixture arsenic, 10ppm maximum heavy metals (as Pb), 30ppm maximum selenium.

- **Anhydrous technical (by-product) grade**
  
  It is a pink to red-brown powder which contains 89wt% Na$_2$SO$_3$ minimum, 5wt% sodium sulfate.

**Pollution control**

During waste water treatment, small amounts of iron sulfide solid waste produced which is not hazardous but extremely insoluble in water and dilute acid.
Health and safety factors

Sodium sulfite's dust and solutions are irritating to the skin, eyes and mucous membranes. Due to the ingestion of sodium sulfite, gastric irritation results from the liberation of sulfurous acid. Large doses can cause diarrhea as well as disturbance of the nervous system. The lowest lethal value for humans is 500mg/kg.

Engineering aspects

For better efficiency, the process is carried out in a series of absorption tower with a scrubbing section added to the top.

As sodium sulfite decomposed on heating, it was prepared from sulfur dioxide and sodium carbonate or caustic soda. Sodium sulfite was an effective scavenger for use in systems operating below 1,000psi. For pressures above 1,000psi breakdowns may form due to corrosive hydrogen sulfide and/or sulfur dioxide. Due to sodium sulfite, the amount of dissolved solids and the conductivity of the boiler water may increases.

PROPERTIES

- **Molecular formula**: \( \text{Na}_2\text{SO}_3 \)
- **Molecular weight**: 126.04gm/mole
- **Appearance**: White solid
- **Odour**: Odourless
- **Boiling point**: Decomposes (separate into elements)
- **Flashpoint**: Non-flammable
- **Melting point**: 33.4°C (dehydration of heptahydrate)
  500°C (anhydrous)
- **Density**: 2.633gm/cm\(^3\) (anhydrous)
  1.561gm/cm\(^3\) (heptahydrate)
- **Refractive index**: 1.465
- **Solubility**: Soluble in water, glycerol and insoluble in ammonia, chlorine

USES

- The principal use is a film preservative and discoloration preventative
- Used in sodium thiosulfate production
- Used as scavenger agent in photographic industry to protect developer solution from oxidation
- As a bleaching, desulfurizing and dechlorinating agent in textile industry
- In purification of trinitrotoluene (TNT)
- In various chemical manufacturing it is used as a sulfonation and sulfomethylation agent
- Froth flotation of ores, oil recovery, food preservatives and in manufacturing of dyes
- Neutral semi chemical pulping, in acid sulfite pulping, in high yield sulfite cooling, and in some kraft pulping processes
- As an agent in the reduction of chlorine or oxygen in water because dissolved oxygen in boiler water leads to enhance pitting and corrosion
- It competes with bisulfite or sulfur dioxide in removing excess free chlorine from municipal and from waste water
- As a reducing agent in certain photographic fixing baths
- In textile processing, it is used as bleach for wood and polyamide fibres
- As a preservative to prevent dried fruit from discolouring
- For preserving meats and to convert elemental halogens to their respective hydrohalic acids